UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
77 WEST JACKSON BOULEVARD
CHICAGO, IL 60604-3590

June 14, 2019

REPLY TO THE ATTENTION OF
SR-6J

Linda B. Albrecht
Midwest ESSD
US Army Environmental Command
2450 Connell Road
Fort Sam Houston, TX 78234-7664

Subject: **U.S. Army Responses to U.S. EPA Comments on the Draft Final Fiscal Year 2018 Annual Performance Report, Twin Cities Army Ammunition Plant**

Dear Ms. Albrecht:

The U.S. Environmental Protection Agency (EPA) has received and reviewed the U.S. Army's responses to comments (RTCs) on, including the markup (track changes) version of, the Draft Final Fiscal Year 2018 Annual Performance Report, Twin Cities Army Ammunition Plant (FY18 APR), which was prepared by PIKA/ARCADIS for the Commander, Twin Cities Army Ammunition Plant. The RTCs are accepted. EPA has no additional comments on the FY18 APR.

If you have any questions, or require additional information, please feel free to contact me by phone at (312) 353-5577 or by e-mail (barounis.thomas @ epa.gov).

Sincerely,

Tom Barounis

Tom Barounis
Remedial Project Manager

cc: Amy Hadiaris, MPCA
HOA Voscott, PIK-ARCADIS

Twin Cities Army Ammunition Plant

# FISCAL YEAR 2018 ANNUAL PERFORMANCE REPORT

New Brighton/Arden Hills Superfund Site

11 June 2019

# FISCAL YEAR 2018 ANNUAL PERFORMANCE REPORT

New Brighton/Arden Hills Superfund Site

Prepared for:

Commander

Twin Cities Army Ammunition Plant

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Date:

11 June 2019

# CONTENTS

# TABLES

# FIGURES

# APPENDICES

# ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| APR | Annual Performance Report |
| AOP | Advanced Oxidation Potential |
| Army | United States Army |
| AS | air sparging |
| Barr | Barr Engineering |
| BGRS | Boundary Groundwater Recovery System |
| BRAC | Base Realignment and Closure Division |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| cis-1,2-DCE | cis-1,2-dichloroethene |
| COC | contaminant of concern |
| CRA | Conestoga-Rovers & Associates, Inc. (now GHD) |
| DNAPL | dense non-aqueous phase liquid |
| EBS | Environmental Baseline Survey |
| EE/CA | Engineering Evaluation/Cost Analysis |
| ESA | Environmental Site Assessment |
| ESD | Explanation of Significant Difference |
| EW | extraction well |
| FFA | Federal Facility Agreement |
| FS | feasibility study |
| FY | fiscal year |
| GAC | granular activated carbon |
| GOS | TGRS Global Operation Strategy |
| gpm | gallons per minute |
| HRL | Health Risk Limits |
| JV | PIKA Arcadis U.S., Inc. a Joint Venture |
| LUC | land use control |
| LUCRD | land use control remedial design |
| MCL | Maximum Contaminant Level |
| MCLG | Maximum Contaminant Level Goal |

| | |
|---|---|
| MDH | Minnesota Department of Health |
| MNA | monitored natural attenuation |
| MOS | TGRS Micro Operation Strategy |
| MNARNG | Minnesota Army National Guard |
| MPCA | Minnesota Pollution Control Agency |
| MW | monitoring well |
| NB/AH | New Brighton/Arden Hills |
| NBCGRS | New Brighton Contaminated Groundwater Recovery System |
| NBM | New Brighton Municipal |
| NPL | National Priorities List |
| OM | Operational Minimum |
| OS | TGRS Operating Strategy |
| OU | Operable Unit |
| OU1 | Operable Unit 1 |
| OU2 | Operable Unit 2 |
| OU3 | Operable Unit 3 |
| OU1TG | OU1 Technical Group |
| PCE | tetrachloroethene |
| PGAC | permanent granular activated carbon |
| PGRS | Plume Groundwater Recovery System |
| PLC | programmable logic controller |
| PM | preventative maintenance |
| POTW | Publicly-Owned Treatment Works |
| PTA | Primer/Tracer area |
| QAPP | Quality Assurance Project Plan |
| QC | quality control |
| ROD | Record of Decision |
| RPD | Relative Percent Difference |
| scfm | standard cubic feet per minute |
| SDWA | Safe Drinking Water Act |
| Shaw | Shaw Environmental & Infrastructure, Inc. (formerly Stone & Webster) |

| | |
|---|---|
| SVE | soil vapor extraction |
| SWBCA | special well boring and construction area |
| SWCA | special well construction area |
| TCAAP | Twin Cities Army Ammunition Plant |
| TCE/TRCLE | trichloroethene |
| TGRS | TCAAP Groundwater Recovery System |
| USACHPPM | US Army Center for Health Promotion & Preventive Medicine |
| USEPA | United States Environmental Protection Agency |
| UV | Ultra Violet |
| VOC | volatile organic compound |
| Wenck | Wenck Associates, Inc. |
| WWP | Wet Well Pump |
| µg/L | micrograms per liter |

# 1 EXECUTIVE SUMMARY

This Fiscal Year (FY) 2018 Annual Performance Report (APR) summarizes the status of remedy implementation, and addresses how the remedies are performing, for each of the three operable units related to the New Brighton/Arden Hills (NB/AH) Superfund Site. Figure 2-1 shows the approximate locations of the three operable units (OUs). FY 2018 is defined as the period from October 1, 2017 through September 30, 2018.

Records of Decision (RODs) have been signed for each of the three OUs:

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

The RODs, and subsequent Amendments and Explanations of Significant Differences (ESDs), present the major components of the final remedies for the media of concern. This report looks at each of the major components and addresses:

1. Are the remedies being implemented? (Compliance check with the RODs and ROD Amendments)
2. Are the remedies doing what they are supposed to?

Table 1-1 summarizes the status of remedial actions at the end of FY 2018. Following are highlights of the accomplishments for each OU, as well as other activities during FY 2018.

**Operable Unit 1 (OU1)**

OU1 consists of the "north" plume of volatile organic compound (VOC) groundwater contamination. The final remedy for OU1 consists of pumping from six municipal wells (New Brighton Municipal [NBM] wells NBM #3, #4, #5, #6, #14, and #15), treating the extracted groundwater through the Permanent Granular Activated Carbon (PGAC) system, and discharging the treated water to the New Brighton water supply system for distribution as potable water. Routine OU1 remedy pumping was ceased on April 15, 2015, with notice to the United States Environmental Protection Agency (USEPA)/Minnesota Pollution Control Agency (MPCA), due to detection of 1,4-dioxane in the Prairie du Chien and Jordan Aquifer municipal wells. Since the PGAC does not remove 1,4-dioxane, a "remedy time-out" was placed and New Brighton switching to preferential extraction from deep aquifer wells while evaluating removal technologies. In early summer 2016 New Brighton switched to the City of Minneapolis water system (Mississippi River). Other remedy components include providing alternate water supply and/or well abandonment to affected private wells, and drilling advisories for new well construction. Highlights for FY 2018 are:

- A new treatment technology using Ultraviolet (UV)/Peroxide Advanced Oxidation Process (AOP) was selected during a pilot study in 2015-2016 to remove both VOCs and 1,4-dioxane. Upgrades (including implementation of a full scale AOP system) October. A formal change to the Comprehensive Environmental Response, Compensation, and Liability Act remedy regarding AOP treatment is still required. .
- The Minnesota Department of Health (MDH) Special Well Construction Area (SWCA) remains in effect. The MDH has the regulatory responsibility to assure that wells constructed in the advisory area

meet appropriate well construction and human health requirements. In FY 2018, there were no new recommendations for abandonment or alternate water supply.

**Operable Unit 2 (OU2)**

OU2 is defined as the area occupied by Twin Cities Army Ammunition Plant (TCAAP) in 1983, when the NB/AH Superfund Site was placed on the National Priorities List. The remedial action requirements were set forth in the OU2 ROD (1997), ROD Amendment #1 related to Site C-2 (2007), ROD Amendment #2 related to Site I groundwater (2009), ROD Amendment #3 related to various soil sites (2009), ESD #1 related to groundwater (2009), ESD #2 related to various soil sites (2009), ROD Amendment #4 related to Building 102 shallow groundwater, aquatic sites, and various soil sites (2012), and ROD Amendment #5 related to various soil sites (2014). Highlights for activities within OU2 during FY 2018 are:

- Shallow Soil Sites: No activities other than ongoing United States Army (Army) implementation of land use controls (LUCs).
- Deep Soil Sites: No activities other than ongoing Army implementation of LUCs.
- Site A Shallow Groundwater
  - In accordance with the Site A Shallow Groundwater: 10-Year Evaluation Report (Wenck Associates [Wenck] 2008a), and with regulatory approval, the groundwater extraction system was shut down on September 24, 2008 to evaluate monitored natural attenuation (MNA) through abiotic degradation as a potential remedy component in lieu of groundwater extraction and discharge. The groundwater system has remained in stand-by mode in case MNA does not adequately control plume migration and one or more extraction wells need to be restarted. In late 2015, following review of FY 2015 groundwater monitoring results, MNA was deemed an acceptable remedy by the USEPA and MPCA. The Army, USEPA, and MPCA drafted a ROD amendment in FY 2017 to document the change in this remedy component. Formal approval of the ROD amendment was received during FY 2018.
  - Monitoring results from three of the four contingency wells located along the north side of County Road I did not exceed the approved trigger levels, which are equal to the cleanup levels for all Site A contaminants of concern. Well 01U902 exceeded the trigger level in FY 2018 and actions are presented in Section 6.5.
  - The MDH SWCA remains in effect. In FY 2018, there were no locations identified in need of well abandonment or alternate water supply.
- Site C Shallow Groundwater
  - In accordance with the Site C Groundwater Extraction System Evaluation Report (Wenck 2008c), and with regulatory approval, the groundwater extraction system was shut down on November 13, 2008. System operation ceased because the lead concentrations in the groundwater plume contacting extraction wells  are now below groundwater cleanup levels.
  - Only monitoring wells located near the source area still exceeded the groundwater cleanup level for lead in FY 2018.
  - None of the groundwater contingency locations exceeded the approved lead trigger levels in FY 2018.

  - Continued monitoring is recommended with follow-up discussions to evaluate formal changes to the remedy to eliminate the groundwater extraction component.
- Site I Shallow Groundwater
  - All Site I Unit 1 monitoring wells abandoned in FY 2014 to allow demolition of building 502 and related soil cleanup activities by Ramsey County; therefore, no new groundwater quality data are available to evaluate.
  - Previous investigations show Unit 1 groundwater is discontinuous and does not extend beyond Site I; rather, Unit 1 impacts migrate downward into Unit 3, which is hydraulically influenced by TCAAP Groundwater Recovery System (TGRS) operation.
  - Monitoring well 01U667 will be reinstalled following redevelopment related grading to occur in the area. The well was scheduled to be reinstalled in 2017 but was delayed due to the extent of grading to be completed. The well will be reinstalled upon completion of the regrading and related construction at the Site.
- Site K Shallow Groundwater
  - The Site K groundwater extraction trench and treatment system continued to operate as designed. For FY 2018, the system captured and treated 4,667,972 gallons of water and maintained a continuous zone of capture downgradient of the former Building 103. A total of 7.9 pounds of VOCs were removed in FY 2018.
  - Groundwater samples were collected from all eight wells scheduled for sampling in FY 2018. With the exception of relatively stable trichloroethene (TCE) concentrations in 01U615, the overall trend throughout Site K Unit 1 monitoring wells continues to show a gradual decrease in TCE concentrations over the last twenty plus years of sampling.
  - The extracted water was treated and discharged to Rice Creek in compliance with discharge criteria.
  - Fifteen Unit 1 wells at Site K were abandoned as part of redevelopment activities in FY 2014; three of these wells are scheduled to be reinstalled upon the completion of the regrading and related construction. One Unit 1 Site K well was abandoned in FY 2017 as part of redevelopment activities and will not be reinstalled.
- Building 102 Shallow Groundwater
  - VOC concentrations were generally similar to those observed in the prior year.
  - The well adjacent to Rice Creek continued to show shallow groundwater discharging to Rice Creek below the Site cleanup levels.
  - Monitoring wells were sampled to confirm the FY 2017 results which suggested 1,4-dioxane is not present in Building 102 shallow groundwater. The FY 2017 sampling results were consistent with the FY 2015 and FY 2016 results for 1,4-dioxane, except at well 01U048, where 1,4-dioxane was detected at 1.1 micrograms per liter (µg/L), which is above the MDH Health Risk Limit (HRL). There were no detections of 1,4-dioxane in Building 102 shallow groundwater in FY 2018.
- Aquatic Sites: No activities other than ongoing discussion of Round Lake.
- Deep Groundwater

- The TGRS operated in accordance with the OU2 ROD.
- The TGRS operated at a rate sufficient to support the conclusion that the OU2 5 µg/L TCE source area footprint is hydraulically influenced respective of the OU2 ROD. In FY 2018, the total extraction well water pumped averaged 1,746 gallons per minute (gpm), which exceeds the Global Operation Strategy (GOS) Operating Minimum (OM) (1,745 gpm). In March, April, May, June, July, and September 2018, the TGRS extraction rate was less than the GOS minimum due to communication issues between the programmed logic controller (PLC) and Building 116. The communication line was damaged during construction in the fall of 2017.
- In FY 2018, the TGRS extracted and treated approximately 917,437,500 gallons of water. The mass of VOCs removed was 1,911 pounds, 77 pounds less than FY 2017. The total VOC mass removed by the TGRS through FY 2018 is 218,660 pounds.
- Groundwater analytical data shows a continued general decrease in TCE concentration. This decrease demonstrates that the TGRS is removing VOC mass from the aquifer.
- Effluent VOC concentrations were below contaminant specific requirements for all sampling events.
- Sampling for 1,4-dioxane continued in FY 2018. Sample results were similar to that reported in FY 2015, FY 2016, and FY 2017.

**Operable Unit 3 (OU3)**

OU3 contains the South Plume of VOC groundwater contamination. Overall, the statistical evaluation of groundwater data collected in FY 2018 indicates stable to declining concentration trends at the center and edge of the South Plume. 1,4-dioxane sampling continued in FY 2018 with results similar to FY 2015, FY 2016, and FY 2017.

**Other Investigation and/or Remediation Activities Not Prescribed by a Current ROD**

- Round Lake Supplemental Remedial Investigation and Feasibility Study
    - After a series of conference calls held in attempt to resolve the informal dispute between the Army, USEPA, and MPCA regarding Round Lake ecological risks and commensurate remedy, the USEPA Region 5 Federal Facilities Chief and Headquarters Department of Army personnel reached an agreement on September 20, 2016. Per the agreement, a revised Final Supplemental Remedial Investigation and Feasibility Study for Round Lake was prepared and submitted to the USEPA and MPCA on September 7, 2018. After formal regulatory approval, the Draft Final Proposed Plan will be submitted followed by a public meeting and Draft Final ROD.

# 2 INTRODUCTION

## 2.1 Purpose

The Annual Performance Report (APR) is intended to both summarize the status of remedy implementation and address remedy performance. For FY 2018, remedial actions at the New Brighton/Arden Hills (NB/AH) Superfund (Site) extend from October 1, 2017 through September 30, 2018. Additionally, the NB/AH Site is divided into three designated Operable Units: (OU)1, OU2, and OU3 (Figure 2-1). OU1 encompasses off-site deep groundwater sometimes referred to as the North Plume. OU2 includes soil, sediment, surface water, and groundwater contamination in the area that comprised the Twin Cities Army Ammunition Plant (TCAAP) in 1983, when the NB/AH Site was placed on the National Priorities List (NPL). OU2 also includes the Site A groundwater plume that extends off the north end of the federally-owned property. OU3 consists of off-site deep groundwater sometimes referred to as the South Plume. A Record of Decision (ROD) was developed and signed for each OU:

- OU1 ROD signed 1993, Amended 2006;
- OU2 ROD signed 1997, Amended 2007, 2009, 2012, and 2014; 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. Monitoring activities and submittal of this APR are in fulfillment of the Federal Facility Agreement (FFA) signed in 1987 by the United States Army (Army), United States Environmental Protection Agency (USEPA), and Minnesota Pollution Control Agency (MPCA) with performance assessment answered via two questions:

*1. Are all of the remedies being implemented? (Compliance check with the RODs)*

*2. Are the remedies performing as required?*

For each OU, this APR answers the questions posed above by evaluating the major components of the selected remedies of each ROD (and subsequent modifications). Performance standards are then presented for each major remedy component and subsequently used to evaluate successful implementation or completeness. For some remedy components, performance standards are clearly defined in the RODs (soil or groundwater cleanup levels). For others (alternate water supply) performance standards are less clear but may have been agreed within Work Plans or design documents. With performance standards identified, the APR then addresses both questions discussed above through a series of sub-questions, written to facilitate a focused and user-friendly document promoted, as possible, in the form of figures and/or graphs.

In addition to reporting on FY 2018, proposed future monitoring is also presented (Appendix A), with proposed changes in monitoring locations and/or sampling frequencies highlighted in yellow. Monitoring covers a rolling 5-year time span (i.e., currently FY 2018 through FY 2022 where next year FY 2018 will drop off and FY 2023 will be added).

This document represents collaboration by the Army and Northrop Grumman Innovation Systems (Northrop Grumman; formerly Orbital ATK). On behalf of the Army, PIKA Arcadis U.S., Inc., a Joint

Venture (JV) prepared Sections 2 through 7, 10, 11 and 14. On behalf of Northrop Grumman, GHD (formerly Conestoga-Rovers & Associates, Inc. [CRA]) prepared Sections 8, 9, 12 and 13. JV and GHD both contributed to the Executive Summary.

## 2.2 Brief Overview of TCAAP

TCAAP was constructed between August 1941 and January 1943 in the northern portion of the Minneapolis – St. Paul metropolitan area, in Ramsey County, surrounded by the cities of New Brighton, Arden Hills, Mounds View, and Shoreview, Minnesota (Figure 2-1). TCAAP primarily produced and proof-tested small-caliber ammunition and related materials for the Army. Other uses included manufacture of munitions-related components, handling/storage of strategic and critical materials for other government agencies, and various non-military activities. Production began in 1942, and operations alternated between periods of activity and standby related to wars until manufacturing ceased in 2005. During active periods, solvents were used as part of some manufacturing operations. Disposal of solvents and other wastes resulted in soil and groundwater contamination that migrated beyond the original TCAAP boundary.

Groundwater impacts were first discovered in July 1981, leading to soil and groundwater investigations on and off-Site. In 1983, it was determined the source of impacts and other areas of affected groundwater contamination were from TCAAP, which was placed on the NPL denoted as the NB/AH Superfund Site.

Several known and potential contaminant source areas on the TCAAP property were initially identified within OU2: Sites A, B, C, D, E, F, G, H, I, J, K, 129-3, 129-5, and 129-15 (Figure 2-2). The 1997 OU2 ROD specified requirements for each site except Site F (which was addressed under the Resource Conservation and Recovery Act prior to 1997) and Site J (a sewer line determined not to have a contamination release). Additionally, other areas have also undergone investigation and/or remediation, namely the Grenade Range, Outdoor Firing Range, Trap Range, 135 Primer/Tracer Area (PTA) (and adjacent stormwater ditch), 535 PTA, Water Tower Area, Environmental Baseline Survey (EBS) Areas, and Building 102. These areas are also shown on Figure 2-2.

Since 1983 the size of TCAAP has periodically shrunk due to property transfers. Some property has been transferred out of federal-ownership to Ramsey County and the City of Arden Hills. Other property is still owned by the federal government, but control has been reassigned to the Army Reserve or the National Guard Bureau, which has licensed property to the Minnesota Army National Guard (MNARNG). Figure 2-3 presents property under federal ownership at the end of FY 2018, along with the organizations responsible for control. The minimal remaining TCAAP (BRAC-controlled) property is currently in the process of being transferred out of federal ownership. It is likely that within the next few years, there will no longer be an organization or property called TCAAP. These property transfers do not alter the responsibilities of the Army under the FFA.

## 2.3 Hydrogeologic Units and Well Nomenclature

For purposes of studies and work related to the NB/AH Superfund Site, four hydrogeologic units have been designated: Unit 1 through Unit 4, described in Appendix B, along with well designation nomenclature overview. A well-designation cross-reference guide is included in Table B-1 within Appendix B. The well index includes all Army owned or used wells to gather groundwater elevation or water quality data, sorted by Minnesota unique number. Well information includes the Army designation (Installation Restoration Data Management Information System number), Minnesota unique number, and any other name(s). Well locations included in the monitoring plan are shown on Figure B-2 (OU1/OU3 wells) and Figure B-3 (OU2 wells) in Appendix B. With a known well name, the location can be identified using the “Edit, Find” or “Edit, Search” function and typing in the well name, which will highlight the desired well name on the figure. Available information concerning a well, including well logs and other information, can be viewed in the Appendix B Attachment, which is sorted by the Minnesota unique number. See instructions in Appendix B for more information.

## 2.4 Data Collection, Management, and Presentation

Performance monitoring data were collected in accordance with the FY 2018: Monitoring Plan for Groundwater Monitoring Wells, Monitoring Plan for Remedial Treatment Systems, Monitoring Plan for Surface Water and New Brighton Water System Sampling and Analysis Plan. Data were collected by the JV on behalf of the Army, GHD on behalf of Orbital ATK, and Barr Engineering (Barr) on behalf of the City of New Brighton. Data collection, management, and presentation are discussed in Appendix C. Lastly, comprehensive groundwater levels and quality databases from 1987 through FY 2018 are contained in Appendix D.1.

**Are the data complete and representative (are we making decisions based on complete and technically-sound information)?**

Yes. The data were collected in accordance with the FY 2018 Monitoring Plan and verified and validated in accordance with the Quality Assurance Project Plan (QAPP) for Performance Monitoring (Pika-Arcadis JV 2016), which is updated as appropriate.

Data tables in the various report sections and the comprehensive water quality databases (Appendix D.1) show the assigned data qualifiers as a result of data verification and/or data validation. The data qualifiers assigned to FY 2018 data are explained in the data table footnotes. Data verification (performed on 100% of the data) and data validation (performed on 100% of 1,4-dioxane data and a minimum of 10% of the data, except at Site K) were provided to the USEPA and MPCA via submittal of quarterly Data Usability Reports covering FY 2018 information. The final MPCA/USEPA approval letter for the FY 2018 Data Usability Reports is included in Appendix C.3.

Regarding completeness, Appendix C.2 summarizes any deviations from the FY 2018 Monitoring Plan. The emergence of 1,4-dioxane in 2015 prompted substantial changes in FY 2016, which continues to be carried over. The field and laboratory completeness goals for performance monitoring are both 95%, except for TCAAP Groundwater Recovery System (TGRS) effluent, Site K effluent, and well inventory samples, for which field and laboratory completeness goals are 100%. Aside from two wells that were not operational and therefore not able to be sampled, actual field and laboratory completeness were both 100%, meeting overall completeness goals (dry, frozen, or inoperative wells were not considered as missed samples, nor owner nonresponsive or refused sample collection). Also, the actual field and laboratory completeness for the subset of samples with 100% completeness goals was successful at 100%.

Regarding Quality Control (QC) samples, the QAPP specifies field duplicates, equipment rinse blanks, and matrix spike/matrix spike duplicates are to be collected at overall frequencies of 10%, 10%, and 5%

respectively. Actual QC sample frequencies met these goals, with the exception of equipment rinse blanks, with respective frequencies of 12%, 9% and 6%.

With regard to data validation, the performance monitoring QAPP specifies that data validation be completed at an overall rate of 10%, with 100% validation of 1,4-dioxane data and well inventory samples. The actual validation rate for VOCs far exceeded 10%, and all data requiring 100% data validation were fully validated, meeting the specified validation rates for performance monitoring.

FY 2018 data are deemed to be representative and meet data quality objectives based on: 1) adherence to QAPP-specified sampling and laboratory analytical procedures; 2) completion of data verification and data validation; and 3) comparability to historical results (any substantial deviations from historical and/or anticipated results are discussed within the site-specific sections of this APR).

The wells sampled by the JV on behalf of the Army during the FY 2018 annual sampling were sampled using standard purge methods and a new method in OU1: OU1 wells were sampled via no-purge methodology using a HydraSleeve™ and OU2 wells were sampled using a peristaltic pump and low-flow methodology. Historically, all wells were sampled using the standard purge method which is time consuming, creates large amounts of purge water, and requires field staff to deploy heavy pumps, posing an unnecessary health and safety risk. A side-by-side comparison study was conducted with at least 5% of wells in each OU being sampled using both the standard purge method and the low or no method. In total, 14 wells were comparison sampled during the FY 2018 event. All sampling equipment, including submersible pumps, tubing influent, and HydraSleeves™, were positioned in the midpoint of the screen or open interval. OU1 wells were first sampled using standard purge methodology. Then a HydraSleeve™ was deployed and left in the well for at least 72 hours while the well equilibrated. Shallow groundwater methodologies were not conducted in a specific order as both methods pull water directly from the formation. All sampling was performed in accordance with applicable standard operating procedures and QAPP guidance.

Relative Percent Difference (RPD) was selected as the point of comparison using the following equation:

$$RPD = \frac{concentration\ by\ standard\ purge - concentration\ by\ new\ method}{average\ of\ concentrations\ by\ standard\ purge\ and\ new\ methods}$$

A 35% RPD is considered the industry standard for duplicates and was therefore used to determine whether the new methods provided similar analytical results. If a comparison was above the 35% RPD threshold, historical analytical trends, contaminant of concern (COC) concentrations, and quality of the well were considered. A number of wells in the comparison study have COC concentrations below 5 µg/L; RPD results above 35% are still considered acceptable for these wells and are evaluated on an individual basis, as it often represents a difference of only 1 to 2 µg/L. 83% of constituent pairs with COC concentrations above 5 µg/L had RPD results below 35%.

Of the 14 wells sampled, six wells had all constituents below 35% RPD: 01U139, 01U584, 04J847, 04J849, 04U849, and 409550. Analytical results and RPD calculations are presented on Table 2-1. Wells 01U563, 03L822, and 03L841 have COC concentrations below 5 µg/L and therefore the RPD is not representative of a significant difference in results between the previous and new sampling methods. Wells 01U355 and 04U843 had RPD results greater 35%; however, the new method yielded higher COC concentrations than the previous method. This is likely due to the standard purge method mixing impacted and non-impacted groundwater and resulting in a diluted sample.

Well 04U847 had RPD results ranging from 38% to 99%. This well is known to have a caved-in interval, which leaves only 7 feet of open interval accessible for sampling. Over 60 feet of open interval is below the bedrock bridge. Given that 04U847 is the most impacted well in OU1, it is recommended that the well be repaired so the remainder of the formation is accessible for sampling. This well will continue to be sampled using stand purge methodology and no-purge sampling will be revisited as an option if the well is repaired.

94% of constituent pairs have either COC concentrations above 5 µg/L, the new method yielded more conservative analytical results, or the RPD results are below 35%. Therefore HydraSleeve™ and low-flow sampling are deemed acceptable methods for sampling, with the exception of 04U847 which will continue to be sampled using the standard purge method.

# 3 OPERABLE UNIT 1: DEEP GROUNDWATER

The 1993 OU1 ROD was amended in 2006 to formalize adoption of groundwater quality statistical analysis. Primary elements of the OU1 ROD are as follows (amendment changes in italics):

1. Providing alternate 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 New Brighton Contaminated Groundwater Recovery System* (NBCGRS), subject to the following:
    a. the initial aggregate groundwater extraction rate shall be consistent with long-term NBCGRS operating history;
    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 Feasibility Study (FS) that was the basis for the original remedy selection;
    c. future changes to the aggregate or individual well extraction rates shall be made 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;
    d. future changes to the aggregate or individual well extraction rates shall be made 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;
4. Future changes to the aggregate or individual well extraction rates shall be made 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 Pumping the extracted groundwater to the permanent granular activated carbon (PGAC) Water Treatment Facility in New Brighton for removal of volatile organic compounds (VOCs) by a pressurized granular activated carbon (GAC) system.
5. Discharging all treated water to the New Brighton municipal distribution system.
6. *Monitoring the groundwater to verify effectiveness of the remedy through measurement of overall plume shrinkage (geographically) and decreasing contaminant concentrations*.

Requirement No. 6 is met by evaluating analytical groundwater 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 the USEPA and MPCA). The statistical analysis is conducted annually and is reported in the APR.

The OU1 remedy encountered a new and substantial issue in FY 2015 that has continued to affect remedy performance. In early 2015, the City of New Brighton was notified by the Minnesota Department of Health (MDH) that an emerging contaminant, 1,4-dioxane, had been detected in New Brighton's water supply (with detections up to 6.8 micrograms per liter [µg/L]). The NBCGRS wells extract groundwater from the Prairie du Chien and/or Jordan Aquifers (Upper and Lower Unit 4). Concentrations of 1,4-dioxane in samples collected from New Brighton's deeper municipal wells (Mount Simon Aquifer) were non-detect. Currently, no 1,4-dioxane federal drinking water standard exists; however, a state MDH Health Risk Limit (HRL) of 1 µg/L is in place, with most of the 1,4-dioxane concentrations in samples collected from the NBCGRS exceeding the MDH HRL. A ‘remedy time-out’ was placed, ceasing NBCGRS operation on April 15, 2015. The City switched to preferential extraction from deep aquifer wells while evaluating removal technologies. A pilot study report for Advanced Oxidation Technology for treatment of 1,4-dioxane was completed in August 2016.

A preliminary design review was held with the Army and Regulators in December 2016. Barr Engineering was awarded a contract in May 2017 and began the design process for installation of Ultraviolet Reactor(s) to treat 1,4-dioxane at the NBCGRS. A new treatment technology using UV/Peroxide Advanced Oxidation Potential was selected for pilot study in 2017, with upgrades to the New Brighton water treatment plant completed in November 2018 when pumping from six municipal wells was restarted. The six major components of the remedy prescribed by the amended ROD are evaluated below, including discussion of the effects of the remedy time-out noted above.

## 3.1 Remedy Component #1: Alternate Water Supply/Well Abandonment

**Description: “**Providing an alternative water supply to residents with private wells within the North Plume.” (OU1 ROD, page 2)”.

- Clarified by the *OU1 Alternate Water Supply Plan* (Montgomery Watson 1995) to delete “residents with” because the remedy applies to other wells in addition to residential wells. The plan also lists the criteria for identifying the wells that are eligible for an alternate water supply.
- Clarified by the *OU1 Alternate Water Supply Plan* to also include well abandonment.
- Clarified by the *OU1 Alternate Water Supply Plan* (page i-2) to also encompass OU3 and the OU2 Site A shallow groundwater plume.

**Performance Standard (how do you know when you’re done):**

For alternate water supply, when the owners of all wells that meet all the following criteria have been offered and provided with an alternate water supply (or when the well owners have rejected the offers):

i. The well is located within the area affected by groundwater plumes that originate at OU2, as shown on Figures E-1, E-2 and E-3 in Appendix E; and
ii. The well is completed in an affected aquifer; and
iii. The well contains detectable concentrations of the NB/AH Superfund Site-related COCs identified on page 18 of the OU1 ROD (or page 26 of the OU3 ROD, or Table 1 of the OU2 ROD, as appropriate for the well location); and
iv. The well is used in a manner to cause exposure (uses are defined in the *OU1 Alternate Water Supply Plan*); and
v. The well owner does not already have an alternate water supply.

If eligible well owners refuse the offer to have an alternate water supply provided, this also satisfies the performance standard.

For well abandonment, when the owners of all wells that meet all the following criteria have been offered and provided abandonment (or when the well owners have rejected the offers):

i. The well is located within the area affected by groundwater plumes that originate at OU2; and

ii. The well is completed in an affected aquifer; and

iii. The well contains detectable concentrations of the NB/AH Superfund Site-related COCs identified on page 18 of the OU1 ROD (or page 26 of the OU3 ROD, or Table 1 of the OU2 ROD, as appropriate for the well location); and

iv. The well was constructed prior to the MDH SWCA advisory; and

v. The well is being used by the well owner or use was discontinued due to contamination; and

vi. The well is used in a manner to cause exposure (uses are defined in the Alternate Water Supply Plan).

If eligible well owners refuse the offer for abandonment, this also satisfies the performance standard. An exception to abandonment would be if the well is needed for groundwater monitoring.

Also, note that per Appendix E, program requirements for both alternate water supply and well abandonment have been clarified such that a well should contain a cleanup level exceedance (or an additivity of 1.0, similar to the MDH Hazard Index calculation), rather than merely “detectable concentrations” as noted above. On a case-by-case basis, review by the Army, USEPA, and MPCA could lead to an Army offer for alternate water supply and/or well abandonment for a given well with detectable concentrations that do not exceed a cleanup level (or additivity criteria), particularly if that well is used to supply drinking water.

**Is this remedy component being implemented?**

Yes. The Alternate Water Supply and Well Abandonment Program has been implemented and is an ongoing, Army maintained program. The process of identifying wells eligible for alternate water supply and/or abandonment is accomplished by maintaining a “well inventory” (Appendix E). The well inventory is a database that was initially developed in 1992 and has been periodically updated since (now annually as part of the APR). For the purposes of the well inventory, a study area was established to encompass the groundwater plume (same area as the MDH SWCA). The well inventory is intended to include all wells within the study area, whereas areas of concern are defined by the edge of the groundwater plume, plus an additional ¼-mile buffer. 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. Wells in categories with the potential to be impacted are periodically sampled to see if they qualify for alternate water supply and/or abandonment. Thus, maintenance of the well inventory consists of the following tasks:

1. Check if the area of concern needs to be adjusted based on the extent of contamination,
2. Check if there are any previously unknown wells to be added to the database (coordination with the MDH as described in Appendix E),
3. Sample wells on a prescribed schedule,
4. Take the appropriate course of action per results,

5. Update the well inventory database with any new information (e.g., water quality results, owner information, construction information, well re-categorizing),
6. Report findings in the APR.

The following questions and answers summarize developments since the last APR with respect to OU1.

**Did the area of concern within OU1 change during FY 2018, as defined by the 5 µg/L contour line?**

As shown on Figure 3-1, the area of concern did not change significantly during FY 2018. The well inventory study area encompasses the FY 2018 area of concern.

**Were any additional water supply wells discovered within the area of concern for OU1 that are completed within an aquifer of concern?**

No. See Appendix E for additional information.

**Were any water supply wells within the area of concern for OU1 sampled during FY 2018 (outside of those included in the OU1 performance monitoring plan)? If yes, what were the findings?**

No. The next comprehensive sampling event for water supply wells within the OU1 area of concern is scheduled for FY 2020.

**Were any well owners offered an alternate water supply and/or well abandonment during FY 2018?**

No.

**For OU1, are there any well owners that meet the criteria, but have not yet been provided an alternate water supply?**

No.

**For OU1, are there any wells that meet the criteria, but have not yet been abandoned?**

No.

**Is any sampling of water supply wells (excluding those included in the OU1 performance monitoring plan) proposed prior to the next report?**

No. FY 2019 is not a scheduled sampling event for inventory wells, as shown in Appendix A.1. The next major sampling event is scheduled for FY 2020.

**Are there any changes or additional actions required for this remedy component?**

No.

## 3.2 Remedy Component #2: Drilling Advisories

**Description:** "Implementing drilling advisories that would regulate the installation of new private wells within the North Plume as a SWCA." (OU1 ROD, page 2)

**Performance Standard (how do you know when you're done):**

For initial implementation, when the MDH has issued a SWCA Advisory. Implementation will continue until such time that the groundwater concentrations are below the cleanup levels.

**Has the MDH issued a SWCA Advisory?**

Yes, in June 1996. In June 1999, the MPCA requested the MDH extend the SWCA boundary further southwest to the Mississippi River and Marshall Avenue ensuring the southern boundary fully encompassed the plume. The SWCA also covers OU3 and, as of April 2016, all of OU2. The current boundary of the SWCA is shown on Figure E-1 (Appendix E).

**Are any changes or additional actions required for this remedy component?**

No.

## 3.3 Remedy Component #3: Extract Groundwater

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

1. The initial aggregate groundwater extraction rate shall be consistent with the long-term operating history of the NBCGRS;
2. 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;
3. 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;
4. 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 5-2 & 5-3).

Through January 2008, the remedy component consisted of recovering deep (Unit 4) groundwater using three primary City of New Brighton wells (NBM #4, #14, and #15) with three alternate wells (NBM #3, #5, and #6). NBM #3 and #4 were existing wells completed in both the Prairie du Chien and Jordan. NBM #5 and #6 were existing wells completed in the Jordan. NBM #14 and NBM #15 were constructed in the Prairie du Chien as part of the remedy and began pumping in December 1996 and March 1998, respectively. The locations of the recovery wells are shown on Figure 3-1.

The extracted groundwater is used as part of the New Brighton water supply system (except during the current remedy time-out), and as such, New Brighton took the lead on design and construction of the system and is responsible for system operation. New Brighton contracted Barr to provide design and construction oversight services. The federal government is paying for the OU1 remedy.

In 2006, New Brighton proposed to the Army modifying the agreement between the two parties to allow more flexibility in how they operate the NBCGRS, and to increase removal of contaminant mass from the aquifer. In November 2007, the USEPA and MPCA provided consistency approval of the revised pumping rates. Appendix A.5 (Table D-1 and Table D-2 from the settlement agreement between the Army and New Brighton) presents the new pumping rates in effect as of January 2008.

The revised pumping approach does not affect the approved statistical analysis used to evaluate the effectiveness of the remedy as set forth by the OU1 ROD Amendment. The Army has made it clear to

New Brighton that if the changes cause statistical evaluation results that are not in compliance with the OU1 ROD Amendment, the pumping allocations will revert to the previous scheme.

**Performance Standard (how do you know when you're done):**

When the NBCGRS is operating consistent with long-term NBCGRS operating rates.

**During FY 2018, did the OU1 extraction system operate per the New Brighton operational plan and consistent with past operations?**

No. As discussed above, 1,4-dioxane detections in the NBCGRS wells caused pumping cessation on April 15, 2015, including the Fridley Interconnection. Based on past operations, the target average daily pumping rate is 3.168 million gallons per day (Appendix A.5). In FY 2018, the NBCGRS was in a remedy time-out, but began operation again in November 2018. Hence, FY 2018 pumping did not meet targeted extraction.

**Are any changes or additional actions required for this remedy component?**

Yes. The City of New Brighton will continue the process of designing and installing Ultraviolet Reactors for Advanced Oxidation to treat 1,4-dioxane, enabling restart of the groundwater extraction remedy.

## 3.4 Remedy Component #4: Removal of VOCs by GAC

**Description:** "Pumping the extracted groundwater to the PGAC Water Treatment Facility in New Brighton for removal of VOCs by a pressurized GAC system." (OU1 ROD, page 2)

Treatment by the PGAC (along with iron and manganese removal and chlorination) makes the recovered groundwater suitable for municipal drinking water purposes, with respect to VOCs. The PGAC is located approximately one-third mile south of Interstate 694 near Silver Lake Road. The City of New Brighton is responsible for operation and maintenance of the PGAC, with cost reimbursement from the Army for the operations related to the remedy.

**Performance Standard (how do you know when you're done):**

When the treated water meets the MCL and non-zero Maximum Contaminant Level Goals (MCLGs) established by the Safe Drinking Water Act (SDWA) for the chemicals of concern, as identified on page 18 of the OU1 ROD.

**Did the treated water meet the MCLs and non-zero MCLGs established by the SDWA for the OU1 chemicals of concern?**

Not applicable. As the NBCGRS did not operate in FY 2018, treated water samples could not be collected and evaluated for compliance. Some very limited pumping occurred for non-supply plant operations (e.g., filter backwashing).

**Is any sampling of the treated water proposed prior to the next report?**

Sampling of the treated water will resume in FY 2019 because  the NBCGRS began operation again in November 2018. .

**Are any changes or additional actions required for this remedy component?**

Yes. The City of New Brighton will continue with its process of designing and installing Ultraviolet Reactors for Advanced Oxidation treatment so the water treatment remedy component can resume. Note that this remedy component will need to be modified in a pending ESD such that “removal of VOCs by GAC” will become “removal of VOCs and 1,4-dioxane by Advanced Oxidation.”

## 3.5 Remedy Component #5: Discharge of Treated Water

**Description:** “Discharging all of the treated water to the New Brighton municipal distribution system” (OU1 ROD, page 2).

**Performance Standard (how do you know when you’re done):**

When the connection to the New Brighton municipal supply system has been completed and water is being discharged.

**Is the treated water being discharged to the New Brighton municipal distribution system?**

No. As a remedy time-out is still in place, no water was treated or discharged in FY 2018.

**Are any changes or additional actions required for this remedy component?**

Yes. The City of New Brighton will continue with its process of designing and installing Ultraviolet Reactors for Advanced Oxidation treatment at the NBCGRS to treat 1,4-dioxane so the groundwater discharge remedy component can resume.

## 3.6 Remedy Component #6: Groundwater Monitoring with Verification of Continuing Aquifer Restoration

**Description:** “Monitoring the groundwater to verify the effectiveness of the remedy through measurement of overall plume shrinkage (geographically) and decreasing contaminant concentrations” (2006 OU1 ROD Amendment, page 5-3).

**Performance Standard (how do you know when you’re done):**

When performance groundwater monitoring verifies aquifer restoration.

**Is this remedy component being implemented?**

Yes. Performance monitoring programs have been established to collect the data required to verify the effectiveness of remedy components #1 through #6. Table 3-1 summarizes the performance monitoring requirements, implementing parties, and the specific documents that contain the monitoring plans.

**Were the groundwater monitoring requirements for this remedy met?**

Yes. FY 2018 was a “major” sampling year. Also, with the detection of 1,4-dioxane in the NBCGRS wells, the USEPA and MPCA requested that the Army analyze groundwater samples for 1,4-dioxane at all scheduled OU1 sampling locations during the summer FY 2018 sampling event. All the required and requested sampling was completed.

**Is any groundwater monitoring proposed prior to the next report?**

Yes. When operating, monthly monitoring of the extraction wells and treatment system effluent is performed by the City of New Brighton in accordance with the "New Brighton Water System Sampling and Analysis Plan," June 1997. However, the OU1 extraction system was not restarted until November 2018 and therefore no such monitoring occurred.

Other groundwater monitoring will be in accordance with the Groundwater Monitoring Plan included as Appendix A.1. A "major" event was conducted for FY 2018. The next "minor" performance monitoring event will be in FY 2019. The next "major" well inventory sampling event is scheduled for FY 2020.

**Does groundwater monitoring show aquifer restoration is occurring?**

Historic groundwater data trends and quality (Appendix D) indicate there has been significant improvement in groundwater conditions as a result of both TGRS and NBCGRS operation. Based on data leading up to the April 2015 remedy time-out, TCE trends in the NBCGRS wells appeared to be stable for NBM #3, #4, #14, and #15 and decreasing for NBM #5 and #6, as shown in Figure 3-2. Aquifer restoration based on TCE trends in the NBCGRS wells will be further examined when monitoring resumes upon restarting the NBCGRS remedy.

Figure 3-3, Figure 3-4, and Figure 3-5 show both the TCE and 1,4-dioxane plumes depicted by depth and geology (5 µg/L for TCE; 1 µg/L for 1,4-dioxane) in the Upper and Lower Unit 3 Combined, Upper Unit 4, and Lower Unit 4 portions of the aquifer for FY 2018, along with cross-section lines, based on the summer 2018 sampling event. Figure 3-3 presents the combined Upper and Lower Unit 3 TCE plume with the highest concentrations residing near the OU2 source areas. Concentrations decline as the plume moves toward the southwest due to mass removal by the TGRS and as concentrations migrate into bedrock via deeply eroded bedrock valleys as mapped by the Minnesota Geologic Survey (Mossler 2013). The regional presence of these valleys within and beyond TCAAP affects groundwater movement. TCAAP is divided roughly in half by a southeast-to-northwest trending bedrock valley, which is joined from the east by a branching valley containing south trending dead-end tributary valleys crossing portions of OU1.

The buried valleys may act as hydraulic short-cuts, allowing groundwater to move directly from Unit 3 into bedrock. Moreover, buried valleys create isolated points and bedrock knobs, cut off from adjacent bedrock by valley-fill sediments. In a bedrock aquifer system as complex as this, groundwater does not flow uniformly from up-to-down-gradient, distributed evenly along parallel paths, but is concentrated in the highest permeability, most-interconnected beds, within conduits (Prairie du Chien) and bedding-plane fractures (Jordan). Figures 3-4 and 3-5 present both TCE and 1,4-dioxane in the Upper and Lower Unit 4 bedrock plumes, respectively. Additionally, unlike historical plume maps, these figures show a conceptual representation of bedrock geology. As presented in both figures, eroded bedrock valleys are filled with overburden where concentration isocontours follow the bedrock topography. Further discussion on buried bedrock valleys and the effect on local hydrogeology is discussed in the remedy review report, which received approval by regulatory agencies in June 2018.

Figure 3-1 shows the 1 µg/L TCE contour for Upper Unit 4 in 1990, 1999, 2009, and 2018. Figures 3-6, 3-7, and 3-8 depict cross-sections showing both the OU1 and OU3 plumes. Figures 3-6 and 3-7 overlap to some extent and should be viewed together. Figure 3-9 depicts the 100 µg/L TCE contour for Upper Unit 4 for certain years between 1990 and 2018, similar to Figure 3-1 which shows the 1 µg/L TCE contour over that same period. In general, the plumes show "no trend" or stable concentrations (see statistical analysis below); as Figure 3-1 and Figure 3-9 show, the plume footprint remains similar to 2009. A slight northward shift of the 1 µg/L and 100 µg/L TCE contours north of the NBCGRS can be seen on the northwest edge of the plume, likely a result of the NBCGRS remedy time- out since April 2015. This shift was first observed following the FY 2015 sampling event and was observed slightly farther north again in FY 2016. Additional sampling will be needed to see if the trend continues, and to see if the west edge of the plume in areas south of the NBCGRS also begin to show a similar trend. Other differences between 2009 and 2018 plumes are due to plume reinterpretation by JV as part of the OU Remedy Review. The water level data from summer 2018 for Upper Unit 4 are presented as a potentiometric map on Figure 3-10.

The OU1 Technical Group Technical Memorandum Statistical Evaluation Method for Water Quality Data, Operable Unit 1 (Army 2004) was prepared to develop statistical methods specifically selected to evaluate the long-term progress of remediation, plume evolution, and aquifer restoration in OU1. The OU1 Technical Group (OU1TG) states the objective of the statistical evaluation as follows:

"Verify progress in cleanup of the plume through measurement of overall geographic plume shrinkage and decreasing contaminant concentrations."

The OU1TG identified five issues that need to be statistically evaluated with respect to the above objective:

1. Measure changing concentrations immediately downgradient of the 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 OU1TG developed a series of five well groups designed to address each of the issues listed above. For each group, appropriate statistical tools were specified, and a threshold identified that would trigger closer scrutiny by the Army and regulators (USEPA and MPCA). Appendix D.2.1.5 shows the factors to consider and potential additional actions that may be implemented if the statistical threshold is triggered. As Appendix D.2.1.5 shows, a threshold trigger initiates a closer look at the data and the context of the data in terms of remedy performance or potential risk. A threshold trigger does not automatically require any specific action. The five groups, corresponding to the five issues discussed above, are:

***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. Furthermore, 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.

***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 plume size if VOC concentrations continue to decline.

***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.

***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.

***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.

In October 2005, the Army received a consistency determination on Modification #1 to: *OU1 Technical Group Technical Memorandum Statistical Evaluation Method for Water Quality Data, Operable Unit 1,* prepared by the Army, dated December 2004. This modification created well Group 6 to address the Jordan portion of the Unit 4 aquifer.

***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. Additional detail on the well groups and analysis is presented in the OU1 Technical Memorandum, Modification #1 and Appendix D.2.

Table 3-2 presents the FY 2018 groundwater quality data for OU1 collected to support the statistical analysis developed by the OU1TG. Historical TCE concentrations at any well can be viewed in the Appendix D Groundwater Quality: Organic Data spreadsheet included on the FY 2018 APR CD-ROM. The statistical analysis in Appendix D.2 follows the format described in the OU1 Technical Memorandum and Modification #1.

Table 3-3 summarizes the statistical results for all groups, from Appendix D.2, reflecting the data collected through FY 2018. Table 3-3 includes an assessment of the statistical thresholds that were triggered in the analysis and brief comments addressing these threshold triggers. Only wells that were sampled in 2018 and have "increasing" or "no significant trend" trends are discussed below. For discussion of other wells or well groups, refer to the FY 2016 APR.

<u>Group 2 (Plume Edge Wells):</u>03U805 (Increasing): Concentrations of TCE at this well have been increasing since FY 2013 and was 49 µg/L in both FY 2016 and FY 2018 (was 1.5 µg/L in FY 2005). The trend indicates an increasing trend and most likely reflects plume shifts. This well is located on the southern edge of the OU1 plume immediately downgradient from the TGRS.

04U832 (No Significant Trend): TCE concentrations at this well have been generally stable, fluctuating between 41 µg/L and 59 µg/L since FY 2005. This well is located on the southern edge of the OU3 plume.

04U843 (Increasing): TCE concentrations at this well have been erratic, but generally increasing since its installation in 1987. The overall trend appears to be stabilizing. This well is in the central part of the north plume not far downgradient of the TGRS and just downgradient of 04U847, which has the highest concentration of TCE in OU1. As this area is outside of the TGRS capture zone, this well can be expected to increase as migration of TCE from 04U847 continues downgradient.

04U846 (Increasing): The TCE concentration has increased from 4.2 µg/L in FY 2005 to 17 µg/L in FY 2018. Concentrations at this well have historically been erratic, with a maximum concentration of 120 µg/L in 1988 and dipping down below 1 µg/L from 1998 through 2001. It is located towards the south side of the OU1 plume. The historically erratic trend is likely due to varying flow patterns created by the NBCGRS.

04U877 (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 1.3 µg/L) since 2005, the erratic increases and decreases in TCE concentrations over the years has resulted in a high “p-value” and thus a no significant trend outcome for this well.

409549 (Probably Increasing): TCE concentrations at this well have fluctuated between 4.4 µg/L and 220 µg/L since it was installed in 1985. The concentration has been steadily increasing over the last 10 years but decreased to 28 µg/L in FY 2018, which is well within the historical trend at the well.

409557 (Probably Increasing): TCE concentrations at this well have fluctuated between non-detect and 79 µg/L since it was installed in 1987. The concentration has been steadily increasing the last 15 years but decreased to 17 µg/L in FY 2018, which is well within the historical trend at the well.

<u>Group 5 Unit 3 Wells:</u>

03L809 (No Significant Trend): TCE concentrations show a generally decreasing trend. Concentrations have been between 90 µg/L and 150 µg/L since FY 2011 and appear to have stabilized around 120 µg/L. This well is in the OU1 plume just down gradient from the TGRS.

03U822 (No Significant Trend): TCE concentrations have been between 42 µg/L and 160 µg/L since FY 2005. The raw trend for this well is slightly increasing; however, the well is in the center of the north plume and therefore the increasing raw trend most likely represents slight shifts in the core of the plume.

<u>Group 6 (Jordon Wells):</u>

<u>04J708 (Increasing): TCE concentrations at this well have increased steadily since FY 2009. The concentration in FY 2018 was 9.7</u> µg/L. This well is located on the southern edge of the OU1 plume and may indicate a slight shift or expansion of the plume.

04J836 (Increasing): This well is directly downgradient from the NBCGRS and has previously shown “No Significant Trend”. TCE concentrations have increased slightly from 10 µg/L in FY 2013 to 40 µg/L in FY 2016 and then decreased to 26 µg/L in FY 2018. This general increase may have been influenced by the NBCGRS shut down in 2015.

04J838 (No Significant Trend): TCE concentrations at this well have historically been stable around 30 µg/L; however, in FY 2018 the concentration decreased to 0.91 µg/L. This well is downgradient from the NBCGRS and the change may have been influenced by the system shut down in 2015.

04J839 (No Significant Trend): TCE concentrations at this well have historically been below 5 µg/L; however, in FY 2018 the concentration increased to 6.1 µg/L. This well is downgradient from the NBCGRS and this slight increase may have been influenced by the system shut down in 2015.

04J847 (No Significant Trend): 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 640 µg/L in FY 2018. 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 concentration decreased again in FY 2018 to 1.3 µg/L. Continued annual monitoring is appropriate to further evaluate how the OU1 plume is shifting.

Group 6 (Nested Wells):

04U702 (No Significant Trend): Concentrations of TCE at this well have consistently been below 3 µg/L; therefore, a “No Significant Trend” result is not of concern.

04U836 (No Significant Trend): This well is near the NBCGRS; therefore, greater variability is expected. TCE concentrations at this well have historically varied between 23 µg/L and 79 µg/L. The TCE concentration decreased in FY 2018 to 18 µg/L, likely due to plume shifts as a result of the NBCGRS shut down.

04U837 (No Significant Trend): This well is near the NBCGRS; therefore, greater variability is expected. TCE concentrations at this well have historically remained below 5 µg/L; therefore, a “No Significant Trend” result is not of concern.

04U838 (No Significant Trend): TCE concentrations have been below 3 µg/L since FY 2009 but increased to 47 µg/L in FY 2018. A similar increase occurred in FY 2007 when the TCE concentration spiked to 48 µg/L. Additional monitoring will be conducted to assess the overall trend.

04U839 (Increasing): This well is near the NBCGRS so greater variability is expected. The well is located on the west/northwest edge of the plume and has historically had concentrations below 3 µg/L; however, the concentration increased to 15 µg/L in FY 2015 and has had concentrations between 40 µg/L and 50 µg/L during the three most recent sampling events. This increase may be influenced by the NBCGRS shut down.

04U849 (No Significant Trend): Concentrations of TCE at this well have been erratic, but generally increasing. This well is located near the center of the OU1 plume downgradient from well 04U847, which is the well with the highest concentration of TCE in the OU1 plume. TCE concentrations have generally stabilized within the last few years but appear to have a downward trend within the last few sampling events.

Overall Statistical Assessment:

Two additional threshold triggers were identified in FY 2018 at wells 409549 and 409557. Discussion of established threshold triggers can be found in the FY 2016 APR. These triggers highlight specific areas of the plume that are changing over time. This type of behavior is expected in a large complex flow system such as OU1. The thresholds triggered do not suggest any problems with the remedial systems but suggest movement within the established plumes. Overall, the data meet the statistical criteria developed in this document for assessing the remedial progress in the OU1 aquifers. The data show continuing improvement in the OU1 plume through FY 2018. The statistical behavior of the OU3 plume is addressed in Section 13.

**How much VOC mass has been removed (at each well and total)?**

The NBCGRS did not operate in FY 2018; therefore, no VOCs were removed by the NBCGRS in FY 2018. The total cumulative VOCs removed by the NBCGRS through April 2015 is 23,644 pounds.

Figure 3-11 shows the annual VOC mass removed (graph top), annual pumping volumes, and annual mass removal per unit volume pumped since FY 1997 (when NBM #14 was brought online). As stated above, the mass removal in FY 2018 was null, due to the remedy time-out. Generally, mass removal has been decreasing since FY 1998, when the last extraction well was activated (NBM #15). This overall decline in mass removal is consistent with observed decreasing trends for TCE in OU1 deep groundwater, suggesting that aquifer restoration is progressing.

**Are any changes or additional actions required for this remedy component?**

Yes. The City of New Brighton completed an Advanced Oxidation treatment system in November 2018 so aquifer restoration can resume with better protection for the consumer.

# 4 OPERABLE UNIT 2: SHALLOW SOIL AND DUMP SITES

The 1997 OU2 ROD and subsequent Amendments and ESDs are discussed in Sections 4 through 12 of this APR. This section specifically addresses the shallow soil and dump sites. Relevant modifications to the OU2 ROD include Amendments #1, #3, #4, #5, and ESD #2.

Through the OU2 Remedial Investigation/Feasibility Study process, Sites A, C, E, H, 129-3, and 129-5 were found to have inorganic and/or organic contaminants above the cleanup goals specified in Table 1 of the OU2 ROD. Unpermitted landfills, or dumps, were identified within Sites A, B, E, H, and 129-15. The OU2 ROD (page 2) describes nine remedy components to address the shallow soil and dump sites.

OU2 ROD Amendment #1 modified the requirements for Site C-2 soil and sediment (note that Site C groundwater and surface water is addressed separately in Section 7). Because the depth to groundwater is shallow at Site C-2, it was not feasible to remove all contaminated soil and sediment. The Amendment modified remedy component #2 related to excavation of soil, to allow the placement of a 4- foot thick soil cover over areas where contamination remains in-place above the cleanup levels. ROD Amendment #1 also specified land used controls (LUCs) as an additional remedy component for Site C-2.

OU2 ROD Amendment #2 addressed shallow groundwater at Site I, which is discussed in Section 8.

OU2 ROD Amendment #3 affected the shallow soil and dump sites in four principal ways:

1. The Amendment documented, as final remedies, the additional actions performed for shallow soil at Site D and the dump at Site G, after completion of the deep soil requirements set forth for both in the OU2 ROD (see Section 5 of this report for discussion of the deep soil).
2. The Amendment documented the use of soil covers as part of the final remedy at Sites E, G, H, and 129-15.
3. The Amendment documented final remedies for five sites with soil contamination that were not originally included in the OU2 ROD: Grenade Range, Outdoor Firing Range, 135 PTA Stormwater Ditch, Trap Range, and Water Tower Area. At these sites, either previous removal actions had been completed that reduced soil contamination to below cleanup levels, or investigations had determined that no action or no further action was needed. The Amendment incorporated the remedies for these sites into the overall remedy for OU2.
4. The Amendment specified LUCs as an additional remedy component for shallow soil and dump Sites D, E, G, H, 129-15, Grenade Range, and Outdoor Firing Range. LUCs are not needed for the 135 PTA Stormwater Ditch or Trap Range because contamination levels are suitable for unlimited use/ unrestricted exposure. The water tower area is also suitable for unlimited use/ unrestricted exposure; however, it is located within the area having blanket land use restrictions as specified in the Land Use Control Remedial Design (LUCRD).

ESD #1 is discussed in Section 6 (Site A shallow groundwater), Section 9 (Site K shallow groundwater), and Section 12 (OU2 deep groundwater).

ESD #2 specified LUCs as an additional remedy component for Sites A, C-1, 129-3, and 129-5. ESD #2 also documented that no further action is required at Site B. Site B is located within the area having blanket land use restrictions.

ROD Amendment #4 was signed in January 2012 and documents previously-completed soil removal actions conducted at two sites: the 535 PTA and Site K. No further action is required for the soils located near the excavation areas at these two sites; though the excavation area for the 535 PTA is located within the area of the Arden Hills Army Training Site that has restricted commercial use. The ROD amendment also addressed Building 102 shallow groundwater, discussed in Section 10, and OU2 aquatic sites, discussed in Section 11.

ROD Amendment #5 was signed in March 2014 and documents previously-completed soil removal actions conducted at soil areas of concern at three sites: Site A, the eastern portion of the 135 PTA, and the MNARNG EBS Areas. It also documents that LUCs are required at these sites.

## 4.1 Remedy Components #1 through #9: Soil Remediation

The nine remedy components specified in the OU2 ROD (page 2) 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.

## 4.2 Remedy Component #10: Land Use Controls

**Description:** "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 unlimited use and unrestricted exposure. LUCs are also necessary to protect the integrity of the soil covers constructed at various sites."

**Performance Standard (how do you know when you're done):**

Initial implementation was done when the USEPA and MPCA provided consistency approval for an OU2 LUCRD document. Implementation will continue indefinitely unless further action is taken that would allow for unlimited use and unrestricted exposure.

**Has a LUCRD document been approved to address LUC issues for OU2, and is it being implemented?**

Yes. The USEPA and MPCA provided consistency approval for the OU2 LUCRD in September 2010 and it has been implemented by the Army. Revision 4 of the OU2 LUCRD was approved by the USEPA and MPCA in August 2016. This revision eliminated soil LUCs from the "California-Shaped Area" (which is 380 acres of the 427 acres transferred/leased to Ramsey County in 2013), following soil cleanup to levels consistent with unlimited use / unrestricted exposure. LUCs for other shallow soil sites were not affected by this revision. Revision 5 of the OU2 LUCRD was approved by the USEPA and MPCA in March 2018. Revision 5 changed the land use controls for approximately 108 acres in the western portion of OU2 to allow for recreational use, on land to be transferred to Ramsey County.

**Was an annual site inspection for LUCs conducted in FY 2018?**

Yes. On July 30, 2018, the Army, National Guard, and JV conducted the annual inspection of OU2 sites. The checklist that was completed during the inspection is included as Appendix F.

**Did the inspection identify any follow-up actions needed to maintain the protectiveness of the LUCs?**

No.

# 5 OPERABLE UNIT 2: DEEP SOIL SITES

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 (pages 2-3) 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 (Section 12) and is not discussed separately in this section. 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 in Section 4.

# 6 OPERABLE UNIT 2: SITE A SHALLOW GROUNDWATER

Shallow groundwater at Site A has been impacted by VOCs and antimony. The selected remedy in the OU2 ROD incorporates the use of a groundwater extraction system, which began operation May 31, 1994. When operating, the system conveyed extracted groundwater to the sanitary sewer for treatment at a Publicly-Owned Treatment Works (POTW). However, as further discussed below, the groundwater system ceased operation (with regulatory approval) on September 24, 2008, while implementation of monitored natural attenuation (MNA) was being evaluated. The ROD prescribes five major components of the remedy, and until a ROD amendment can be approved, the original components will be retained in this section (with discussion that is appropriate to the MNA remedy).

The original 8-well groundwater extraction system that was selected in the OU2 ROD began operation May 31, 1994. On July 11, 2000, with regulatory approval, EW-5 through 8 (the "second line" of extraction wells) were shut down due to VOC concentrations in these wells having declined below cleanup levels. In July 2008, the USEPA and MPCA approved the Site A Shallow Groundwater: 10-Year Evaluation Report (Wenck 2008a). The 10-Year Report was prepared to fulfill a requirement of the ROD, which states that for shallow groundwater contamination at Site A, "should aquifer restoration not be attained within the ten-year lifespan of the remedy, additional remedial measures will be addressed". Because the 10-year mark had been reached and contamination was still present above the cleanup levels, the 10-Year Report was prepared to discuss the status of the site and to evaluate any potential changes to the remedy that would be beneficial. MNA (through abiotic degradation) was the recommended alternative for Site A that was approved by the USEPA and MPCA.

In September 2008, the USEPA and MPCA approved the Site A Shallow Groundwater: Monitoring and Contingency Plan (Wenck 2008b), and EW-1 through 4 (the "first line" of extraction wells) were then shut off on September 24, 2008. The Monitoring and Contingency Plan presented the monitoring plan to be implemented when the extraction wells were shut off, and presented the contingency actions that will be taken by the Army if groundwater monitoring indicates that any of the identified trigger points are exceeded. These monitoring and contingency actions were incorporated into the APR, and thus any changes to monitoring and contingency actions must be approved by the USEPA and MPCA through revisions to the APR.

The decision to proceed with MNA was based in part on the MPCA and USEPA natural attenuation study at the site (2000) and follow-up MPCA/USEPA microcosm studies that have verified that abiotic degradation of VOCs in Site A groundwater is occurring at substantial rates. Such degradation acts to reduce contaminant mass and mobility by breaking down the contaminants as they move downgradient. The decision to proceed with MNA was also based on the absence of any likely receptors. The closest potential groundwater receptor is located approximately 1,000 feet downgradient from 01U352 (EW-2) and 01U353 (EW-3). This domestic well has not been operable for many years (and even when it was, the water was only used for irrigation purposes). Beyond this unlikely receptor, there are no other existing downgradient receptors between the plume and Rice Creek, which is approximately 1,800 feet away.

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. This change was approved in ROD Amendment #6 in early FY 2018. Since the extraction wells are still included in the monitoring plan for Site A, they will not be sealed.

## 6.1 Remedy Component #1: Groundwater Monitoring

**Description:** "Groundwater monitoring to track plume migration and remedy performance." (OU2 ROD, page 3)

**Performance Standard (how do you know when you're done):**

When a performance groundwater monitoring program has been established and ongoing monitoring is compliant with the program.

**Is this remedy component being implemented?**

Yes. Table 6-1 summarizes performance monitoring requirements, implementing parties, and monitoring plan documents. The FY 2018 Monitoring Plan is included in Appendix A, and the FY 2018 water quality monitoring locations and frequencies are also summarized on Figure 6-1. Any deviations are explained in Appendix C.2. Figure 6-2 presents summer 2018 measured groundwater elevation contours.

**Were the groundwater monitoring requirements for this remedy met?** Yes.

**Is any groundwater sampling proposed prior to the next report?**

Yes, sampling of Site A groundwater monitoring wells will be according to the monitoring plan in Appendix A.1.

Groundwater sampling of water supply wells related to alternate water supply and well abandonment will be in accordance with recommendations in Appendix E. The next "major" event was previously scheduled for FY 2019; however, due to the discovery of 1,4-dioxane in deep groundwater, an unscheduled "major" event was conducted in FY 2015 and repeated by the Army in FY 2016. The next "major" event is now scheduled for FY 2020 to maintain the normal frequency of once every four years.

**Are any changes or additional actions required for this remedy component?**

Yes. As first proposed in the FY 2015 APR, monitoring of wells 01U350, 01U351 (EW-1), and 01U354 (EW-4) ceased in FY 2017. These wells are essentially redundant monitoring points to nearby wells 01U108, 01U116, and 01U138, respectively. However, 01U350 will be used as a temporary monitoring point in place of 01U108 until the obstruction that prevented monitoring in FY 2017 can be removed. As of the end of the FY 2018, the obstruction has not been removed from 01U108.

## 6.2 Remedy Component #3A: Land Use Controls

**Description:** The OU2 ROD (page 3) stated: "Institutional controls to restrict new well installations and provide alternate water supplies and well abandonment as necessary." For ease of discussion, the requirement has been broken into two pieces, with this section focusing on the LUCs. OU2 ESD #1 clarified the LUC component to include protection of the groundwater monitoring and extraction system infrastructure.

**Performance Standard (how do you know when you're done):**

For initial implementation, when the MDH has issued a SWCA Advisory, and when the USEPA and MPCA have provided consistency approval for an OU2 LUCRD document. Implementation will continue until such time that the groundwater concentrations are below the cleanup levels.

**Has the MDH issued a SWCA Advisory for the area impacted by Site A?**

Yes, issued June 1996, revised in December 1999 and April 2016; however, these revisions did not affect the boundary for the Site A vicinity.

**Has a LUCRD document been approved to address LUC issues for OU2, including Site A groundwater, and is it being implemented?**

Yes. The USEPA and MPCA provided consistency approval for the OU2 LUCRD in September 2010, which is being implemented by the Army. Subsequent revisions to the OU2 LUCRD have not changed the LUCs for Site A.

**Was an annual site inspection for LUCs conducted in FY 2018?**

Yes. On July 30, 2018, the Army, National Guard, and JV conducted OU2 site annual inspection, with a completed checklist included as Appendix F.

**Did the inspection identify any follow-up actions needed to maintain the protectiveness of the LUCs?**

No.

## 6.3 Remedy Component #3B: Alternate Water Supply/Well Abandonment

**Description:** The OU2 ROD (page 3) states: "Institutional controls to restrict new well installations and provide alternate water supplies and well abandonment as necessary." For ease of discussion, the requirement has been broken into two pieces, with this section focusing on the alternate water supplies and well abandonment.

**Performance Standard (how do you know when you're done):**

When well owners who qualify have been offered and provided with alternate water supply and/or have had their wells abandoned (or the offers have been rejected).

**Is the remedy component being implemented?**

Yes. The OU1 Alternate Water Supply and Well Abandonment Program is underway and was expanded to cover the area affected by the OU2 Site A shallow groundwater plume. See Section 3.1 for further information.

**Did the boundary of the Site A plume get any bigger during FY 2018, as defined by the 1 µg/L contour?**

No. Table 6-2 presents the FY 2018 groundwater quality data for Site A. Using these data, Figure 6-3 shows the tetrachloroethene (PCE) concentrations and Figure 6-4 shows the cis-1,2-dichloroethene (cis-

1,2-DCE) concentrations. The latter is a degradation product of the former and represents the larger areal footprint. The plume decreased in size and the axis of the plume appears to have shifted slightly from the previous year, as shown on Figure 6-5.

**Were any additional water supply wells discovered within the area of concern for the Site A plume that are completed within the aquifer of concern?**

No.

**Were any water supply wells within the Site A plume sampled during FY 2018? If yes, what were the findings?**

No wells were sampled.

**Were any well owners offered an alternate supply and/or well abandonment in FY 2018?**

No.

**Within the Site A plume, are there any well owners that meet the criteria, but have not yet been provided an alternate water supply?**

No.

**Within the Site A plume, are there any wells that meet the criteria, but have not yet been abandoned?**

No.

**Is any sampling of water supply wells proposed prior to the next report?**

No. There are no water supply wells in the vicinity of Site A vicinity that require sampling.

**Are any changes or additional actions required for this remedy component?**

No.

## 6.4 Remedy Component #5: Source Characterization/ Remediation

**Description:** “Source characterization/remediation” (OU2 ROD, page 3).

**Performance Standard (how do you know when you’re done):**

For characterization, when the investigation answered needed questions to prepare remedial design documents. For remediation, when soil contaminant concentrations are below cleanup levels specified in Table 1 of the OU2 ROD.

**Is this remedy component being implemented?**

Yes. Characterization work has been completed. Stone & Webster performed investigation work in 1997 and the Final Site A Investigation Report (Stone & Webster Environmental Technology & Services 1997) was issued December 12, 1997. The report delineated the extent of both VOC-contaminated and metal-contaminated soils requiring remediation. The source of VOC-contaminated soils was found to be the “1945 Trench”.

Remediation has been completed. Shaw Environmental and Infrastructure, Inc. (Shaw, formerly Stone & Webster) completed removal of metal-contaminated soils in FY 1999. Construction of an air sparging/soil vapor extraction (AS/SVE) system to remediate VOC-contaminated soils was completed by Stone & Webster in FY 2000, which began operation in early FY 2001. The AS system was shut off permanently in June 2001 due to a lack of increase in SVE VOC levels and due to concern regarding potential plume spreading. The AS system was being implemented voluntarily by the Army and was not a OU2 ROD requirement. Soil samples were collected within the source area in July 2002 (and previously in August 2001). In both events, the results showed minimal reduction in soil VOC concentrations. Since it appeared that many years of SVE system operation would be required before soil cleanup levels would be reached (if ever), the Army ceased SVE system operation on August 21, 2002, and submitted a work plan clarification to the USEPA and MPCA for excavation of source area VOC-contaminated soils, which received regulatory approval in early FY 2003. Post approval, 688 cubic yards of contaminated soil were excavated by Shaw and transported off-site to a permitted disposal facility (see Figures 6-3 and 6-4 for the location of the soil excavation area at the former 1945 Trench). The Site A Former 1945 Trench Closeout Report (prepared by Shaw) received regulatory consistency in FY 2004.

**Are any changes or additional actions required for this remedy component?**

No.

## 6.5 Overall Remedy for Site A Shallow Groundwater

**Performance Standard (how do you know when you're done):**

When the cleanup levels in Table 1 of the OU2 ROD have been attained throughout the areal and vertical extent of the Site A plume (OU2 ROD, page 54).

**Has the Site A shallow groundwater remedy been completed (i.e., have the cleanup levels in Table 1 of the OU2 ROD been attained throughout the areal and vertical extent of the Site A plume)?**

No. Table 6-2 presents the FY 2018 groundwater quality data and highlights the values that exceed a cleanup level. The respective cleanup levels were exceeded by concentrations of cis-1,2-DCE at 01U139 (710 µg/L), 01U355/EW-5 (300 µg/L), and 01U902 (92 µg/L)and of antimony at 01U103 (6.7 µg/L). None of the other COCs exceeded their respective cleanup levels in FY 2018.

**What impact is MNA having on contaminant concentrations?**

As evident in Table 6-2, and on Figures 6-3 and 6-4, PCE and TCE continue to be degraded to cis-1,2-DCE via natural attenuation. This degradation generally occurs within the distance between the source area and the first line of extraction wells (EW-1 through EW-4), with primarily only cis-1,2-DCE being detected downgradient of the first line of extraction wells. Figure 6-6 shows the cis-1,2-DCE concentrations plotted on geologic cross sections to illustrate the vertical extent of contamination (the cross-section locations are illustrated on Figure 6-4). Cis-1,2-DCE continues to be degraded via an abiotic process as the plume migrates. The MPCA and USEPA initially evaluated attenuation at the site using computer modeling of contaminant degradation, as documented in Evaluation of Natural Attenuation of Chlorinated Solvents in Ground Water at the Twin Cities Army Ammunition Plant (MPCA and USEPA 2000). The MPCA conducted a follow-up microcosm study (unpublished), the results of which were presented to the Army and USEPA on April 10, 2007. The work conducted in this study showed that the degradation being observed at Site A was an abiotic process (not biological), which likely involves the presence of the mineral magnetite in soils. Note that the predominant degradation process does not “degrade through” vinyl chloride, which is no longer monitored at this site given the historical lack of detections that led to the OU2 ROD not selecting this compound as a COC.

Since September 2008 when the “first line” of extraction wells was shut off, some wells have shown decreased concentrations while others have, in some periods, shown increased concentrations (see Figures 6-7, 6-8, 6-9, and 6-10). Collectively, the cis-1,2-DCE water quality trends evident on Figures 6-7 through 6-10 indicate the plume has essentially stabilized. Historically, the contingency locations (the four 900-series wells located along the north side of County Road I) have peaked and now show stable or decreasing trends at concentrations below the cis-1,2-DCE cleanup level of 70 µg/L (Figure 6-10); however, during FY 2018 contingency location 01U902 had a cis-1,2-DCE concentration of 92 µg/L while all other contingency locations remained below the cleanup level. Further monitoring will be completed to evaluate trends.

Specifically, concentrations of cis-1,2-DCE in 01U901 and 01U903 have been at or near non-detect since 2008 and basically throughout their history. The concentrations of cis-1,2-DCE in 01U902 had stabilized between 15 and 20 µg/L by June 2013. Well 01U902 was 29 ug/L (2016), 35 ug/L (2017), and 92 ug/L (2018). Two more sampling rounds (2019 and 2020) will be collected to confirm trend. The concentration of cis-1,2,-DCE in 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 01U904 was 27 µg/L in June 2017 and was non-detect in 2018. 01U904 is located directly downgradient of the two highest-concentration wells in June 2017: 01U157 and 01U355.

Concentrations of cis-1,2-DCE at EW-8 have been stable near non-detect since December 2012. Concentrations of cis-1,2-DCE at EW-7 peaked just above the cleanup level in December 2012 and have steadily declined to the June 2017 concentration of 11 µg/L. At EW-5, cis-1,2-DCE concentrations appeared to have stabilized below the cleanup level; however, in June 2017 the cis-1,2-DCE concentration increased to 200 µg/L and increased again in 2018 to 300 µg/L. A generally increasing trend has been observed at EW-6 since 2012. The reason for this is not clear, but continued monitoring of EW-6 will be performed. In addition, a call with be scheduled to discuss a path forward regarding the groundwater plume at Site A..

In the monitoring wells located between the two rows of extraction wells (Figure 6-8), concentrations of cis-1,2-DCE appeared to have stabilized or to have been on a declining trend. 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, and appeared to have stabilized between 240 and 350 µg/L. However, in June 2017, the cis-1,2-DCE concentration increased to 540 g/L and increased again in 2018 to 710 µg/L. Future monitoring will be evaluated to confirm the overall trend. 01U140, after showing three slight exceedances of the cleanup level in 2011 and 2012, has shown a steadily declining cis-1,2-DCE concentration to non-detect in 2018. 01U157 had two slight exceedances of the cis-1,2-DCE cleanup level in 2011 and 2012 and appeared to have stabilized between 18 and 25 µg/L; however, the cis-1,2-DCE concentration in June 2017 increased to 380 µg/L and was non-detect in 2018. Future monitoring will be evaluated to confirm the overall trend.

01U158 had a peak cis-1,2-DCE concentration of 410 µg/L in April 2011, but had since stabilized between 28 and 67 µg/L. The observed cis-1,2-DCE concentration of 80 µg/L in June 2016 was the first exceedance of the cleanup level at 01U158 since December 2011. The June 2017 concentration decreased to 13 µg/L and the 2018 concentration was consistent at 12 µg/L. The overall trend at this location still appears to be stable.

In EW-1 through EW-4 (Figure 6-7), concentrations of cis-1,2-DCE have been at or near non-detect since 2010 or earlier. In summer 2018, samples were collected from EW-2 and EW-3 (sampling has been discontinued at EW-1 and EW-4, as discussed in Section 6.1). The concentration of cis-1,2-DCE was 1.0 µg/L in EW-3 and non-detect in EW-2.

In summary, the cis-1,2-DCE plume has largely stabilized following shutdown of EW-1 through EW-4 in 2008. Most importantly, contingency locations 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 (despite 01U904 being located directly downgradient of EW-6). The cis-1,2-DCE concentration in 01U902 increased slightly in 2016, 2017, and again in 2018 to above the cleanup level and will require continued monitoring to assess this potential upward trend. Hence the collective trend suggests that the slight uptrend at EW-6 merely reflects a slight shifting of the axis of the plume in the "cross-plume" direction, which also likely explains the greater variability that is evident in two other wells near the axis of the plume (01U157 and 01U139).

**Were any trigger levels exceeded at any of the contingency locations?**

Yes. The four contingency locations are 01U901, 902, 903 and 904, which are the four monitoring wells located along the north side of County Road I. The trigger level is equal to groundwater cleanup levels and 01U902 exceeded the cis-1,2-DCE cleanup level in FY 2018. The other three contingency locations did not have any detections of COCs exceeding their respective cleanup levels in these four wells in FY 2018 (Table 6- 2). As noted previously, 01U901 and 01U903 have been at or near non-detect for cis-1,2-DCE since 2008 and basically throughout their history. Concentrations of cis-1,2-DCE in 01U904 show a stable or slightly decreasing trend with cis-1,2-DCE concentrations below the cleanup level of 70 µg/L.

The *Site A Shallow Groundwater: Monitoring and Contingency Plan* (Wenck 2008b) noted that if the groundwater trigger is exceeded, three key contingency actions are required:

1. Army will contact the well owner at 1783 Pinewood Drive to verify the well remains out of service (and will do this annually for as long as the trigger is being exceeded);
2. Army will prepare and submit a plan to address the exceedance to the USEPA and MPCA for approval; and
3. Army will prepare and submit a plan to evaluate the indoor air pathway.

The third action was perhaps the most critical item, as no soil vapor sampling had ever been conducted at Site A and increasing VOC groundwater concentrations in any of the wells north of County Road 1 would raise the question of whether these increases could cause an increase in soil gas VOC concentrations leading to a vapor intrusion risk. A vapor intrusion report had been prepared previously: Off-TCAAP Vapor Intrusion Pathway Analysis, Operable Unit 1, Operable Unit 3, and Operable Unit 2 (Site A) prepared by Tecumseh/Wenck Installation Support Services, May 2005. This report concluded that the vapor intrusion pathway for the offsite Site A plume was incomplete, since the concentrations in groundwater were below the USEPA generic screening criteria. However, no actual soil vapor sampling was conducted for that report. In December 2012, the MPCA requested that soil vapor sampling be conducted, since their 2008/2010 vapor intrusion guidance is newer than the 2005 report, and since that guidance states that groundwater screening levels should not be used as a single line of evidence for decisions regarding vapor intrusion risk. Based on this MPCA request, the Army prepared an investigation QAPP, which was approved by the USEPA and MPCA in June 2013, and then conducted the vapor intrusion investigation work in July 2013. This work was documented in Site A Vapor Intrusion Investigation Report (Wenck 2014), which received regulatory consistency approval in FY 2014. The report concluded that no significant VOC concentrations are present in soil gas near the 14 samples collected (10 of which were located along the north side of County Road I), and that there is no significant soil vapor risk. Hence, the third contingency action has already been completed and was ultimately found not to be of concern.

With regard to the first contingency action, according to the TCAAP Well Inventory and MDH records the well at 1783 Pinewood Drive was sealed in 2014. No further action is required in regard to this contingency action.

The only remaining contingency action is the second. However, the need to “address the exceedance” would be driven primarily by either a groundwater receptor or a vapor receptor, and since these pathways have been eliminated as discussed above, a slight exceedance of the trigger does not require any specific remedial action, especially given the strong degradation evident at the site (i.e., the distance any slight exceedance would carry downgradient from the “900” wells would be expected to be minimal). The contingency locations will be sampled according to the monitoring plan in FY 2019 and the data will be evaluated to determine whether further action is required.

**Can it be determined whether MNA is an adequate long-term remedy for Site A in lieu of groundwater extraction and discharge? (If MNA is determined to be adequate, a recommendation to formally change the remedy should be made.)**

Yes. In the November 11, 2015 Technical Memorandum, the Army recommended that MNA be implemented as the long-term remedy for Site A in lieu of groundwater extraction and discharge. This recommendation was made in consideration of three key facts: 1) the vapor intrusion investigation concluded that there is no significant soil vapor risk north of County Road I; 2) the only known groundwater receptor between Site A and Rice Creek (1783 Pinewood Drive) was sealed in 2014; and 3) 1,4-dioxane was not found to be present in Site A shallow groundwater. ROD Amendment #6 was approved in FY 2018, changing the remedy to MNA for Site A shallow groundwater.

Annual monitoring of Site A wells for VOCs will continue in FY 2019 according to the monitoring plan in Appendix A.

**Do additional remedial measures need to be addressed?** No.

# 7 OPERABLE UNIT 2: SITE C SHALLOW GROUNDWATER

Impacts to Site C shallow groundwater had not occurred at the time of the 1997 OU2 ROD. In FY 1997, the U.S. Army Environmental Command sponsored a technology demonstration to phyto-remediate Site C lead-contaminated soil. During the growing seasons, ethylenediaminetetraacetic acid and acetic acid were applied to the soils to improve metals uptake by the crops and had the unintended consequence of causing migration of lead from the soils into the shallow groundwater present within a few feet from the ground surface. In FY 2000, the MPCA took enforcement action, requiring the Army implement corrective actions. Initially, the Army installed a groundwater recovery trench to contain the lead plume (operated between November 2000 and July 2001). On July 6, 2001, the Army began operating three extraction wells to contain the plume (replacing recovery trench operation), with discharge of extracted groundwater (treated as necessary) to a POTW. In FY 2004, a Stipulation Agreement was signed that resolved the enforcement action and directed that response actions be conducted under the authority of the FFA. The 2007 OU2 ROD Amendment #1 incorporated the existing groundwater extraction system as the final remedy.

On November 13, 2008, the groundwater system was shut off (with regulatory approval), since the lead concentrations in the three extraction wells had been below the groundwater cleanup level since March 2008 (i.e., the area of lead concentrations exceeding the groundwater cleanup level was not reaching the extraction wells and so operation of the extraction system was no longer required for plume containment). The recommendation to de-energize the extraction system was presented in the Site C Groundwater Extraction System Evaluation Report (Evaluation Report; Wenck 2008c) and was approved by the USEPA and MPCA in November 2008. 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 in this section (with discussion that is appropriate to the current remedy implementation status).

The Evaluation Report also presented the monitoring plan to be implemented at the point that the extraction wells were shut off and presented the contingency actions that will be taken by the Army if groundwater and/or surface water monitoring indicates that any of the stated trigger points are exceeded. These monitoring and contingency actions have been incorporated into the APR, and thus any changes to monitoring and contingency actions must be approved by the USEPA and MPCA through revisions to the APR.

At some point, the remedy could be formally changed. This change would presumably require an ESD, at a minimum, or possibly a ROD amendment. However, 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.

## 7.1 Remedy Component #1: Groundwater and Surface Water Monitoring

**Description:** "The existing Site C groundwater monitoring program will be revised as needed." "A new surface water monitoring plan will be prepared" (OU2 ROD Amendment #1, page 39-40).

**Performance Standard (how do you know when you're done):**

When a performance groundwater and surface water monitoring program has been established and ongoing monitoring is in compliance with the program.

**Is this remedy component being implemented?**

Yes. Table 7-1 summarizes the performance monitoring requirements, the implementing parties, and the documents that contain the monitoring plans. FY 2018 monitoring was conducted in accordance with the Monitoring Plans included in Appendix A. The water quality monitoring locations and frequencies are also summarized on Figure 7-1, and any deviations explained in Appendix C.2.

**Were the monitoring requirements for this remedy met?**

Groundwater samples were collected as per the FY 2018 monitoring plan in Appendix A.

**Is any sampling proposed prior to the next report?**

Yes. Groundwater and surface water monitoring at Site C will be in accordance with the monitoring plans shown in Appendix A.1 and A.3, respectively.

**Are any changes or additional actions required for this remedy component?** No.

## 7.2 Remedy Component #2: Groundwater Containment

**Description:** "Three extraction wells, EW-1 through EW-3, will continue collecting contaminated groundwater" (OU2 ROD Amendment #1, page 38).

**Is this remedy component being implemented?**

No. As discussed previously, 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.

## 7.3 Remedy Component #3: Discharge of Extracted Water

**Description:** "Extracted groundwater will be pretreated onsite (as necessary) to meet the sanitary sewer discharge limit" (OU2 ROD Amendment #1, page 38).

**Is this remedy component being implemented?**

No. As discussed previously, 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.

## 7.4 Remedy Component #4: Land Use Controls

**Description:** “LUCs will be 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” (OU2 ROD Amendment #1, page 39).

**Performance Standard (how do you know when you’re done):**

For initial implementation, when the USEPA and MPCA have provided consistency approval for an OU2 LUCRD document. Implementation will continue until such time that the groundwater concentrations are below the cleanup levels.

**Has a LUCRD document been approved to address LUC issues for OU2, including Site C groundwater, and is it being implemented?**

Yes. The USEPA and MPCA approved the OU2 LUCRD in September 2010 and it is being implemented by the Army. Revision 5 of the OU2 LUCRD was approved by the USEPA and MPCA in March 2018. Site C is part of the 108 acres planned for transfer to Ramsey County as described in Revision 5. The LUCs for groundwater and a soil cover for Site C remain in place.

**Was an annual site inspection for LUCs conducted in FY 2018?**

Yes. On July 30, 2018, the Army, National Guard, and JV conducted the annual inspection of OU2 sites. The checklist that was completed during the inspection is included as Appendix F.

**Did the inspection identify any follow-up actions needed to maintain the protectiveness of the LUCs?** No.

## 7.5 Overall Remedy for Site C Shallow Groundwater

**Performance Standard (how do you know when you’re done):**

When the cleanup levels in Table 1 of OU2 ROD Amendment #1 have been attained throughout the areal and vertical extent of the Site C plume.

**Has the Site C shallow groundwater remedy been completed (i.e., have the cleanup levels in Table 1 of the OU2 ROD Amendment #1 been attained throughout the areal and vertical extent of the Site C plume)?**

No. Table 7-2 presents FY 2018 groundwater quality data and highlights the values that exceed the lead cleanup level. Surface water quality data are presented on Table 7-3. Figure 7-2 presents groundwater elevation contours based on measurements in summer 2018. Figure 7-3 shows the lead results for groundwater and surface water locations. Figures 7-4 and 7-5 show the lead concentrations plotted on geologic cross sections for Site C to illustrate the vertical extent of contamination (the cross-section locations are illustrated on Figure 7-3).

In FY 2018, lead exceeded the groundwater cleanup level of 15 µg/L in two monitoring wells located near the source area. The lead concentrations at MW-13 and MW-14 were detected at 150 µg/L and 61 µg/L in summer 2018. The water quality trends (dissolved lead) for wells nearest the source (MW-3, MW-13, MW-14, and MW-15) are shown on Figure 7-6. As Figure 7-6 shows, the variable concentrations observed at individual wells in FY 2018 has occurred throughout recent years for the four source area wells. Overall, lead concentrations at source area wells have decreased significantly in the last 10 years indicating substantial progress towards reaching groundwater cleanup levels.

Surface water monitoring results were all below the surface water cleanup level in FY 2018.

**Were any trigger levels exceeded at any of the contingency locations?**

No. The Site C contingency locations and trigger levels are shown in Table 7-4. Depending on the location, the trigger level is either equal to the groundwater cleanup level or a surface water cleanup level. Groundwater and surface water results (Table 7-2 and Table 7-3) show that trigger levels were not exceeded in FY 2018. If a trigger level were exceeded, the Army would implement contingency action(s) specified in the footnotes to Table 7-4.

**Can it be determined whether a formal change to the remedy should be made (to eliminate the groundwater extraction and discharge components) or, possibly, whether the Site should just be closed?**

No. Two wells still exceeded the cleanup level. Additional monitoring should be conducted before this determination is made.

**Do additional remedial measures need to be addressed?**

No. Site C wells have had stable COC concentrations and the existing groundwater plume does not appear to be migrating. Continued monitoring of the site will be performed to evaluate when closure for Site C is appropriate.

# 8 OPERABLE UNIT 2: SITE I SHALLOW GROUNDWATER

VOCs have been identified in Unit 1 (perched aquifer) at Site I. The selected remedy in the OU2 ROD (1997) consisted of four components: Groundwater monitoring, Groundwater extraction, POTW discharge, and Additional characterization.

The additional investigation and Predesign Investigation Work Plan (Work Plan) were completed in FY 2000. Based on these documents, the proposed remedy was to consist of a dual phase vacuum extraction system, which combined groundwater extraction with soil vapor extraction, to be installed beneath Building 502. A dual phase extraction pilot test subsequently determined that the technology was not feasible due to the low Unit 1 permeability. OU2 ROD Amendment #2 (2009) revised the requirements for shallow groundwater to groundwater monitoring, additional characterization and LUCs. These three major remedy components are evaluated in the following sections

## 8.1 Remedy Component #1: Groundwater Monitoring

**Description:** " Groundwater monitoring to track remedy performance." (OU2 ROD, page 3).

**Performance Standard (how do you know when you're done):**

When a monitoring plan has been established and ongoing monitoring is in compliance with the plan.

**Is the remedy component being implemented?**

Yes. Table 8-1 summarizes the performance monitoring requirements, the implementing parties, and documents containing monitoring plans. Appendix A summarizes the FY 2018 monitoring plan and any deviations are explained in Appendix C.2.

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 could be delayed beyond FY 2019 due to the extent of pending regrading associated with planned site redevelopment. Because well 01U667 was not replaced in FY 2018, no groundwater sampling was conducted during FY 2018. Once reinstalled, monitoring well 01U667 will be sampled annually in accordance with the FY 2018 - FY 2022 Monitoring Plan (Appendix A.1). Figure 8-1 presents a site plan for Site I, including the former locations of the now abandoned monitoring wells and a cross section location presented on Figure 8-2.

**Is any groundwater sampling proposed prior to the next report?**

Yes, although it is contingent on completion of grading activities in this area and subsequent reinstallation of monitoring well 01U667. Groundwater monitoring at Site I will be in accordance with the monitoring plan shown in Appendix A.1.

**Are any changes or additional actions required for this remedy component?**

Yes. Monitoring well 01U667 must be reinstalled after grading activities have been completed.

## 8.2 Remedy Component #2: Additional Investigation

**Description:** "Additional characterization of the Unit 1 and Unit 2 soil and groundwater." (OU2 ROD, page 3).

**Performance Standard (how do you know when you're done):**

When the work has been completed according to an agency approved work plan.

**Has the remedy component been implemented?**

Yes. Additional investigation results were included in Appendix A of the Predesign Investigation Work Plan (January 1999) which resulted in a pilot study to evaluate dual phase vacuum extraction technology applicability. The resultant Predesign Investigation Report (March 2001) concluded that neither dual phase extraction nor groundwater extraction is feasible at Site I. The May 2009 OU2 ROD Amendment removed the groundwater extraction and POTW discharge component of the remedy.

**Are any changes or additional actions required for this remedy component?** No.

## 8.3 Remedy Component #3: Land Use Controls

**Description:** "LUCs will be 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." (OU2 ROD Amendment #1, page 39).

**Performance Standard (how do you know when you're done):**

Implementation of the land use controls will continue until such time that the groundwater concentrations are below the cleanup levels.

**Has a LUCRD document been approved to address land use control (LUC) issues for OU2, including Site I groundwater, and is it being implemented?**

Yes. The USEPA and MPCA provided consistency approval for the OU2 LUCRD in September 2010, and the LUCRD is being implemented by the Army. Subsequent revisions to the LUCRD have not changed the groundwater LUCs for Site I. Following additional soil investigation and remediation completed by Ramsey County in 2014/2015, the site is now suitable for unrestricted use/unlimited exposure and soil LUCs at Site I are no longer necessary. The USEPA and MPCA provided consistency approval for the OU2 LUCRD Revision 5 in March 2018, which formally removes Site I soil LUCs.

**Was an annual site inspection for land use controls conducted in FY 2018?**

On July 30, 2018, the Army, National Guard, and JV conducted the annual OU2 site inspection. The completed checklist is included as Appendix F.

**Did the inspection identify any follow up actions needed to maintain the protectiveness of the LUCs?** No.

## 8.4 Overall Remedy for Site I Shallow Groundwater

**Performance Standard (how do you know when you're done):**

When the cleanup levels in Table 1 of the OU2 ROD have been attained throughout the areal and vertical extent of the Site I plume (OU2 ROD, page 55).

**Has the Site I shallow groundwater remedy been completed (i.e., have the cleanup levels in Table 1 of the OU2 ROD been attained throughout the areal and vertical extent of the Site I plume)?**

No. Groundwater monitoring was not conducted in FY 2018 due to the approved abandonment of all Unit 1 wells related to Site I demolition activities; however, the most recent groundwater quality data (from FY 2013) suggests that cleanup levels have not been attained. Table 8-2 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 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 8-3 presents the FY 2013 Site I shallow groundwater TCE and vinyl chloride sample results.

**Do additional remedial measures need to be addressed?**

Yes. As requested by Orbital ATK (now Northrop Grumman) in their letter dated August 12, 2013 and approved by the USEPA and MPCA on August 14, 2013, all Unit 1 monitoring wells were abandoned in 2014. In accordance with the Orbital ATK request and agency approval, monitoring well 01U667 will be reinstalled at the same location and depth following completion of redevelopment-related grading to occur at former Building 502, with expected installation to be in 2018. However, due to the significant extent of grading to occur, reinstallation of 01U667 could be delayed.

# 9 OPERABLE UNIT 2: SITE K SHALLOW GROUNDWATER

VOC contamination has been identified in Unit 1 (perched aquifer) at former Building 103. The limits of the VOC plume in the perched groundwater have been defined to be beneath and immediately northwest of former Building 103.

The remedy selected in the OU2 ROD consisted of seven components that incorporated the existing groundwater extraction trench and air stripper, which began operation in August 1986. The remedy also included additional investigation of the unsaturated soils beneath the building slab. OU2 ESD #1 added LUCs as a remedy component in 2009.

## 9.1 Remedy Component #1: Groundwater Monitoring

**Description:** "Groundwater monitoring to track remedy performance." (OU2 ROD, page 3)

**Performance Standard (how do you know when you're done):**

When a monitoring plan is established, and monitoring is in compliance with the plan.

**Is the remedy component being implemented?**

Yes. Table 9-1 summarizes the performance monitoring requirements, the implementing parties, and the monitoring plan documents. Appendix A summarizes the FY 2018 monitoring plan and any deviations are explained in Appendix C.2.

Water levels are collected annually from monitoring wells and bundle piezometers in the vicinity of the groundwater collection and treatment system. In FY 2014, 15 Unit 1 monitoring wells were permanently abandoned, as approved by the USEPA/MPCA on August 14, 2013 and May 7, 2014. In FY 2017, one Unit 1 monitoring well (01U047) was permanently abandoned as approved by the USEPA/MPCA in September 2017. The monitoring wells currently included in the Site K Monitoring Plan were sampled in June/July 2018. Figure 9-1 presents the sampling and water level monitoring locations, as well as the location of the monitoring wells that have been abandoned. Figure 9-1 also shows the cross-section alignment.

Three of the wells abandoned in 2014 (01U608, 01U609, and 01U611) were scheduled to be reinstalled in spring 2017; however, the schedule has been extended due to delays associated with site redevelopment. Once reinstalled, the wells will have the same monitoring requirements as 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. Monitoring well 01U047 was permanently abandoned in FY 2017 for site redevelopment activities and will not be reinstalled once the redevelopment activities are completed.

**Is any groundwater sampling proposed prior to the next report?**

Yes. Groundwater monitoring at Site K will be in accordance with the monitoring plan shown in Appendix A.1.

**Are any changes or additional actions required for this remedy component?**

Yes. Wells 01U608, 01U609, and 01U611, which were abandoned in 2014, are scheduled to be reinstalled once construction activities associated with site redevelopment are completed.

## 9.2 Remedy Component #2: Sentinel Wells

**Description:** "Installation of sentinel wells at the bottom of Unit 1 and top of Unit 3." (OU2 ROD, page 3)

**Performance Standard (how do you know when you're done):**

When the wells have been installed according to a regulator approved work plan.

**Is the remedy component being implemented?**

Yes. The Upper Unit 3 sentinel well was installed in February 2000 to monitor potential VOCs migration through the Unit 2 till aquitard into the Unit 3 aquifer.

Existing piezometers were used to accomplish the deep Unit 1 sentry monitoring. Piezometers 01U625D, 01U626D, 01U627D, and 01U628D were used since they monitor the Unit 1 aquifer base near the trench. The issue is the potential for Dense Non-Aqueous Phase Liquids (DNAPLs) to migrate beneath the trench along the Unit 1/Unit 2 interface. These four piezometers are screened at that interface. Figure 9-1 shows the location of the Upper Unit 3 sentinel well (03U621) and the piezometers.

**What are the results of the Unit 1 piezometer and Unit 3 sentinel well sampling?**

The piezometers (Unit 1 sentinel wells) were sampled in March 2000 with results showing no DNAPL presence at the Unit 1/Unit 2 interface, as discussed in the FY 2000 APR. This was a one-time sampling event, as required by the MPCA/USEPA approved Predesign Investigation Work Plan, Site K, TCAAP, CRA, February 1999, and as documented in the Predesign Investigation Report, Site K, TCAAP, CRA, December 2001, for which concurrence was received.

The Unit 3 sentinel well (03U621) was sampled in March, July, and September 2000 and in January 2001 for the quarterly sampling required by the Work Plan. Subsequently, the well was incorporated into the regular TCAAP monitoring plan. The well was sampled in June 2018 for FY 2018 with results presented in Table 9-7. No Site K COCs were detected in the Unit 3 sentinel well at concentrations above the method detection limit. However, the 03U621 sample reported a 1,4-dioxane concentration of 8.3 (duplicate 8.4) µg/L. 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.

**Are any changes or additional actions required for this remedy component?** No.

## 9.3 Remedy Component #3: Hydraulic Containment

**Description:** "Use of existing interceptor/recovery trench to contain the plume and remove impacted groundwater." (OU2 ROD, page 3)

**Performance Standard (how do you know when you're done):**

When the trench is operating as designed and capturing all groundwater exceeding the cleanup levels as presented in Table 1 of the OU2 ROD, and further described below.

**Is the remedy component being implemented?**

Yes. The groundwater collection system continues to provide capture (as described later) of the Unit 1 groundwater, upgradient of the trench and beneath the former Building 103 footprint, as designed. In FY 2014, the Building 103 slab was removed as part of the site redevelopment activities.

**Is the system providing hydraulic capture of the plume?**

Yes. Water level data are presented in Table 9-3. Figure 9-2 presents a plan view of the groundwater contours from the June 2018 round of groundwater level measurements. At nested wells, the numerically lowest water elevation was used to create the plan view contours. Monitoring wells downgradient (i.e. 01U627) of the extraction trench show consistently higher water levels than those near of the trench (i.e. 01U626). This demonstrates that the horizontal hydraulic gradient has been reversed toward the extraction trench due to system operation.

Vertical capture was also effective as illustrated on Figure 9-3. As seen in the figure, groundwater both upgradient and downgradient of the trench is captured and collected. The upward gradient exhibited on the downward gradient side of the trench (01U626) indicates that groundwater does not migrate below the trench. The monitoring coverage provided by the bundle piezometers, demonstrates complete vertical and horizontal hydraulic capture.

Upgradient well (01U625C) is obstructed. The cause of the obstruction is unknown. An unsuccessful attempt was made to remove the obstruction the spring 2017 and again in the spring of 2018. Well 01U625C is not critical in the collection trench flow evaluation. Historically, this well has maintained a similar groundwater elevation as 01U625B and 01U625D (see Appendix D). Based on 2016, 2017, and 2018 groundwater elevation data showing the return to typical levels, the abandonment of 01U625C, without subsequent replacement, is recommended.

Figure 9-4 presents the TCE concentrations from the 2018 annual sampling event. The plume was originally defined based on data from all of the monitoring wells. The plume was then refined based on the results of the 2014 geoprobe investigation. The current monitoring well network is used to confirm the plume contours and measure the progress of remediation. Thus, the contours on Figure 9-4 were drawn with consideration of the extensive historical data, specifically the 2014 data from the geoprobe investigation.

**Are any changes or additional actions required for this remedy component?**

Not at this time. Two monitoring wells (01U604 and 01U628) historically used to monitor hydraulic capture were abandoned in 2014 because of site redevelopment activities. However, existing wells (01U603, 01U612, 01U615, 01U617, 01U621, 01U625, 01U626 and 01U67) located up and down gradient of the collection trench provide adequate coverage for shallow groundwater hydraulic and water quality monitoring and verify hydraulic containment at Site K. Additional monitoring (including the need for additional monitoring wells) will be evaluated upon completion of redevelopment plans for the area.

## 9.4 Remedy Component #4: Groundwater Treatment

**Description:** “Treatment of contaminated groundwater using air stripping.” (OU2 ROD, page 3)

**Performance Standard (how do you know when you’re done):**

When the air stripping facility is treating water to the cleanup standards.

**Is the remedy component being implemented?**

Yes. During FY 2018, the treatment system functioned and was operational 96% of the time. During FY 2018, a regular maintenance schedule was maintained. Appendix G.1 summarizes operational data and events at the groundwater extraction and treatment system.

**Are any changes or additional actions required for this remedy component?** No.

## 9.5 Remedy Component #5: Treated Water Discharge

**Description:** "Discharge of treated groundwater to Rice Creek." (OU2 ROD, page 3)

**Performance Standard (how do you know when you're done):**

When the system is operating as designed and the treated water discharges to the storm sewer that outlets to Rice Creek. Treated water is required to meet the substantive requirements of Document No. MNU0009579 (MPCA), which contains the state-accepted discharge limits for surface water. Sampling and analysis are performed to monitor performance (see below).

**Is the remedy component being implemented?**

Yes. See discussion in Section 9.6.

**Are any changes or additional actions required for this remedy component?** No.

## 9.6 Remedy Component #6: Discharge Monitoring

**Description:** "Monitoring to track compliance with discharge requirements." (OU2 ROD, page 3)

**Performance Standard (how do you know when you're done):**

When a monitoring plan is established and is being implemented in accordance with the plan.

**Is the remedy component being implemented?**

Yes. Treatment system monitoring consisted of quarterly influent and effluent sampling. Influent and effluent analytical results are presented in Table 9-4 (organics) and Table 9-5 (inorganics). The discharge met the treatment requirements during FY 2018. As report in the FY 2017 APR, infrequent exceedances of the phosphorus and zinc discharge criteria occurred but no cause was determined. Sampling procedures were modified to thoroughly flush all sampling piping before effluent samples are collected. This procedure has apparently reduced the potential that particles accumulating on the piping are not being carried over into the samples causing the exceedances of zinc and phosphorus limits.

**Are any changes or additional actions required for this remedy component?** No.

## 9.7 Remedy Component #7: Additional Investigation

**Description:** "Additional characterization of the unsaturated Unit 1 soil." (OU2 ROD, page 3)

**Performance Standard (how do you know when you're done):**

When the additional investigation has been completed according to a regulator approved work plan.

**Is the remedy component being implemented?**

Yes. The Work Plan was approved in FY 1999. A report of the investigation results received a consistency determination from the Agencies on December 6, 2001. The report defined the extent of VOC contaminated soils beneath Building 103 and refined the location of the source area. The report and subsequent follow up sampling resolved anomalous dissolved zinc, lead, and nickel data at two monitoring wells. Zinc, lead, and nickel are no longer groundwater concerns.

**Are any changes or additional actions required for this remedy component?** No.

## 9.8 Remedy Component #8: Land Use Controls

**Description:** "LUCs will be 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." (OU2 ROD Amendment #1, page 39)

**Performance Standard (how do you know when you're done):**

Implementation of the land use controls will continue until such time that the groundwater concentrations are below the cleanup levels.

**Has a LUCRD document been approved to address land use control (LUC) issues for OU2, including Site K groundwater, and is it being implemented?**

Yes. The USEPA and MPCA provided consistency approval for the OU2 LUCRD in September 2010 and it is being implemented by the Army. Subsequent revisions to the LUCRD have not affected the groundwater LUCs for Site K.

**Was an annual site inspection for land use controls conducted in FY 2018?**

On July 30, 2018, the Army, National Guard, and JV conducted the annual inspection of OU2 sites. The checklist that was completed during the inspection is included as Appendix F.

**Did the inspection identify any follow-up actions needed to maintain the protectiveness of the LUCs?** No.

## 9.9 Overall Remedy for Site K

**Performance Standard (how do you know when you're done):**

Once the cleanup levels in Table 1 of the OU2 ROD have been attained throughout the areal and vertical extent of the Site K plume (OU2 ROD, page 55).

**Has the Site K shallow groundwater remedy been completed (i.e., have the cleanup levels in Table 1 of the OU2 ROD been attained throughout the areal and vertical extent of the Site K plume)?**

No. Overall, the remedy for Site K continued to operate consistent with past years and in compliance with the required performance criteria.

Table 9-6 presents the VOC mass removal and monthly flow rates. The treatment system captured and treated 4,667,972 gallons of water resulting in the removal of 7.9 pounds of VOCs from the aquifer in FY 2018. The cumulative VOC mass removal is 389 pounds of VOCs.

As shown on Figure 9-4, TCE concentrations ranged from non-detect to 1,500 µg/L. In general, Site wide TCE concentrations were lower than those reported in 2016. Monitoring wells 01U611 and 01U615 monitored 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 2018. Prior to abandonment, TCE concentrations at monitoring well 01U611 had been relatively stable over the previous seven years, ranging from 4,900 µg/L to 11,000 µg/L.

The TCE concentration at well 01U615 slightly increased from 1,200 µg/L in FY 2017 to 1,500 µg/L in FY 2018. The FY 2018 concentration of TCE at 01U615 is still low compared with historical concentrations from the last ten years of sampling, which have ranged from 1,200 µg/L to 6,500 µg/L. Figure 9-5 shows TCE and total 1,2-dichloroethene versus time for 01U615. Water levels measured during the FY 2018 monitoring were 1.8 feet lower at 01U615 compared to FY 2017 elevations. This well has historically exhibited fluctuating groundwater elevations.

Concentrations of TCE in monitoring well 01U603 had always been non-detect (less than 1.0 µg/L). However, in May 2014, TCE was detected at a 2,000 µg/L in 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 the well. However, groundwater samples collected downgradient of 01U603 as part of a Site K geoprobe investigation in September 2014 were non-detect for TCE and confirmed capture by the collection trench. The geoprobe investigation in 2014 determined 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. The geoprobe results were submitted to the USEPA and MPCA in a letter dated February 3, 2015. Since that time, TCE concentrations in 01U603 have steadily declined, to 1200 µg/L (FY 2015), 30 µg/L (FY 2016) and now 3.3 µg/L (FY 2017). In FY 2018 the TCE concentration slightly increased from 3.3 µg/L (FY 2017) to 5.1 µg/L.

Well 01U617 continues to exhibit low and relatively consistent concentrations of 1,2-dichloroethene downgradient of the groundwater collection system's capture zone. The concentration at this well was consistent with those measured in FY 2014 and previous years. The detected 1,2-dichloroethene concentration is below the cleanup level for Site K.

**Do additional remedial measures need to be addressed?** No.

## 9.10 Other Related Activity in FY 2018

In March 2015, the USEPA and MPCA requested sampling and analysis for 1,4-dioxane to be included in the annual sampling event for Site K. The analysis was added to all regularly-scheduled monitoring wells in 2015 and 2016. Due to low 1,4-dioxane concentrations in Unit 1 wells (less than 1 µg/L), no Unit 1 wells were required to be sampled for 1,4-dioxane in FY 2017. Unit 3 monitoring well, 03U621 had a 1,4-dioxane concentration exceeding the HRL in 2015, 2016, and 2017, therefore, monitoring well 03U621 was sampled for 1,4 dioxane in FY 2018. The 1,4-dioxane concentration at 03U621 decreased from 9.3 µg/L in FY 2016 to 8.4 µg/L in FY 2017 to 8.4 µg/L in FY 2018. As mentioned above, the presence of 1,4-

dioxane in 03U621 is likely related to its presence in Unit 3 groundwater throughout the western portion of TCAAP, as opposed to a release from Site K.

Table 9-7 presents the FY 2018 1,4-dioxane sampling results. No Federal MCL has been established for 1,4-dioxane; however, the MDH established a HRL value of 1.0 µg/L as shown on Table 9-7.

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# 10 OPERABLE UNIT 2: BUILDING 102 SHALLOW GROUNDWATER

The former Building 102, located as shown on Figure 10-1, was constructed in 1942 and used periodically until the 1980s for production of small caliber ammunition and various other munitions components. Between March 2002 and February 2004, shallow (Unit 1) groundwater contamination was discovered emanating from beneath Building 102 (discovered during Phase I and Phase II Environmental Site Assessment [ESA] in support of future TCAAP property transfer).

Additional groundwater investigation was conducted and is documented in the Groundwater Investigation Report for Building 102 (Wenck and Keres Consulting Inc 2006), approved by the USEPA and MPCA in FY 2006. The Army then proceeded to address the remedy for Building 102 shallow groundwater as a non-time critical removal action under Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). To support the Engineering Evaluation/Cost Analysis (EE/CA), additional groundwater investigation was conducted in FY 2007 and FY 2008 to further define the extent and magnitude of groundwater contamination. Delineation was completed and COCs were identified, including TCE and related chlorinated VOCs (TCE was found to be degrading to cis-1,2-DCE and vinyl chloride through abiotic degradation). The EE/CA documenting the additional investigation work and recommending a remedy for Building 102 shallow groundwater was approved by the USEPA and MPCA in FY 2008.

The Army Action Memorandum documenting the final remedy selection for Building 102 groundwater MNA was signed in FY 2009. The remedy also includes LUCs to prohibit installation of water supply wells in the contaminated portion of the Unit 1 aquifer and protect the groundwater monitoring system infrastructure (i.e., monitoring wells). OU2 ROD Amendment #4 formally documented selection of MNA and LUCs for the Building 102 groundwater remedy and thereby added this site to the OU2 remedy.

The decision to proceed with MNA was based on strong evidence from water quality monitoring (i.e., degradation products) and on MPCA microcosm studies which verified abiotic degradation of VOCs in Building 102 groundwater is occurring at substantial rates. Such degradation acts to reduce contaminant mass and mobility by breaking down the contaminants as they migrate. The decision to proceed with MNA was also based on the absence of any groundwater receptors.

## 10.1 Remedy Component #1: Monitored Natural Attenuation

**Description:** ""Use of naturally-occurring abiotic degradation to limit plume mobility and to ultimately restore the aquifer" (OU2 ROD Amendment #4, page 4-1).

**Performance Standard (how do you know when you're done):**

When a monitoring program is established, and monitoring is in compliance with the regulator approved Annual Monitoring Plan.

**Is the remedy component being implemented?**

Yes. Appendix A summarizes the FY 2018 monitoring plan and any deviations are explained in Appendix C.2. Details of the groundwater monitoring program are discussed in the next section.

## 10.2 Remedy Component #2: Groundwater Monitoring

**Description:** "Groundwater monitoring to track remedy performance and to verify that groundwater reaching Rice Creek does not exceed state surface water standards" (OU2 ROD Amendment #4, page 4-1).

**Performance Standard (how do you know when you're done):**

When a performance groundwater monitoring program has been established and ongoing monitoring is in compliance with the program.

**Is this remedy component being implemented?**

Yes. Table 10-1 summarizes performance monitoring requirements, implementing parties, and the documents that contain the monitoring plans. The FY 2018 Monitoring Plan is included in Appendix A, documenting the water quality monitoring locations and frequencies. Building 102 groundwater level data collected in summer 2018 are shown as groundwater elevation contours on Figure 10-2. Site K water levels are also contoured to provide a more complete water level map in the Site vicinity. Groundwater quality data collected in FY 2018 are shown in Table 10-2. Groundwater quality data for FY 2018 are also shown for three of the COCs: TCE (Figure 10-3), cis-1,2-DCE (Figure 10-4), and vinyl chloride (Figure 10-5). Figure 10-6 shows the vinyl chloride concentrations plotted on geologic cross sections for Building 102 to illustrate the vertical extent of contamination (the cross-section locations are illustrated on Figure 10-5.)

Monitoring for 1,4-dioxane was repeated during FY 2018 summer sampling to verify that 1,4-dioxane is not a COC in Building 102 shallow groundwater. As shown in Table 10-2, there were no detections of 1,4-dioxane in Building 102 shallow groundwater during summer 2018. Monitoring for 1,4-dioxane will be discontinued in Building 102 shallow groundwater.

**Were the groundwater monitoring requirements for this remedy met?** Yes.

**Is any groundwater sampling proposed prior to the next report?**

Yes. Groundwater monitoring at Building 102 will be in accordance with the monitoring plan shown in Appendix A.1.

**Are any changes or additional actions required for this remedy component?** No.

## 10.3 Remedy Component #3: Land Use Controls

**Description:** : "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)" (OU2 ROD Amendment #4, page 4-2).

**Performance Standard (how do you know when you're done):**

Implementation of the LUCs will continue until such time that the groundwater concentrations are below the cleanup levels.

**Has a LUCRD document been approved to address LUC issues for OU2, including Building 102 groundwater, and is it being implemented?**

Yes. The USEPA and MPCA provided consistency approval for the OU2 LUCRD in September 2010 and is being implemented by the Army. Subsequent revisions of the LUCRD have not changed the groundwater LUCs for Building 102.

**Was an annual site inspection for LUCs conducted in FY 2018?**

Yes. On July 30, 2018, the Army, National Guard, and JV conducted the annual inspection of OU2 sites. The completed checklist during inspection is included as Appendix F.

**Did the inspection identify any follow-up actions needed to maintain the protectiveness of the LUCs?** No.

## 10.4 Overall Remedy for Building 102 Shallow Groundwater

**Performance Standard (how do you know when you're done):**

When the cleanup levels in OU2 ROD Amendment #4 have been attained throughout the areal and vertical extent of the Building 102 plume (OU2 ROD Amendment #4, page 2-13).

**Has the Building 102 shallow groundwater remedy been completed (i.e., have the cleanup levels in the table on Page 2-13 of OU2 ROD Amendment #4 been attained throughout the areal and vertical extent of the Building 102 plume)?**

No. As shown in Table 10-2, cleanup levels have not been reached throughout the areal extent of the plume and the site cannot be closed. TCE concentrations exceed the cleanup level in three monitoring wells and vinyl chloride exceeds the cleanup level in one monitoring well.

**What impact is MNA having on contaminant concentrations?**

Natural attenuation continues to occur, 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). Significant changes that were noted in the FY 2018 groundwater quality results include:

- 01U579 and 01U580 (source area): TCE concentration increased marginally in 01U579 and 01U580 from 0.7 µg/L and 1.1 µg/L to 1.5 µg/L and 1.2 µg/L, respectively. Historically, the concentrations in these two wells have shown relatively large increases and decreases.
- 01L582 (further downgradient of the source area): Concentration of cis-1,2-DCE increased (8 µg/L to 16 ug/L), however this well appears to be stable and is still below the cleanup level of 70 ug/L. The vinyl chloride concentration was consistent at 0.26 µg/L, which exceeds the Building 102 cleanup level.
- 01U048 (adjacent to Rice Creek): 1,4 dioxane was not detected in this well in FY 2018. 1,4- Dioxane was detected at 1.1 µg/L in FY 2017, above the MDH HRL of 1.0 µg/L. The 1,4-dioxane concentration increased in the previous three years of monitoring; this well was non-detect for 1,4-dioxane in 2015 and had a concentration of 0.15 µg/L in 2016.

**Were any trigger levels exceeded at the contingency location?**

No. The contingency location is 01U048, located next to Rice Creek. The trigger level is equal to groundwater cleanup levels or, in the case of 1,4-dioxane, the MDH HRL. No COCs for Building 102 shallow groundwater exceeded their respective cleanup levels in FY 2018 (Table 10-2).

**Do additional remedial measures need to be addressed?**

No. However, it should be noted that as part of Ramsey County's site redevelopment work, Ramsey County has relocated a section of Rice Creek to create more space for construction of a new I-35W / County Road H interchange. The relocation work placed Rice Creek much closer to the west side of the Building 102 plume. While the long-term impacts to groundwater flow are not yet known, given that Unit 1 groundwater discharges to Rice Creek, it is a possible that the new location could cause contaminated groundwater to begin flowing in a more westerly direction, and could potentially discharge into the creek in its revised location rather than continuing to discharge into the creek near 01U048. With this potential adverse outcome in mind, in FY 2016, Ramsey County installed two sets of nested monitoring wells adjacent to the revised creek location, on the east side of the creek near the point of potential groundwater discharge. Ramsey County intends to perform ongoing sampling at the new wells. The MPCA has indicated to Ramsey County that if Ramsey County's actions cause a shift in the Building 102 plume and resultant exceedance of an action level in a Ramsey County Rice Creek monitoring well, it will be Ramsey County's responsibility to address that situation.

Bay West, working on behalf of Ramsey County, provided the "Groundwater Monitoring Report – August 2018 Sampling Event for the Rice Creek Remeander, TCAAP Redevelopment" to Arcadis in September 2018. According to quarterly groundwater monitoring performed at Building 102 beginning in March 2017 after completion of the remeander through August 2018, there appears to be no impacts to groundwater quality. Vinyl chloride was detected in 01URC1D during the March 2017 event at a concentration of 0.058 µg/L and at a concentration of 0.086 µg/L during the August 2018 event, which are well below the MDH HRL of 0.2 µg/L. As of the August 2018 groundwater monitoring event, there was no apparent change in the Building 102 plume configuration or groundwater flow. Bay West will continue to monitor the groundwater quality during two additional semi-annual events and will provide a monitoring report with cumulative monitoring data following each event. For a more detailed summary of the Rice Creek Remeander groundwater monitoring, refer to Bay West, 2018.

It should also be noted that Ramsey County plans further development in this area that may result in loss of monitoring wells (subject to Army and regulator approval) due to installation of a storm water control basin. Ongoing efforts will be made to address any issues resulting from Ramsey County's development plans.

# 11 OPERABLE UNIT 2: AQUATIC SITES

The Tier II Ecological Risk Assessment Report (U.S. Army Center for Health Promotion and Preventative Medicine [USACHPPM] 2004) for aquatic sites, was approved by the MPCA and USEPA in December 2004. In June 2005, the Army submitted a draft feasibility study (FS) for aquatic sites to support the risk management decisions with respect to “No Further Action” or “Implement a Remedy” for each aquatic site. Following comments to the draft FS, it was agreed that additional sampling of Marsden Lake and Pond G would be conducted. This sampling was completed in 2008. Revised draft FS versions were submitted in January 2009 and April 2010. After review of the 2010 draft FS, the USEPA and MPCA requested that the Army prepare a work plan for collection of additional Round Lake sediment data (Round Lake is located off the southwest corner of OU2). Given the time required to collect the additional data, the Army, USEPA, and MPCA agreed to separate the FS into two documents: one for Round Lake and one for the OU2 aquatic sites, i.e., Rice Creek, Sunfish Lake, Marsden Lake North, Marsden Lake South, and Pond G. These sites are located as shown on Figure 11-1.

The USEPA and MPCA provided consistency for the Rice Creek, Sunfish Lake, Marsden Lake, and Pond G FS in January 2011. No Action was recommended for Rice Creek, Sunfish Lake, Marsden Lake North, and Marsden Lake South. A remedy was recommended for Pond G (surface water hardness adjustment) to attain compliance with the Minnesota surface water standard for lead (Class 2Bd chronic standard). OU2 ROD Amendment #4, which documents selection of the recommended alternative, was signed in January 2012.

The USEPA and MPCA provided consistency for the Pond G RD/RA Work Plan in March 2012, and the pond was treated in June 2012. The pond surface water was then monitored in 2012 and 2013, and results verified compliance with the surface water standard for lead. The completed Pond G remedial action work and surface water monitoring results were documented in the Remedial Action Completion and Close Out Report, Pond G (Wenck 2013b), which received regulatory consistency approval in FY 2014. The report recommended that the Pond G site be closed with no long-term maintenance, monitoring, or LUC requirements. The 2014 CERCLA five-year review also indicated final concurrence regarding the adequacy of the Pond G remedy, and the Pond G site has been closed. Since the completed remedy does not result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, future CERCLA 5-year reviews are not required for Pond G and, as noted above, there are no monitoring or LUC requirements.

# 12 OPERABLE UNIT 2: DEEP GROUNDWATER

The selected remedy for the Deep Groundwater in the OU2 ROD consists of five remedial components that include continued use of the TGRS, with modifications to improve VOC contaminant removal from the source area. It also includes an annual review of new and emerging technologies potentially applicable to the Deep Groundwater. This report documents all performance and monitoring data collected from October 2017 through September 2018.

**Historical Design and Evaluation of TGRS Remedial Action**

Historical design has been previously discussed in various APRs to date. As a brief summary, an Interim Response Action Plan for TCAAP (USEPA 1987) was prepared providing specific criteria for the Boundary Groundwater Recovery System (BGRS) which started on October 19, 1987. Initially operated as six extraction wells on the southwest OU2 boundary, the BGRS was later expanded between 1987 and 1989 to include six additional extraction and five source control wells as part of the TGRS. The TGRS was designed to prevent TCE mass migrating from OU2 towards OU1 based on a 5 µg/L TCE plume contour width at the southwestern OU2 boundary. As the TCE plume has narrowed since the start of operation, select wells positioned outside the plume footprint, or not contributing substantive capture benefit, have been turned off. As of 2018, 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 gallons per minute (gpm), which includes a significant safety margin above its current operational flow rate to accommodate potential fluctuations in system operation.

The 1989 Annual Monitoring Report was the first report covering the fully configured TGRS, which concluded that a continuous zone of capture, approximately 4,500 feet wide, was developed at the TCAAP property boundary. The zone of capture widened to approximately 8,300 feet upgradient of the boundary. This zone of capture was developed at average system pumping rates of 2,400 to 2,700 gpm.

Operation of the TGRS remedy has been effective in reducing COC concentrations at nearly all OU2 monitoring wells by over approximately one order of magnitude. Significant reductions in TCE concentrations were evident during the early 1990s; however, slower relative declines in TCE concentration have occurred over the last 10 to 20 years. A remedy review was conducted and approved by the regulatory agencies in June 2018. This report presents improvements for consideration toward overall mass removal and TGRS operational efficiency.

In FY 2003, the Army received agency approval on the TGRS Operating Strategy (OS) document. The OS was based, in part, on findings from the 1989 Annual Monitoring Report. The OS presented a Global Operation Strategy (GOS) for the entire TGRS extraction system and a Micro Operation Strategy (MOS) for selected well groups. Evaluations now consider and compare actual pumping rates to the GOS and MOS rates presented in the Final TGRS OS.

**TGRS Modifications**

For most of FY 2018, the TGRS operated with 11 extraction wells. However, in September 2018, the agencies approved shutdown of SC2. As a result of the TCAAP Operable Unit Remedy Review, up to three additional extraction wells are proposed to be installed and operated during FY 2019. One of these wells will be located downgradient of Site G and serve as a replacement for SC2. For more detailed discussion on historical modifications refer to previous APRs.

## 12.1 Remedy Component #1: Hydraulic Containment and Contaminant Removal From the Source Area

**Description:** "Groundwater extraction to hydraulically contain the contaminated source area to the 5 µg/L TCE concentration contour and optimize the removal of contaminants from the source area through pumping of select wells." (OU2 ROD, page 3)

**Performance Standard (how do you know when you're done):**

When the TGRS is containing the contaminated source area to the 5 µg/L TCE contour and the system is operated to maximize the contaminant removal from the source area.

**Is the remedy component being implemented?**

Yes. The TGRS operated in FY 2018 consistent with the requirements of the OU2 ROD. Table 12-1 presents the TGRS cleanup requirements per the OU2 ROD. During FY 2018, the TGRS average extraction rate was approximately 1,746 gpm, as shown in Table 12-2. This rate meets the GOS Total System Operational Minimum (1,745 gpm) where the Army and the agencies agree that OU2 ROD requirements are met with an adequate safety factor.

Two of the three individual well groupings were above their respective MOS minimums for FY 2018. The B1, B11, B13 well grouping was below the MOS minimum of 415 gpm due to an approved February 2013 B11 shut down and TGRS maintenance events. B11 will continue to be monitored to verify containment.

**How is the system operated and what preventative maintenance measures were conducted during the year?**

Summary of Operations

Previous APRs denote the Summary of Operations. As of 2018, the TGRS operates with 11 wells including eight southwestern boundary extraction wells (B1, B3, B4, B5, B6, B8, B9, and B13) and three source control wells downgradient of interior OU2 source areas (SC1, SC2, and SC5). The TGRS layout is presented on Figure 12-1.

On September 6, 2018 GHD (on behalf of the Army) submitted an email to USEPA and MPCA requesting to discontinue pumping at SC2 because of extensive maintenance due to fouling (the well was down since July 2018) with very little benefit in the way of hydraulic containment or mass removal (typical operation was near 30 gpm). USEPA and MPCA agreed to the request in an email dated September 11, 2018.

The TGRS was designed and constructed with three options for treated water discharge: recharge at the Arsenal Sand and Gravel Pit, discharge to Rice Creek, and discharge to the elevated water tank. Water stored in the elevated tank was "softened" and then "polished" with GAC prior to distribution at the Facility. Since the Army discontinued all non-environmental services at the Facility in September 2007, the elevated water tank and the water softening and polishing equipment are no longer used. As such, the Arsenal Sand and Gravel Pit receives all of the extracted and treated water from the TGRS.

**System Operation Specifications**

In general, the influent and effluent water flow rates at the treatment plant are designed to be equal, thereby providing continuous operation of all processes and equipment. The following is a summary of the original system design parameters:

- The groundwater extraction system, including the treatment center and 17 TGRS extraction wells, was originally designed to provide a theoretical hydraulic capacity of 2,900 gpm and a sustained daily average capacity of 2,730 gpm.
- The influent to the treatment plant is divided between Towers 1 and 2, each receiving up to a maximum of 1,450 gpm.
- Wet Well Pumps 1 and 2 (WWP#1 and WWP#2 located in Wet Wells 1 and 2) transfer water to Towers 4 and 3, respectively. Each pump and tower handles up to a maximum of 1,450 gpm.
- Wet Well Pumps 3 and 4 (WWP#3 and WWP#4 located in Wet Well 3) discharge treated water to an end use at a combined rate of up to a maximum of 2,900 gpm
- Air blowers provide air to the towers. Each blower for Towers 1 and 2 is designed to provide 6,000 – 7,000 standard cubic feet per minute (scfm). The blowers for Towers 3 and 4 are designed to provide 9,000 – 14,000 scfm.

The TGRS was modified to allow for 2 air stripping tower treatment instead of the original design of 4 air stripping tower treatment, which resulted in a reduction of energy use while still meeting the 5 µg/L TCE effluent discharge limit. Wet Well Pumps 1 and 2 (40 horsepower each) and blowers 1 and 2 (5 horsepower each) were shut down and the valves to Towers 1 and 2 were closed. Since March 2010, groundwater has been effectively treated by air stripping Towers 3 and 4 while Towers 1 and 2 remain in standby.

Water level sensors within the wet wells communicate with the PLC according to changing water levels. A complete and balanced operation should provide continuing water levels above the low-level sensors and below the high-level sensors. However, given the probability of unbalanced flows for any number of reasons (e.g., changing hydraulic heads, maintenance, repairs, temporary malfunctions), the PLC has provisions within its program to cycle-off the extraction well(s) or wet well pumps according to high water levels occurring in the wet wells; and in turn, cycle-off the wet well pumps according to low levels occurring within these wet wells.

The system operates such that the wet well pumps cycle rather than the extraction well pumps. The rationale behind this is that there are a relatively small number of motors, starters and electrically controlled valves associated with the wet wells when compared with the extraction well field. This also provides for more continuous and complete hydraulic capture within the aquifer units. However, the extraction well field will cycle if necessary, starting with the least contaminated extraction well, B7 (if operating), and followed by the other extraction wells in a predetermined sequence. In summary, the priority of operation is as follows:

- Maintain constant operation of all extraction wells and air stripping towers above the operating minimum;
- Maintain the desired flow rates at individual wells;
- If operating in four tower mode, maintain WWP#1 and WWP#2 pumping rates equal to or slightly above the combined pumping rate of the extraction well field; and
- Maintain treatment center WWP#3 and WWP#4 pumping rate equal to or slightly above the WWP#1 and #2 pumping rate (if operating in four tower mode) or slightly above the combined pumping rate of the extraction well field (if operating in two tower mode).

**FY 2018 Maintenance and Inspection Activity**

During FY 2018, the following inspection and maintenance activities occurred:

Preventive Maintenance (PM): The extensive PM program allowed 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 was scheduled rather than waiting for the failure to occur. A broad range of system-specific information was collected during this year’s PM. This information is used to direct future repair work.

Electrical Inspection and Temperature Survey: A system-wide electrical inspection and infrared temperature survey was performed to identify loose connections and overheating components. Component overheating often precedes equipment failure. Electrical components that were identified as failing were replaced.

Verification of Flow Meters: As part of the routine PM, flow meters in the pumphouses were compared to a factory-calibrated flow meter. Flow volume measurements before and after conducting maintenance on the meters were compared to verify the consistency of measurements. Meters found to be out of calibration were replaced or recalibrated.

Daily Tracking of Flow Rates: Pumphouse and treatment center meter readings were recorded in the course of the daily inspections. Daily meter readings were tabulated and the flow rates were calculated and reviewed by the operations staff. Early detection of changes in flow rate was critical in early identification of failing equipment. By early detection of flow rate changes, equipment repair was typically scheduled before a failure occurred.

**Did the system operate at a rate sufficient for complete capture?**

Respective of current OU2 ROD requirements, yes. At 1,746 gpm, the total extraction well pumping rate was above the GOS Total System Operational Minimum (1,745 gpm) where the Army and the agencies agree that OU2 ROD requirements are met with an adequate safety factor. The TGRS OS pumping scheme was developed, in part, on the findings in the 1989 Annual Monitoring Report and updated to hydraulically capture the 5 µg/L TCE contour for the TCE source areas based on 2001 chemical data. A factor of safety was added to the base theoretical capture rate (1,200 gpm) to provide a buffer and/or flexibility for system maintenance. Based on this approach, a minimum combined TGRS extraction rate of 1,745 gpm was agreed to by the Army and the agencies that OU2 ROD requirements are met with an adequate safety factor.

Figure 12-2 plots the TGRS daily average flow rate from October 1, 2017 through September 30, 2018 and shows operation above the Operational Minimum (OM) for the majority of the time (253 days or 70 percent of the time) in FY 2018. Significant loss of extraction water volume occurred due to power failures and communications issues between wells and the Building 116 PLC. This issue has since been remedied. Appendix G.2 provides additional information on the various downtimes throughout FY 2018.

The monthly and annual volume of water pumped is presented in Table 12-2 and 12-3. Table 12-2 presents the pumphouse metered monthly flow volumes of each extraction well. The individual pumphouse flow meters are used to determine the amount of groundwater extracted from the various well groups, individual extraction wells, and the total amount of groundwater extracted during the fiscal year. Table 12-3 presents the combined pumphouse-metered flow volume (extraction wells) and the flow volumes metered at various stages in the treatment center along with historical data. These flow meters are used to evaluate the flow of water through the treatment process to ensure proper system operation.

As shown on Table 12-3, the TGRS successfully captured and treated approximately 917,437,500 gallons of contaminated water from October 2017 through September 2018 based on the sum of the individual pumphouse flow meters. This volume converts to an average flow rate of 1,746 gpm, which meets the GOS minimum of 1,745 gpm.

**Monthly Flow Reports**

Each month a Monthly Flow Report is prepared. The report includes the month's meter totalizer readings, calculated flow volumes and operational notes. Flow volumes are presented on a daily basis and are totaled to provide a monthly flow volume. A compilation of FY 2018 operational notes is presented in Appendix G.2. During FY 2018, the sum of the individual pumphouse flow meters was used to measure total flow volumes in monthly reports for comparison with Operating Strategy limits. Daily variation in readings at individual wells is primarily due to differences in the time of day when meter readings were taken.

**How much down time occurred during the year?**

The down time for each extraction well, over the last five years, is presented in Table 12-4. A summary of average down time for the pumphouses and the treatment center by the category of failure is presented in Table 12-5. A description of each down time event, organized chronologically, is presented in Appendix G.2. The same descriptions organized by affected pumphouse, treatment center, and forcemain is presented in Appendix G.3.

Treatment center and extraction well down times resulted primarily from failure and subsequent repair of components in the pumphouses, treatment center, and electrical service. The downtime in FY 2018 increased from FY 2017 (from 6.7 days in FY 2017 to 14.2 days in FY 2018). As explained above, the increase in downtime was primarily due to communication issues between the PLC and the pumphouses and electrical power outages.

**Description of Down Time Categories**

Pumphouse component failures accounted for an average of 1.9 days down time per pumphouse. The major pumphouse repairs causing down time were:

- Communication issues causing pumphouses to shut down when signal is lost,

- Electrical issues (including power outages), and
- Redevelopment of B5 and installation of larger capacity pump and motor, per the TCAAP Operable Unit Remedy Review.

Treatment center component failures and repairs that caused pumphouse down time consisted of electric check valve maintenance, malfunctions and repairs, and electrical control equipment failures and troubleshooting communication issues and subsequent repairs.

Treatment center component failures, repairs, and adjustments accounted for an average of 0.5 days down time per pumphouse. The major treatment center repair causing substantial down time was a failed pilot and solenoid valve that had to be removed and rebuilt.

Electrical service system failures accounted for an average of 4.9 days down time per pumphouse. Electrical storm damage and power grid failures were the primary causes of down time.

Preventative maintenance procedures accounted for less than 0.5 days of down time in FY 2018. For the most part, preventative maintenance was able to be performed without interruptions to the treatment system. Preventative maintenance procedures are described in the project Operation and Maintenance Manual. System modifications did not account for any days of down time in FY 2017.

System modifications accounted for an average of 0.4 day of down time in FY 2018. System modifications included upgrading the pump and motor at extraction well B5.

**Were there any major operational changes during the year?** No.

**Did the system achieve hydraulic capture?**

Respective of current OU2 ROD requirements hydraulic influence is noted via extraction above the GOS Operational Minimum under Army and agency agreement. In addition, a remedy review has been conducted and approved by the regulatory agencies presenting improvements for consideration toward overall mass removal and TGRS operational efficiency. The OU remedy review received agency approval in June 2018. Another sign, with respect to system operation, is the generally stable or decreasing TCE concentrations evident at many wells across the TGRS boundary since FY 2001. Moreover, comparison of the OU1 TCE plume footprint over the past 20 years as summarized in the last four USEPA five-year reviews and further discussed below indicates a stable bedrock TCE plume footprint. Groundwater elevation measurements collected in summer 2018 are presented in Appendix D.

**How much VOC mass was removed by the system and how is it changing with time?**

As discussed above, the TGRS extracted and treated approximately 917,437,500 gallons of water from October 2017 through September 2018. Based on the monthly influent and effluent VOC concentrations and the monthly flow totals as measured by the extraction well flow meters, the TGRS removed a total of 1,911 pounds of VOCs from October 2017 through September 2018. The VOC mass removal in FY 2017 was 1,988 pounds. The decrease in the VOC mass removal occurred because of the increased amount of downtime and slightly lower average influent VOC concentrations. When comparing the FY 2018 to FY 2017 and past years and taking into account operational downtime, the trend still depicts an overall reduction in mass removal.

Average VOC influent concentrations decreased slightly from 256 µg/L in FY 2017 to 250.7 µg/L in FY 2018. Table 12-6 summarizes the individual VOC mass contribution of each extraction well and the entire system. Overall, the TGRS has removed over 109 tons (218,660 pounds) of VOCs from the aquifers since 1987 and 21 tons of VOCs since the end of FY 2001 (the TGRS OS was based on data through 2001). If the annual VOC mass removal from the TGRS is less than 1,709 pounds (50 percent of the FY 2001 mass removal) then the Army and agencies have agreed that review of the OS operating minimum rates should be conducted and potentially reduced. At 1,911 pounds in FY 2018, the VOC mass removal from the TGRS is at 56 percent of the FY 2001 mass removal.

The total mass removed is based on the monthly TGRS influent and effluent sampling and flow through the treatment system. The monthly sampling of the treatment system provides the best estimate of overall mass removal, compared to the individual extraction well sampling, due to the larger number of samples and consistency in the month-to-month analytical results. The percent contributions for each well are based on the average flows from each well and the semi-annual VOC results from each well.

VOC samples were collected semi-annually from the TGRS operating extraction wells. Wells B2, B7, B10, B11, B12, SC3, and SC4 are shut down, but were temporarily operated for June 2018 sampling.

Table 12-7 presents a summary of the sampling results for the extraction wells. Variations in detection limits from round to round are the result of varying sample dilution performed by the laboratory where dilutions are required due to the high concentrations of some analytes. The locations of the extraction wells are presented on Figure 12-1.

Appendix H.1 presents TCE versus time graphs for each extraction well. As shown, TCE concentrations have declined in each well, and now at many wells TCE concentrations appear to be stable or still declining. Since FY 2001, the following extraction wells have shown the most improvement (greater than 50 percent reduction) in TCE concentrations:

- B11 (4.8 µg/L in FY 2001 to non-detect in FY 2018 – 100% reduction),
- SC3 (5.5 µg/L in FY 2001 to 0.3JP µg/L in FY 2018 – 94% reduction),
- B10 (5.1 µg/L in FY 2001 to non-detect µg/L in FY 2018 – 100% reduction),
- B6 (230 µg/L in FY 2001 to 25 µg/L in FY 2018 – 89% reduction),
- B4 (500 µg/L in FY 2001 to 65 µg/L in FY 2018 – 87% reduction),
- B5 (410 µg/L in FY 2001 to 63 µg/L in FY 2018 – 85% reduction),
- B1 (180 µg/L in FY 2001 to 46 µg/L in FY 2018 – 74% reduction),
- SC2 (100 µg/L in FY 2001 to 28 µg/L in FY 2018 – 72% reduction),
- B3 (8.7 µg/L in FY 2001 to 3.8 µg/L in FY 2018 – 56% reduction),
- B9 (110 µg/L in FY 2001 to 29 µg/L in FY 2018 – 74% reduction),
- SC4 (6.9 µg/L in FY 2001 to 2.2 µg/L in FY 2018 – 68% reduction), and
- B8 (21 µg/L in FY 2001 to 7.9 µg/L in FY 2018 – 62% reduction).

In fact, only 3 wells (B2, SC5, and SC1) have shown less than a 50 percent reduction in TCE concentrations since FY 2001. These trends reflect the overall decline in OU2 deep groundwater contaminant concentrations. In addition, as discussed below, there has been a reduction in overall TGRS influent concentrations over the previous several years

As Table 12-6 illustrates, eight wells, B1, B4, B5, B6, B9, B13, SC1 and SC5, that are located in the centers of the plume, achieve the largest rates of VOC removal. These eight wells together accounted for over 99 percent of the VOC mass removed.

The source control wells, SC1 through SC5, together accounted for over 83 percent of the VOC mass removed while accounting for only 7.3 percent of the water pumped by the system. SC5, in particular, removed 73.3 percent of the total VOC mass at a rate of only approximately 107 gpm (6.1 percent of the total water pumped by the system). This illustrates the efficiency of extracting groundwater from near the source areas, which is further discussed in the current remedy review.

**What do the long-term trends in the monitoring wells show?**

A majority of 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. Due to the complexity of the flow system, changes in flow direction over time, and the variation in chemical transport properties across the study area, the trends may not reflect a uniform or easily predictable pattern.

Several wells were identified in previous APRs, or when reviewing the FY 2018 database that have inconsistent or upward trends in TCE concentrations that warrant further observation and discussion:

| Well | Trend Observation |
|---|---|
| 03L806 | Trend identified in FY 2001 APR. TCE concentrations have steadily decreased from 620 µg/L in 2013 to 38 µg/L in 2018. 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. In 2008, 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 (49 µg/L in 2018). 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.Since then decreased to 360 µg/L in 2016 and 200 µg/L in 2018. Maintain biennial sampling frequency (next event 2020). |
| 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.<br>TCE concentrations decreased from 680 µg/L in 2008 to 250 µg/L in 2015 but increased to 410 µg/L in 2017 and then decreased to 330 µg/L in 2018. Maintain annual sampling frequency. |

| Well | Trend Observation |
|---|---|
| 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 and 31 µg/L in 2018. Maintain biennial sampling frequency (next event 2020). |
| 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 120 µg/L in 2018. Maintain biennial sampling frequency (next event 2020). |
| 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, and has since been steadily increasing as it was 220 µg/L in 2018. This well is nearly 1 mile from the TGRS and is part of the OU1 sampling program; also see Section 3. Maintain biennial sampling frequency (next event 2020). |
| 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 10 and 24 µg/L since 2005 (10 µg/L in 2018). Well is nearly 0.5 mile from TGRS and is part of the OU1 sampling program; also see Section 3. Maintain biennial sampling frequency (next event 2020). |
| 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 42 and 160 µg/L from 2005 to 2015 (42 µg/L in 2018). Well is approximately 1 mile from TGRS and is part of the OU1 sampling program; also see Section 3. Maintain biennial sampling frequency (next event 2020). |
| 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 and again in 2018 to 130 µg/L. Well is approximately 1 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 (next event 2020). |

## 12.2 Remedy Component #2: Groundwater Treatment

**Description:** "Groundwater treatment using air stripping." (OU2 ROD, page 3)

**Performance Standard (how do you know when you're done):**

When the air stripping treatment facility is treating water and meeting the cleanup requirements in Table 1 of the OU2 ROD.

**Is the remedy component being implemented?**

Yes. The air stripping treatment facility has been operating since 1986.

**Did the treatment system meet the treatment requirements in the OU2 ROD?**

Yes. Influent and effluent water were sampled on a monthly basis during FY 2018. The influent/effluent database for FY 2018 is contained in Appendix G.2. Figure 12-6 presents a graph of influent TCE versus time. This graph is cumulative and includes data from before 1989, when the system consisted of only six extraction wells. The average FY 2018 influent TCE concentration was 202.5 µg/L, which is a 3 percent decrease from 209 µg/L in FY 2017. FY 2018 represents the 18th year since the TGRS was reconfigured to pump more in the centers of the VOC plumes and pump less on the edges of the plumes where VOC concentrations are much lower. The influent TCE concentrations had been steadily decreasing for several years, likely due to the overall decrease in plume concentration.

Figure 12-6 also presents a graph of the effluent TCE concentration versus time. As indicated, the effluent was below 5 µg/L TCE for all sampling events in FY 2018. A review of the FY 2018 database indicates that the effluent remained below the treatment requirements for all other VOC compounds specified in the OU2 ROD. Comparison of influent and effluent concentrations for all specified VOC compounds indicates an average removal efficiency of 99.3 percent. As expected, effluent concentrations of TCE increased slightly after the treatment was changed to two tower operation (two tower operation was tested in February 2011 and went into full operation in March 2011). The maximum effluent TCE concentration in FY 2018 was 2.4 µg/L and the average was 1.8 µg/L, which are both well below the discharge limit.

**What was the mass of VOCs emitted into the air?**

The air stripping towers remove VOCs with an efficiency of approximately 99.3 percent. The air emissions are equal to the VOC mass removal rates presented in Table 12-6. Air emissions averaged 5.2 pounds per day based on the VOC mass removal rates. The total VOC emissions from October 2017 through September 2018 were 1,911 pounds. In FY 2019, the Army will be evaluating and potentially implementing measure to reduce the amount of TCE emitted into the air from the TGRS.

## 12.3 Remedy Component #3: Treated Water Discharge

**Description:** “Discharge of treated water to the on-site gravel pit.” (OU2 ROD, page 3)

**Performance Standard:**

When the gravel pit is accommodating the discharge from the treatment system and allowing it to recharge to the aquifer.

**Is the remedy component being implemented?**

Yes. Based on visual observation during FY 2018, there were no noticeable changes in Gravel Pit performance. The Gravel Pit is accommodating the TGRS discharge as designed.

## 12.4 Remedy Component #4: Institutional Controls

**Description:** **“**Institutional controls to restrict access to contaminated aquifers and prevent exposure to contaminated groundwater.” (OU2 ROD, page 4)

**Performance Standard (how do you know when you’re done):**

When a special well construction area and alternate water supply have been established and private wells in impacted areas have been sealed.

**Is the remedy component being implemented?**

Yes. There are no private users of groundwater on the property and no potable water supply. There are ICs in place for future groundwater use associated with upcoming property redevelopment.

**Are any changes or additional actions required for this remedy component?**

Yes. 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.

## 12.5 Remedy Component #5: Review of New Technologies

**Description:** **"**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 annually in accordance with the consistency provisions of the TCAAP FFA." (OU2 ROD, page 4).

The intent is to consider new technologies of merit, which is not on any set schedule. To have merit, a new technology must have promise in reducing cost and time for cleanup. There may be years where no technologies are considered. It is envisioned that at any time, any interested party (Army, USEPA, and MPCA) can suggest new technologies for consideration. If a technology is agreed to have merit by the Army, USEPA, and MPCA, then the Army will evaluate the technology. The level of effort for evaluations can range from simple literature searches to extensive treatability studies. On an annual basis, the Army will report on:

- Whether or not any new technologies were identified and considered to have merit that year,
- The progress or results of any evaluations during that year, and
- Any planned evaluations for the following year.

**Performance Standard (how do you know when you're done):**

When the Army reports on the status of any reviews of emerging technologies in the annual monitoring report.

**Is the remedy component being implemented?**

Yes. Since the FY 1997 Annual Performance Report, the Army reports annually on the status of any reviews of emerging technologies.

- In September 2002, the MPCA and USEPA announced they would be conducting a natural attenuation microcosm study using carbon dating. In October 2002, Army drilled a boring at Site G to collect soil for the study. The study results were published in 2004.
- The MPCA identified a study involving the addition of vegetable oil to groundwater that is being monitored at the Navy site in Fridley, Minnesota, as a potential technology of interest.

**Were any new technologies identified and considered to have merit during FY 2018?**

Yes. The TCAAP Source Identification and TCAAP Operable Unit Remedy Review has been approved by the agencies and is intended to be implemented during FY 2019. In addition, the Army will be evaluating and potentially implementing measures to reduce the amount of TCE emitted into the air from the TGRS.

**What is the status and/or findings of any previously initiated reviews of emerging technologies?**

MPCA continued its research into natural attenuation processes at TCAAP. The MPCA and USEPA published the results of the microcosm study for deep groundwater sediments in 2004 showing that abiotic degradation of cis-DCE is an important factor contributing to the natural attenuation of this compound at the site. (*Non-biological Removal of cis-dichloroethylene and 1,1-dichloroethylene in aquifer sediment containing magnetite*. Environmental Science and Technology, 38: 1746-1752.)

**Are any new reviews planned at this time for the coming year?**

Yes. The Source Area Work Plan and Vapor Phase Carbon System Installation Design and Work Plan are under review.

## 12.6 Remedy Component #6: Groundwater Monitoring

**Description: "**Groundwater monitoring to track remedy performance." (OU2 ROD, page 4).

**Performance Standard (how do you know when you're done):**

When a regulator approved monitoring plan is in place and monitoring is conducted according to the plan.

**Is the remedy component being implemented?**

Yes. Monitoring in FY 2018 was consistent with the OU2 ROD. Water level measurements and water quality samples were collected as stated in Appendix A.1. Appendix A summarizes the FY 2018 monitoring plan and any deviations are explained in Appendix C.2. Monitoring was as follows:

**Groundwater**

TGRS groundwater level measurements were collected during December 2017 and June 2018 according to the monitoring plan. Appendix D contains the comprehensive groundwater quality and water level database for the TGRS monitoring wells. Water quality samples were collected from TGRS wells according to the monitoring plan. Groundwater samples were collected at wells stated in Appendix A.1. All wells were sampled for VOC (8260B) analysis and 1,4-dioxane (Method 522), except for those at Site A where 1,4-dioxane was determined not to be a COC. FY 2018 was a "large round" year in the biennial sample program, samples were collected from a select list of wells. Table 12-8 presents the groundwater quality data for FY 2018. Figures 12-7 through 12-9 present plan views of the TCE and 1,4-dioxane plumes and Figures 12-10 and 12-11 present a cross sectional view of the plume along the property boundary. Results from the FY 2018 groundwater sampling showed that most of the wells sampled continued to have declining or stable TCE concentrations. Notable steadily decreasing trends are observed at 04U806 (decrease from 725 µg/L in 2000 to 49 µg/L in 2018), 03U708 (steady decrease from 120 µg/L in 2005 to 20 µg/L in 2018), 03L806 (620 µg/L in 2013 to 38 µg/L in 2018).

Although the general trend at most wells since 1999 appears to be declining or stable, the monitoring wells listed below had notable increases in TCE concentration in FY 2018:

- 03L014 (86 µg/L in 2017 to 150 µg/L in 2018),
- 03U018 (28 µg/L in 2017 to 49 µg/L in 2018),
- 03U030 (4.6 µg/L in 2017 to 61 µg/L in 2018), and
- 03U077 (10 µg/L in 2017 to 27 µg/L in 2018).

As shown on Figure 12-3, all these wells are well within the capture zone of the TGRS extraction system so the significance of these increases (if they are indeed real increases, and not laboratory or field anomalies) are minimal. Please note that the trends over the last 10 years in these wells have shown a downward trend in TCE, with the exception of FY2018. All of these wells will continue to be monitored and no further sampling beyond the scheduled events is necessary at this time.

<u>Estimated TCE Plume Width</u>

The 2003 TGRS OS stated that the actual measured width of the 5 µg/L TCE plume at the source area based on FY 2001 analytical data was 3,600 feet (this value was then rounded up to 4,000 feet to determine an operating minimum flow rate noted in Section 12-1). Since that time, 21 tons of VOCs have been removed from groundwater. TCE concentrations are decreasing across Site, especially at the following wells which have been below 5 µg/L since 2001: B10, SC4, 03L021, 03L833, 03U701, 04J702, 04U701, 04U702, and 04U833. Monitoring well 03U672, which was located outside the southern end of the 5 µg/L TCE plume, decreased from 3.1 µg/L in 2001 to not detectable (less than 1 µg/L) from 2003 until it was abandoned in 2014. Well 03U677 replaced 03U672 in September 2014 and has never contained detectable concentrations of VOCs (including TCE). In addition, B11, which is no longer operating, reported a June 2018 TCE concentration of not detect.

As a result, the TCE plume width is narrowing. Figure 12-12 shows FY 2018 TCE data with the 5 µg/L TCE contours for FY 2001 and FY 2018. The overall FY 2018 sample results are similar, or lower compared to the FY 2016 sample results.

Based on these contours, the estimated width of the source area TCE plume has decreased approximately 17 percent from 3,600 feet to 3,000 feet or approximately 83 percent of the FY 2001 width. According to the TGRS OS, overall TGRS operating goals will be reviewed if the source area plume width shrinks to 75 percent of the FY 2001 width, or 2,700 feet. At the boundary, the TCE plume narrowing is more pronounced, having decreased approximately 24 percent from 4,600 feet to 3,500 feet, which represents approximately 76 percent decrease from the FY 2001 width.

As stated previously, the Army intends to implement the TCAAP Source Identification and TCAAP Operable Unit Remedy Review during FY 2019 which is intended to maximize contaminant mass removal.

**Treatment System**

The TGRS treatment system influent and effluent was sampled monthly during FY 201 in accordance with the FY 2017 – FY 2021 monitoring plan. Groundwater samples from the extraction wells were collected in December 2017 and June 2018 in accordance with the FY 2017 – FY 2021 monitoring plan.

**Is there additional monitoring proposed prior to the next report?**

No additional monitoring for FY 2018 is proposed beyond that presented in the Monitoring Plan (Appendix A) of the FY 2018 APR. Table 12-9 and Appendix A of this report provide the FY 2018 – FY 2022 monitoring plan. If new extraction wells are installed during FY 2019 then they will be monitored consistent with an approve work plan.

## 12.7 Overall Remedy for Deep Groundwater

**Did the TGRS meet the requirements of the OU2 ROD?** Yes.

- 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 2018 annual average extraction rate was 1,746 gpm.
- The TGRS extracted and treated 917,437,500 gallons of water and removed 1,911 pounds of VOCs from October 2017 to September 2018. Average VOC influent concentrations decreased by 3.9% from FY 2017.
- 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.

**Do any additional measures need to be addressed?**

As stated previously, the Army intends to implement the TCAAP Source Identification and TCAAP Operable Unit Remedy Review.

## 12.8 Other Related Activity in FY 2018

In 2018, monitoring wells proposed for sampling in the FY 2018 Monitoring Plan were sampled for 1,4-dioxane. Table 12-10 presents the results of the 1,4-dioxane sampling for the TGRS influent, effluent, and extraction wells. No Federal MCL has been established for 1,4-dioxane; however, the MDH has established a HRL value of 1.0 µg/L. All locations sampled except extraction wells (B5, B11, and SC5) had 1,4-dioxane concentrations exceeding the HRL. The TGRS influent and effluent were sampled in June 2017 where 1,4-dioxane concentrations were virtually identical in influent and effluent samples, indicating no concentration reduction from the treatment system. The monitoring well sampling results are presented on Table 12-11. A majority of the monitoring wells sampled (55 of 76) had 1,4-dioxane concentrations exceeding the HRL, with the highest concentrations found in the samples at 03U094 (157 µg/L) and 03L014 (107 µg/L). Figure 12-13 shows the 1,4-dioxane concentrations in plan view for the west portion of OU2. Figures 12-14 and 12-15 present cross sectional views of the plume along the property boundary.

# 13 OPERABLE UNIT 3: DEEP GROUNDWATER

A 1992 OU3 ROD was developed, amended and finalized in August 2006 that significantly changed the OU3 remedy. The basis for the OU3 ROD Amendment was the “Groundwater Statistical Evaluation, OU3” technical memorandum, which received consistency on May 2, 2005. This document presented a statistical evaluation showing that 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 well upstream of the PGRS, which 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. Figure 13-1 presents an OU3 site plan.

The PGRS was an off-post groundwater extraction and treatment system and municipal potable water supply. The PGRS consisted of NBM #13 and a GAC treatment plant. New Brighton used the water for municipal supply. The PGRS was designed to contain the South Plume of VOC contamination emanating from the former TCAAP property and to prevent further downgradient migration. Recovered groundwater was treated and used by the City of New Brighton to fulfill its municipal water supply demand.

The PGRS began operating on May 3, 1994. In 1997, the PGRS influent dropped below the ROD required limits for all VOCs. In December 1999, under an agreement with the Agencies, the PGRS pumping rate was reduced from a nominal rate of 1,000 gpm to 400 gpm to help determine if the VOC reductions in concentration were the result of actual plume decreases or the result of dilution from over pumping. In conjunction with the flow rate decrease, a quarterly monitoring program was undertaken to monitor for potential “rebound” in VOC concentrations. By the end of FY 2000, no rebound was observed and a review of the historical database for all of OU3 and the associated source area in OU2 revealed that the entire South Plume had dramatically decreased in size and concentration since the early 1990s. The VOC concentration decreases were such that the leading edge of the South Plume, at the PGRS, dropped below the ROD requirements.

The results of this evaluation were presented to the Agencies on September 6, 2000, and a report titled “Plume History Evaluation, Operable Unit 3”, CRA, was submitted to the Agencies on October 10, 2000. The report documents the history of plume size and concentration reductions throughout OU3. Based on the dramatic reductions in plume size and concentration, the report recommended shutting down the PGRS, which the Agencies subsequently accepted. The City of New Brighton stopped significant pumping in August 2001 and the PGRS was maintained in standby status. During the period May through September 2003, the PGRS was operated solely to satisfy peak water supply demands and then was placed back into standby status, remaining throughout FY 2004, FY 2005, and FY 2006. The City conducted an evaluation of its municipal system to, in part, determine the future use of the PGRS extraction well and treatment system. The City decided the PGRS treatment system and well NBM #13 were not part of the City’s long-term water supply plan. During FY 2007, the PGRS treatment system was dismantled and NBM #13 was abandoned.

## 13.1 Remedy Component #1: Monitored Natural Attenuation

**Description:** “Monitored natural attenuation.” (OU3 ROD Amendment, page 17).

**Performance Standard (how do you know when you're done):**

When a monitoring program is established and monitoring is in compliance with the regulator approved Annual Monitoring Plan.

**Is the remedy component being implemented?**

Yes. Appendix A summarizes the FY 2018 monitoring plan and any deviations are explained in Appendix C.2. Details of the groundwater monitoring program are discussed in Section 13.2.

## 13.2 Remedy Component #2: Groundwater Monitoring

**Description:** "Monitoring of the groundwater for VOCs to verify the effectiveness of the selected remedy and the natural attenuation of the South Plume." (OU3 ROD Amendment, page 17).

**Performance Standard (how do you know when you're done):**

When a monitoring program is established and monitoring is in compliance with the regulator approved Annual Monitoring Plan.

**Is the remedy component being implemented?**

Yes. Appendix A summarizes the FY 2018 monitoring plan and any deviations are explained in Appendix C.2.

Groundwater samples were collected from 18 OU3 wells in FY 2018 as part of OU1, OU2, and OU3 annual sampling. Samples were collected as specified in the monitoring plan and analyzed for VOCs and 1,4-dioxane at locations shown on Figure 13-1. The specific purpose of monitoring each well is provided in Appendix A. Groundwater elevations were also measured during the monitoring event and are presented in Appendix D.1.

Table 13-1 presents a summary of the analytical results for the 18 monitoring wells that were sampled in FY 2018. The wells sampled contained TCE concentrations similar to 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 sixth consecutive year, after rising above 1.0 µg/L for the first time since December 1999 in 2012 (1.2 µg/L).

**What were the results of the Statistical Analyses?**

The Mann-Kendall statistical analysis has historically been completed for ten edge-of-plume and center-of-plume wells. In FY 2018 only well 03M848 was sampled within the ten edge-of-plume and center-of-plume wells. A summary of the statistical analyses was completed for well 03M848 and the other nine well were included with FY 2018 results for an overview of the site and is presented in Table 13-2. A spreadsheet and graph presenting the Mann-Kendall test results for the wells are provided in Appendix I.

The trend for 03M848, which has historically been the center of the South Plume, changed from no trend or stable to decreasing as concentrations have decreased over the last five sampling events. The TCE concentrations at 03M848 have steadily decreased from 1,400 µg/L (FY 1996) to 700 µg/L (FY 1999) to 450 µg/L (FY 2003) to the current concentration of 110 µg/L in FY 2018. However, recent low-level detections of degradation products associated with 1,1,1-trichloroethane (i.e. 1,1- Dichloroethane) at 03M848, may indicate that the North Plume is not only beginning to mingle with the South Plume at the

OU1-OU3 boundary, but may be present toward the center of the South Plume. In summary, based on the data collected in FY 2018, the center of the South Plume, represented by 03M848, indicates decreasing concentration trends. Recent data show that 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.

**Are contingency actions warranted?**

No. 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. The wells analyzed in FY 2017 showed a decreasing trend.

**What groundwater monitoring is proposed before the next report?**

Since the 1,4-dioxane issue in FY 2015, sampling has been conducted including 1,4-dioxane. FY 2019 will continue monitoring for 1,4-dioxane. The proposed OU3 monitoring requirements are presented in Table 13-3 and Appendix A.

## 13.3 Remedy Component #3: Drilling Advisories

**Description:** "Continued implementation of the drilling advisories that regulates the installation of new private wells within OU3 as a Special Well Construction Area." (OU3 ROD Amendment, page 17).

**Performance Standard (how do you know when you're done):**

When a SWCA Advisory is issued.

**Has the MDH issued a Special Well Construction Area Advisory?**

Yes, in June 1996. In June 1999, via the MDH the SWCA boundary extended southwest including the Mississippi River and Marshall Avenue to ensure plume coverage. The SWCA also covers OU3 and all of OU2 as of April 2016, with the current boundary shown on Figure E-1 (Appendix E).

**Are any changes or additional actions required for this remedy component?** No.

## 13.4 Overall Remedy for OU3

**Is the Remedy for OU3 Operating in Compliance with the OU3 ROD and OU3 ROD Amendment?**

Yes. In FY 2018, groundwater monitoring took place as prescribed in the Annual Monitoring Plan. The annual sampling round of FY 2018 indicates that the South Plume footprint appears to be decreasing or at least stable, with a stable to decreasing trend at the center of the plume.

**Are any changes or additional actions required for OU3?**

No. No additional actions are necessary because no increasing trends at the edge of the plume were identified by the statistical analysis.

## 13.5 Other Related Activity in FY 2018

In 2018, samples from 18 wells were collected for 1,4-dioxane for OU3 annual sampling presented in Table 13-4. The wells sampled contained 1,4-dioxane concentrations similar to those reported for the previous sampling events.

# 14 OTHER INSTALLATION RESTORATION ACTIVITIES DURING FY 2018

This section summarizes the status of other activities that are related to the Installation Restoration Program but are not required in the RODs for OU1 through OU3.

## 14.1 Round Lake

The *Tier II Ecological Risk Assessment Report* (USACHPP 2004) for aquatic sites (including Round Lake), was approved by the MPCA and USEPA in December 2004. In June 2005, the Army submitted a draft FS for aquatic sites to support the risk management decisions with respect to "No Further Action" or "Implement a Remedy" for each aquatic site. Based on comments to the draft FS, it was agreed to conduct additional sampling of Marsden Lake and Pond G, which was completed in 2008. A revised FS was submitted in January 2009. Based on comments received and resolution thereof, the Army then submitted a revised (redlined) FS in April 2010. After review of this report, USEPA and MPCA requested that the Army prepare a work plan for collection of additional Round Lake sediment data. Given the time required to collect the additional data, the Army, USEPA, and MPCA agreed to separate the FS for aquatic sites into two documents: one for Round Lake and one for Rice Creek, Sunfish Lake, Marsden Lake, and Pond G.

The USEPA and MPCA provided consistency for the QAPP for Round Lake Sediment Investigation in January 2011. The sediment sampling work was completed in January – February 2011. A *Draft Summary of Investigation Findings* was submitted in May 2011, and a meeting between Army, USEPA, MPCA, Minnesota Department of Natural Resources, U.S. Fish and Wildlife Service, and the TCAAP Restoration Advisory Board was held in June 2011 for preliminary discussion of the findings. Final core dating results were distributed in February 2012. In March 2012, the Army provided responses to the stakeholder comments on the Round Lake portion of the April 2010 FS, which had been placed on hold pending collection and evaluation of the 2011 sediment data. A comment resolution meeting was then held in April 2012, and a TCAAP Restoration Advisory Board meeting was held in May 2012, primarily to discuss the status of the Round Lake FS.

With USEPA and MPCA agreement, the Army initiated a strategy to revise the FS in segments, with the intent to gain agreement/approval at key steps along the way. In accordance with this strategy, the Army submitted revised Sections 1 through 5 of the Round Lake FS in August 2012, and the USEPA and MPCA provided comments in September 2012. The Army sought clarifications on these comments, and ultimately submitted responses to those comments and the proposed redlines to Sections 1 through 5 in January 2013. The USEPA and MPCA provided comments to that submittal in March 2013. Through this process (and the multiple earlier drafts of the FS), it became clear that the Army, USEPA, and MPCA did not agree on the ecological risks and commensurate remedy associated with Round Lake. Given the difficulty reaching a consensus, the Army Environmental Command desired a fresh look at the ecological risk by someone who has national experience with such matters and obtained the assistance of the Risk and Regulatory Analysis Team of the Environmental Sciences Division at the Oak Ridge National Laboratory. In early FY 2014, the Army submitted *a Supplemental Remedial Investigation and Feasibility Study for Round Lake* (Wenck 2013a) which incorporated the *Supplemental Ecological Risk Assessment*

(Oak Ridge National Laboratory 2013). Comments received from the USEPA and MPCA in March 2014 indicated that significant disagreement remained. In April 2014, the Army, USEPA, and MPCA entered an “informal dispute resolution” phase which continued in FY 2015 and FY 2016. In a teleconference between the USEPA Region 5 Federal Facilities Chief and Headquarters Department of Army personnel on September 20, 2016, an agreement was reached in which Army would submit a revised Supplemental Remedial Investigation and Feasibility Study in the third quarter of FY 2017. The document was submitted for regulator review on May 10, 2017. The regulators provided written comments in July 2017, with Army response issued on October 6, 2017. At the end of FY 2018a revised Final Supplemental Remedial Investigation and Feasibility Study for Round Lake was prepared and submitted to the USEPA and MPCA on September 7, 2018.  After formal regulatory approval, the Draft Final Proposed Plan will be submitted followed by a public meeting and Draft Final ROD.

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# TABLES

**Table 1-1**
**Status of Remedial Actions**
**FY 2018 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 1-1**
**Status of Remedial Actions**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

PIKA ARCADIS
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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: 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 1-1**
**Status of Remedial Actions**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

| | 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 1-1**
**Status of Remedial Actions**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

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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 2-1**
**Comparison Study Relative Percent Difference Results**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, MInnesota**

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| Well ID | Date Sampled | Sampling Method | 1,4-Dioxane μg/L | Lead μg/L | 1,1,1-Trichloroethane μg/L | 1,1,2-Trichloroethane μg/L | 1,1-Dichloroethane μg/L | 1,1-Dichloroethene μg/L | 1,2-Dichloroethane μg/L | Benzene μg/L | Chloroform μg/L | cis-1,2-Dichloroethene μg/L | Tetrachloroethene μg/L | Trichloroethene μg/L | Vinyl chloride μg/L |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 01U139 | 7/24/2018 | low-flow | --- | --- | --- | --- | --- | 0.70 | < 1.00 | 6.80 | < 1.00 | 710 | < 1.00 | 0.36 | --- |
| | 7/31/2018 | standard purge | --- | --- | --- | --- | --- | 0.67 | < 1.00 | 7.30 | < 1.00 | 780 | < 1.00 | 0.48 | --- |
| | --- | RPD | --- | --- | --- | --- | --- | -4.38 | 0.00 | 7.09 | 0.00 | 9.40 | 0.00 | 28.6 | |
| 01U355 | 7/25/2018 | low-flow | --- | --- | --- | --- | --- | < 1.00 | < 1.00 | 2.60 | < 1.00 | 300 | < 1.00 | 0.31 | --- |
| | 7/24/2018 | standard purge | --- | --- | --- | --- | --- | < 1.00 | < 1.00 | 1.50 | < 1.00 | 180 | < 1.00 | 0.52 | --- |
| | --- | RPD | --- | --- | --- | --- | --- | 0.00 | 0.00 | -53.7 | 0.00 | -50.0 | 0.00 | 50.6 | |
| 01U563 | 7/27/2018 | low-flow | --- | 2.30 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | 7/27/2018 | standard purge | --- | 3.50 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| | --- | RPD | --- | 41.4 | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 01U584 | 7/27/2018 | low-flow | < 0.07 | --- | --- | --- | --- | < 1.00 | --- | --- | --- | < 1.00 | --- | < 1.00 | < 1.00 |
| | 7/27/2018 | standard purge | < 0.07 | --- | --- | --- | --- | < 1.00 | --- | --- | --- | < 1.00 | --- | < 1.00 | < 1.00 |
| | --- | RPD | 0.00 | --- | --- | --- | --- | 0.00 | --- | --- | --- | 0.00 | --- | 0.00 | 0.00 |
| 03L822 | 7/11/2018 | standard purge | --- | --- | 1.40 | < 1.00 | 2.40 | 3.90 | --- | --- | --- | 4.90 | --- | 150 | --- |
| | 7/17/2018 | no-purge | 16.9 | --- | 0.57 | < 1.00 | 2.20 | 3.60 | --- | --- | --- | 5.00 | --- | 130 | --- |
| | --- | RPD | --- | --- | 84.3 | 0.00 | 8.70 | 8.00 | --- | --- | --- | -2.02 | --- | 14.3 | --- |
| 03L841 | 7/17/2018 | standard purge | 2.50 | --- | 1.00 | 1.00 | 1.00 | 1.00 | --- | --- | --- | 0.56 | --- | 1.00 | --- |
| | 7/20/2018 | no-purge | 2.60 | --- | 1.00 | 1.00 | 1.00 | 0.31 | --- | --- | --- | 0.51 | --- | 0.51 | --- |
| | --- | RPD | -3.92 | --- | 0.00 | 0.00 | 0.00 | 105 | --- | --- | --- | 9.35 | --- | 64.9 | --- |
| 04J847 | 7/13/2018 | standard purge | --- | --- | 14.0 | 1.00 | 32.0 | 34.0 | --- | --- | --- | 7.20 | --- | 520 | --- |
| | 7/19/2018 | no-purge | 45.1 | --- | 11.0 | 1.00 | 33.0 | 32.0 | --- | --- | --- | 6.90 | --- | 640 | --- |
| | --- | RPD | --- | --- | 24.0 | 0.00 | -3.08 | 6.06 | --- | --- | --- | 4.26 | --- | -20.7 | --- |
| 04J849 | 7/11/2018 | standard purge | --- | --- | 0.80 | < 1.00 | 0.47 | 0.76 | --- | --- | --- | < 1.00 | --- | 1.50 | --- |
| | 7/19/2018 | no-purge | 0.35 | --- | 0.63 | < 1.00 | 0.41 | 0.65 | --- | --- | --- | < 1.00 | --- | 1.30 | --- |
| | --- | RPD | --- | --- | 23.8 | 0.00 | 13.6 | 15.6 | --- | --- | --- | 0.00 | --- | 14.3 | --- |
| 04U843 | 7/12/2018 | standard purge | --- | --- | 8.40 | < 1.00 | 9.50 | 15.0 | --- | --- | --- | 1.70 | --- | 150 | --- |
| | 7/19/2018 | no-purge | 13.8 | --- | 25.0 | < 1.00 | 21.0 | 36.0 | --- | --- | --- | 3.50 | --- | 220 | --- |
| | --- | RPD | --- | --- | -99.4 | 0.00 | -75.4 | -82.4 | --- | --- | --- | -69.2 | --- | -37.8 | --- |
| 04U847 | 7/12/2018 | standard purge | --- | --- | 3.30 | < 1.00 | 23.0 | 23.0 | --- | --- | --- | 4.30 | --- | 390 | --- |
| | 7/19/2018 | no-purge | 23.1 | --- | 1.60 | < 1.00 | 17.0 | 15.0 | --- | --- | --- | 2.60 | --- | 160 | --- |
| | --- | RPD | --- | --- | 69.4 | 0.00 | 30.0 | 42.1 | --- | --- | --- | 49.3 | --- | 83.6 | --- |
| 04U849 | 7/11/2018 | standard purge | --- | --- | 2.00 | < 1.00 | 4.00 | 5.10 | --- | --- | --- | 0.95 | --- | 57.0 | --- |
| | 7/19/2018 | no-purge | 8.60 | --- | 1.80 | < 1.00 | 3.40 | 3.80 | --- | --- | --- | 0.81 | --- | 52.0 | --- |
| | --- | RPD | --- | --- | 10.5 | 0.00 | 16.2 | 29.2 | --- | --- | --- | 15.9 | --- | 9.17 | --- |
| 409550 | 7/17/2018 | standard purge | 6.40 | --- | 1.90 | < 1.00 | 0.33 | 0.41 | --- | --- | --- | < 1.00 | --- | 31.0 | --- |
| | 7/20/2018 | no-purge | 6.10 | --- | 1.70 | < 1.00 | 0.31 | 0.47 | --- | --- | --- | < 1.00 | --- | 28.0 | --- |
| | --- | RPD | 4.80 | --- | 11.1 | 0.00 | 6.25 | -13.6 | --- | --- | --- | 0.00 | --- | 10.2 | --- |

**Acronyms and Abbreviations:**
--- = not sampled
RPD = Relative Percent Difference
μg/L = micrograms per liter

**Table 3-1**
**Summary of OU1 Monitoring Requirements**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

| Remedy Component | Monitoring Requirements | Implementing Party | Documents Containing the Monitoring Plan |
|---|---|---|---|
| #1: Alternate Water Supply / Well Abandonment | a. Water quality data for the perimeter of the plume to define the area of concern | Army | OU1 Groundwater Monitoring Plan in the Annual Performance Report |
| | b. Water quality data for water supply wells to determine eligibility for alternate supply/abandonment | Army | Well Inventory Report |
| #2: Drilling Advisories | a. Verification that drilling advisories are in place and functioning as intended | Army/MDH | N/A |
| #3: Extract Groundwater | a. Pumping volume and rates for each extraction well for comparison to target flowrates | New Brighton | New Brighton Water System Sampling and Analysis Plan |
| | b. Water levels from monitoring wells to draw contour maps, if desired | Army | OU1 Groundwater Monitoring Plan in the Annual Performance Report |
| #4: Removal of VOCs | a. Effluent water quality to demonstrate compliance with the Safe Drinking Water Act | New Brighton | New Brighton Water System Sampling and Analysis Plan |
| #5: Discharge of Treated Water | a. Verification of discharge | New Brighton | N/A |
| #6: Groundwater Monitoring with Verification of Continuing Aquifer Restoration | a. Water quality, to assist in evaluation of statistical improvements in groundwater quality. | Army | OU1 Groundwater Monitoring Plan in the Annual Performance Report |
| | b. Water quality data throughout the North Plume to evaluate remedial progress | Army | OU1 Groundwater Monitoring Plan in the Annual Performance Report |

**Acronyms and Abbreviations:**
MDH - Minnesota Department of Health
N/A - not applicable
OU1 - Operable Unit 1

Table 3-2
OU1 Groundwater Quality Data
FY 2018 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

| 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 | --- | --- | --- | --- |
| 03L811 | 7/19/2018 | 11 | < 1.0 U | 18.0 | 0.50 J | < 1.0 U | < 1.0 U | 0.47 J |
| 03L822 | 7/17/2018 | 130 | 0.57 J | 16.9 | 3.6 | 5.0 | < 1.0 U | 2.2 |
| 03L832 | 7/20/2018 | 4.0 | < 1.0 U | 0.24 | < 1.0 U | 0.33 J | < 1.0 U | < 1.0 U |
| 03L841 | 7/17/2018 | < 1.0 U | < 1.0 U | 2.5 | < 1.0 U | 0.56 J | < 1.0 U | < 1.0 U |
| 03L841 | 7/20/2018 | 0.51 J | < 1.0 U | 2.6 | 0.31 J | 0.51 J | < 1.0 U | < 1.0 U |
| 03L846 | 7/19/2018 | 0.58 J | < 1.0 U | 13.9 | 4.5 | 13 | < 1.0 U | 7.6 |
| 03M843 | 7/19/2018 | < 1.0 U | < 1.0 U | 14.4 | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| 03U811 | 7/19/2018 | < 1.0 U | < 1.0 U | 11.0 | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| 03U821 | 8/2/2018 | 6.9 | < 1.0 U | 12.4 | 0.39 J | < 1.0 U | < 1.0 U | 0.42 J |
| 03U822 | 7/17/2018 | 42 | < 1.0 U | 9.8 | 1.6 | 4.0 | < 1.0 U | 1.4 |
| 04J822 | 7/19/2018 | 2.3 | < 1.0 U | 0.61 | 1.3 | 4.1 | < 1.0 U | 1.5 |
| 04J834 | 7/23/2018 | < 1.0 U | < 1.0 U | < 0.07 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| 04J836 | 7/30/2018 | 26 | < 1.0 U | 4.0 | 2.0 | 1.2 | < 1.0 U | 1.9 |
| 04J837 | 7/23/2018 | 2.0 | < 1.0 U | 0.44 | < 1.0 U | 0.46 J | < 1.0 U | < 1.0 U |
| 04J838 | 7/20/2018 | 0.91 J | < 1.0 U | 0.16 | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| 04J838 (Dup) | 7/20/2018 | 0.78 J | < 1.0 U | 0.35 | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| 04J839 | 7/19/2018 | 6.1 | < 1.0 U | 0.42 | 0.39 J | < 1.0 U | < 1.0 U | < 1.0 U |
| 04J847 | 7/19/2018 | 640 | 11 | 45.1 | 32 | 6.9 | < 1.0 U | 33 |
| 04J849 | 7/19/2018 | 1.3 | 0.63 J | 0.35 | 0.65 J | < 1.0 U | < 1.0 U | 0.41 J |
| 04J882 | 7/23/2018 | < 1.0 U | < 1.0 U | < 0.07 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| 04J882 (Dup) | 7/23/2018 | < 1.0 U | < 1.0 U | < 0.07 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| 04U821 | 8/2/2018 | 13 | < 1.0 U | 12.9 | 0.86 J | < 1.0 U | < 1.0 U | 0.91 J |
| 04U834 | 7/23/2018 | 6.1 | < 1.0 U | 0.44 | 0.34 J | < 1.0 U | < 1.0 U | < 1.0 U |
| 04U836 | 7/30/2018 | 18 | 0.36 J | 2.1 | 1.4 | 1.2 | < 1.0 U | 1.3 |
| 04U837 | 7/23/2018 | 2.2 | < 1.0 U | 0.36 | < 1.0 U | 0.37 J | < 1.0 U | < 1.0 U |
| 04U838 | 7/20/2018 | 47 | 0.77 J | 3.2 | 2.9 | 1.1 | < 1.0 U | 2.0 |
| 04U839 | 7/19/2018 | 41 | 0.51 J | 4.7 | 2.9 | 2.9 | < 1.0 U | 2.8 |
| 04U841 | 7/20/2018 | 10 | 1.1 | 2.7 | 1.6 | 0.50 J | < 1.0 U | 1.1 |
| 04U843 | 7/19/2018 | 220 | 25 | 13.8 | 36 | 3.5 | < 1.0 U | 21 |
| 04U844 | 7/31/2018 | 160 | 7.5 | 13.9 | 13 | 3.6 | < 1.0 U | 12 |

Notes and Abbreviations on Page 2.

**Table 3-2**
**OU1 Groundwater Quality Data**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

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| 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 | --- | --- | --- | --- |
| 04U846 | 7/19/2018 | 17 | < 1.0 U | 14.2 | 7.0 | 17 | < 1.0 U | 9.9 |
| 04U847 | 7/19/2018 | 160 | 1.6 | 23.1 | 15 | 2.6 | < 1.0 U | 17 |
| 04U849 | 7/19/2018 | 52 | 1.8 | 8.6 | 3.8 | 0.81 J | < 1.0 U | 3.4 |
| 04U850 | 8/1/2018 | 25 | < 1.0 U | 4.7 | 2.7 | 5.7 | < 1.0 U | 3.0 |
| 04U855 | 8/1/2018 | 21 | 0.33 J | 6.5 | 1.1 | < 1.0 U | < 1.0 U | 1.1 |
| 04U871 | 7/30/2018 | 78 | 3.2 | 5.9 | 4.9 | 1.7 | < 1.0 U | 3.5 |
| 04U872 | 7/30/2018 | 7.0 | < 1.0 U | 1.2 | 0.43 J | < 1.0 U | < 1.0 U | 0.71 J |
| 04U875 | 8/1/2018 | < 1.0 U | < 1.0 U | < 0.07 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| 04U877 | 7/30/2018 | 1.3 | < 1.0 U | 0.35 | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| 04U879 | 8/1/2018 | 3.5 | < 1.0 U | 0.88 | 0.31 J | < 1.0 U | < 1.0 U | 0.31 J |
| 04U880 | 8/1/2018 | < 1.0 U | < 1.0 U | 0.018 J | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| 04U881 | 8/3/2018 | 16 | 0.63 J | 1.7 | 0.61 J | 0.35 J | < 1.0 U | 1.3 |
| 04U882 | 7/23/2018 | 14 | 0.67 J | 1.3 | 0.88 J | < 1.0 U | < 1.0 U | 0.75 J |
| 04U883 | 8/1/2018 | < 1.0 U | < 1.0 U | < 0.07 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| 200154 | 7/30/2018 | < 1.0 U | < 1.0 U | 0.053 J | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| 409547 | 7/30/2018 | 1.2 | 0.80 J | 5.8 | 3.4 | 0.95 J | < 1.0 U | 5.3 |
| 409548 | 8/1/2018 | 5.5 | < 1.0 U | 0.58 | 0.48 J | 0.60 J | < 1.0 U | 0.36 J |
| 409549 | 8/1/2018 | 28 | 0.39 J | 5.4 | 2.4 | 0.55 J | < 1.0 U | 2.4 |
| 409550 | 7/20/2018 | 28 | 1.7 | 6.1 | 0.47 J | < 1.0 U | < 1.0 U | 0.31 J |
| 409555 | 8/1/2018 | < 1.0 U | < 1.0 U | 0.14 | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| 409556 | 9/20/2018 | < 1.0 U | < 1.0 U | < 0.07 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| 409557 | 7/30/2018 | 17 | 0.71 J | 4.0 | 3.2 | 2.3 | < 1.0 U | 3.1 |
| 512761 | 7/30/2018 | 1.9 | < 1.0 U | 0.16 | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| 512761 (Dup) | 7/30/2018 | 2.2 | < 1.0 U | 0.13 | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |
| PJ#318 | 8/2/2018 | 0.83 J | < 1.0 U | 0.086 | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U |

**Footnotes:**

a. The cleanup level for OU1 Groundwater is from page 18 of OU1 Record of Decision. 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.

**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 3-3**
**Group 1, 2, 3, 5, and 6 Mann-Kendall Summary for OU1**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**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:** | | | | | | | |
| 03L673 | -24 | <0.001 | 0.860 | 8 / 8 | Decreasing | No | |
| 03L833 | -17 | 0.0240 | 0.478 | 8 / 8 | Decreasing | No | |
| 03L848 | -23 | 0.00184 | 0.843 | 8 / 8 | Decreasing | No | |
| 03L859 | -23 | 0.00184 | 0.893 | 8 / 8 | Decreasing | No | |
| 03U677 | NA | NA | NA | 0 / 10 | NA | No | All ND |
| 03U805 | 20 | 0.00710 | 0.705 | 8 / 8 | Increasing | Yes | Southern edge of north plume, plume shifted slightly |
| 04U673 | -16 | 0.0310 | 0.0942 | 8 / 8 | Decreasing | No | Near south plume center, plume shifted slightly |
| 04U821 | -18 | 0.0160 | 0.603 | 8 / 8 | Decreasing | No | |
| 04U832 | 5 | 0.317 | 0.105 | 8 / 8 | No Significant Trend | Yes | Relatively stable, between 41 and 59 µg/L since 2005 |
| 04U833 | -30 | <0.001 | 0.623 | 9 / 9 | Decreasing | No | |
| 04U841 | -21 | 0.00500 | 0.690 | 8 / 8 | Decreasing | No | |
| 04U843 | 27 | <0.001 | 0.976 | 8 / 8 | Increasing | Yes | Near plume center |
| 04U845 | -15 | 0.0430 | 0.383 | 8 / 8 | Decreasing | No | |
| 04U846 | 19 | 0.0116 | 0.676 | 8 / 8 | Increasing | Yes | Near plume center, historically erratic |
| 04U854 | -21 | 0.00500 | 0.769 | 8 / 8 | Decreasing | No | |
| 04U859 | -27 | <0.001 | 0.923 | 8 / 8 | Decreasing | No | |
| 04U861 (abandoned) | 11 | 0.0280 | 0.752 | 6 / 6 | NA | NA | Abandoned after 2006 sample, in New Brighton Development |
| 04U875 | -20 | 0.0220 | 0.325 | 4 / 9 | Decreasing | No | |
| 04U877 | 7 | 0.272 | 0.0814 | 9 / 9 | No Significant Trend | Yes | |
| 206688 | -4 | 0.298 | 0.00700 | 6 / 6 | No Significant Trend | Yes | |
| 409549 | 14 | 0.0540 | 0.296 | 8 / 8 | Probably Increasing | Yes | Near plume center, plume shifted slightly |
| 409557 | 12 | 0.0890 | 0.117 | 8 / 8 | Probably Increasing | Yes | Between north & south plume, lateral dispersion |
| **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:** | | | | | | | |
| 03L809 | -11 | 0.114 | 0.470 | 8 / 8 | No Significant Trend | Yes | Raw trend is decreasing |
| 03L822 | -21 | 0.00500 | 0.761 | 8 / 8 | Decreasing | No | |
| 03U821 | -26 | <0.001 | 0.786 | 8 / 8 | Decreasing | No | |
| 03U822 | -5 | 0.317 | 0.230 | 8 / 8 | No Significant Trend | Yes | Between 42 and 160 µg/L since 2005 |
| 03U831 (abandoned) | 9 | 0.0680 | 0.405 | 2 / 6 | NA | NA | Abandoned due to construction after 2007 sampling |
| 409550 | -13 | 0.0720 | 0.489 | 8 / 8 | Probably Decreasing | No | Raw trend is decreasing |
| 409596 (abandoned) | -8 | 0.102 | 0.633 | 6 / 6 | NA | NA | Abandoned due to construction after 2007 sampling |
| 409597 (abandoned) | -11 | 0.0280 | 0.809 | 6 / 6 | NA | NA | Abandoned due to construction after 2007 sampling |

Notes and Abbreviations on Page 2.

Table 3-3
Group 1, 2, 3, 5, and 6 Mann-Kendall Summary for OU1
FY 2018 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

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| Group | S Value | P Value | $R^2$ Value | Fraction of Detections | Results Trend | Threshold Triggered? | Comments |
|---|---|---|---|---|---|---|---|
| **Group 6 OU1 Jordan Wells:** | | | | | | | |
| 04J077 | -24 | 0.00630 | 0.638 | 9 / 9 | Decreasing | No | |
| 04J702 | -24 | <0.001 | 0.570 | 8 / 8 | Decreasing | No | |
| 04J708 | 20 | 0.00710 | 0.678 | 8 / 8 | Increasing | Yes | Southern edge of north plume, plume shifted slightly |
| 04J713 | NA | NA | NA | 0 / 8 | NA | No | All ND |
| 04J822 | -20 | 0.0220 | 0.610 | 9 / 9 | Decreasing | No | |
| 04J834 | -20 | 0.00710 | 0.685 | 4 / 8 | Decreasing | No | |
| 04J836 | 22 | 0.0120 | 0.668 | 9 / 9 | Increasing | Yes | Close proximity to NBCGRS wells, likely influenced by shutdown |
| 04J837 | -15 | 0.0750 | 0.345 | 9 / 9 | Probably Decreasing | No | Close proximity to NBCGRS wells, likely influenced by shutdown |
| 04J838 | 6 | 0.274 | 0.0741 | 8 / 8 | No Significant Trend | Yes | Close proximity to NBCGRS wells, likely influenced by shutdown |
| 04J839 | 8 | 0.238 | 0.134 | 9 / 9 | No Significant Trend | Yes | Historically Below 5 µg/L |
| 04J847 | 12 | 0.250 | 0.00741 | 13 / 13 | No Significant Trend | Yes | Near plume center |
| 04J849 | 24 | 0.00630 | 0.176 | 4 / 9 | Increasing | Yes | Historically Below 1 µg/L. |
| 04J882 | NA | NA | NA | 0 / 8 | NA | No | All ND |
| **Group 6 Nested Unit 4 Wells:** | | | | | | | |
| 04U077 | -26 | <0.001 | 0.858 | 8 / 8 | Decreasing | No | |
| 04U702 | -8 | 0.199 | 0.0451 | 8 / 8 | No Significant Trend | Yes | Below 3 µg/L |
| 04U708 | -20 | 0.00710 | 0.682 | 4 / 8 | Decreasing | No | |
| 04U713 | -16 | 0.0310 | 0.414 | 5 / 8 | Decreasing | No | |
| 04U834 | -13 | 0.0720 | 0.0000615 | 6 / 8 | Probably Decreasing | No | |
| 04U836 | -7 | 0.272 | 0.0246 | 9 / 9 | No Significant Trend | Yes | Close proximity to NBCGRS wells, likely influenced by shutdown |
| 04U837 | -9 | 0.209 | 0.354 | 9 / 9 | No Significant Trend | Yes | Raw trend is decreasing |
| 04U838 | 5 | 0.317 | 0.00262 | 8 / 8 | No Significant Trend | Yes | Historically below 3 µg/L |
| 04U839 | 26 | 0.00290 | 0.642 | 9 / 9 | Increasing | Yes | Close proximity to NBCGRS wells, likely influenced by shutdown |
| 04U847 | -12 | 0.0890 | 0.354 | 8 / 8 | Probably Decreasing | No | Raw trend is decreasing |
| 04U849 | 10 | 0.138 | 0.357 | 8 / 8 | No Significant Trend | Yes | Near plume center, appears relatively stable since 2011 |
| 04U882 | -15 | 0.0430 | 0.491 | 7 / 8 | 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
NBCGRS = New Brighton Contaminated Groundwater Recovery System
ND = non-detect
NP = North Plume
OU = Operable Unit
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
SP = South Plume
µg/L = micrograms per liter

**Table 6-1**
**Summary of Site A Shallow Groundwater Monitoring Requirements**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

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| 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 6-2**
**Site A Groundwater Quality Data**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

| 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 | 7/24/2018 | < 1.0 U | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U102 | 7/18/2018 | < 1.0 U | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U103 | 7/24/2018 | < 1.0 U | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | 6.7 |
| 01U108 [c] | --- | NS | NS | NS | NS | NS | NS | NS | NS | NS |
| 01U115 | 7/18/2018 | < 1.0 U | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U116 | 7/18/2018 | < 1.0 U | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U117 | 7/18/2018 | 2.5 | < 1.0 U | NA | 1.8 | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U126 | 7/24/2018 | < 1.0 U | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U126 (Dup) | 7/24/2018 | < 1.0 U | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U138 | 7/18/2018 | < 1.0 U | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U138 (Dup) | 7/18/2018 | -- | < 1.0 U | NA | < 1.0 U | < 1.0 U | -- | -- | -- | NA |
| 01U139 | 7/24/2018 | < 1.0 U | 0.36 J | NA | 710 | 0.70 J | < 1.0 U | < 1.0 U | 6.8 | NA |
| 01U140 | 7/31/2018 | < 1.0 U | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U157 | 7/31/2018 | < 1.0 U | < 1.0 U | NA | 0.68 J | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U158 | 7/25/2018 | < 1.0 U | 0.34 J | NA | 12 | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U350 [c,d] | 7/18/2018 | 0.90 J | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U352 [d] | 7/31/2018 | < 1.0 U | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U353 [d] | 7/25/2018 | < 1.0 U | < 1.0 U | NA | 1.0 | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U355 [d] | 7/25/2018 | < 1.0 U | 0.31 J | NA | 300 | < 1.0 U | < 1.0 U | < 1.0 U | 2.6 | NA |
| 01U356 [d] | 7/18/2018 | < 1.0 U | < 1.0 U | NA | 5.8 | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U357 [d] | 7/25/2018 | < 1.0 U | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U358 [d] | 7/25/2018 | < 1.0 U | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |

Notes and Abbreviations on Page 2.

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| 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 | --- | --- | --- | --- | --- | --- |
| 01U901 | 7/20/2018 | < 1.0 U | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U902 | 7/20/2018 | < 1.0 U | < 1.0 U | NA | 92 | < 1.0 U | < 1.0 U | < 1.0 U | 1.1 | < 2.0 U |
| 01U902 (Dup) | 7/20/2018 | < 1.0 U | 0.30 J | NA | 89 | < 1.0 U | < 1.0 U | < 1.0 U | 1.2 | < 2.0 U |
| 01U903 | 7/20/2018 | < 1.0 U | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U904 | 7/20/2018 | < 1.0 U | < 1.0 U | NA | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 1.0 U | < 2.0 U |

**Footnotes:**

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

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.

c. 01U108 was not sampled due to an obstruction in the well. 01U350 was sampled as an alternate.

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

**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

NA = sample was not analyzed for compound

NS = not sampled

OU = Operable Unit

µg/L = micrograms per liter

**Table 7-1**
**Summary of Site C Shallow Groundwater Monitoring Requirements**
**FY 2018 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 7-2**
**Water Quality Data for Site C Groundwater**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

| Sample Location | Date | Lead (Dissolved) (µg/L) |
|---|---|---|
| Site C Cleanup Level [a] | | 15 |
| 01U046 | 7/31/2018 | < 1.0 U |
| 01U561 (MW-1) | 8/1/2018 | < 1.0 U |
| 01U561 (MW-1 - Dup) | 8/1/2018 | < 1.0 U |
| 01U562 (MW-2) | 8/1/2018 | < 1.0 U |
| 01U563 (MW-3) | 7/27/2018 | 2.3 |
| 01U564 (MW-4) | 8/2/2018 | < 1.0 U |
| 01U567 (MW-7) | 8/1/2018 | < 1.0 U |
| 01U571 (MW-11) | 8/1/2018 | < 1.0 U |
| 01U573 (MW-13) | 8/1/2018 | 150 |
| 01U574 (MW-14) | 8/2/2018 | 61 |
| 01U575 (MW-15) | 8/1/2018 | < 1.0 U |
| 01U576 (MW-16) | 8/2/2018 | 8.3 |

**Footnotes:**
a. 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 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 7-3**
**Water Quality Data for Site C Surface Water**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

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| Sample Location | Date | Lead (Dissolved) (µg/L) |
|---|---|---|
| Surface Water Cleanup Level [a] | | 6.9 |
| NE Wetlands | 7/24/2018 | 4.9 |
| NE Wetlands | 7/25/2018 | < 1.0 U |
| NE Wetlands | 7/26/2018 | < 1.0 U |
| SW-5 | 7/24/2018 | 0.73 J |
| SW-5 | 7/25/2018 | < 1.0 U |
| SW-5 (Dup) | 7/25/2018 | < 1.0 U |
| SW-5 | 7/26/2018 | < 1.0 U |
| SW-6 | 7/24/2018 | 0.35 J |
| SW-6 | 7/25/2018 | < 1.0 U |
| SW-6 | 7/26/2018 | < 1.0 U |

**Footnotes:**

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

**Acronyms and Abbreviations:**

< 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 7-4
Contingency Locations for Site C Monitoring
FY 2018 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

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| Sampling Location | CONTINGENCY ROLE | |
|---|---|---|
| | Trigger for Contingency Action [a] | Contingency Action |
| MW-4 | If 3-event moving average > 15 µg/L | Note c |
| MW-7 | If 3-event moving average > 15 µg/L | Note c |
| MW-11 | If 3-event moving average > 15 µg/L | Note c |
| MW-16 | If 3-event moving average > 15 µg/L | Note c |
| 01U046 | If 3-event moving average > 6.9 µg/L | Note d |
| NE Wetland [b] | If one sampling event > 6.9 µg/L | Note d |
| SW5 [b] | If one sampling event > 6.9 µg/L | Note d |
| SW6 [b] | If one sampling event > 6.9 µg/L | Note e |

**Footnotes:**

a. Water quality monitoring is for dissolved lead in monitoring wells and surface water.

b. Surface water sampling is performed on three consecutive days and results are averaged for comparison to the trigger.

c. Army notify USEPA/MPCA within 1 week from receipt of data and submit an evaluation report within 30 days from notification.

d. 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.

e. 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 8.1**

**Summary Of Groundwater Monitoring Requirements**
**Fiscal Year 2018**
**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 | Northrop-Grumman Innovation Systems | 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 | Northrop-Grumman Innovation Systems | Site I Monitoring Plan in Annual Performance Report |

**Table 8.2**

**Most Recent Groundwater Quality Data (FY 2018)**
**Site I, OU2**
**Arden Hills, Minnesota**

| | | | cis-1,2-Dichloroethene | trans-1,2-Dichloroethene | Trichloroethene | Vinyl Chloride |
|---|---|---|---|---|---|---|
| **Site I Cleanup Level[1]** | | | **70 (total)** | | **30** | **0.20** |
| **Location** | **Date** | **Dup** | **µg/L** | **µg/L** | **µg/L** | **µg/L** |
| 01U064 | 4/26/2013 | | 4.2 | < 1.0 | 0.94 JP | < 1.0 |
| 01U632 | 4/26/2013 | | 27 | 0.35 JP | 120 | < 1.0 |
| 01U636 | 4/26/2013 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 01U639 | 4/26/2013 | | < 1.0 | < 1.0 | 9.5 | < 1.0 |
| 01U640 | 4/26/2013 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| I01MW | 4/26/2013 | | < 1.0 | < 1.0 | 0.33 JP | < 1.0 |
| I02MW | 4/26/2013 | | < 1.0 | < 1.0 | 0.62 JP | < 1.0 |
| I02MW | 4/26/2013 | D | < 1.0 | < 1.0 | 0.76 JP | < 1.0 |
| I05MW | 4/26/2013 | | < 1.0 | < 1.0 | 1.6 | < 1.0 |
| 01U667 | 8/13/2013 | | 500 | 1.4 | 4.7 | 300 |

Notes:

(1) Cleanup levels for Site I 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 9.1**

**Summary Of Groundwater Monitoring Requirements**
**Fiscal Year 2018**
**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 | Northrop-Grumman Innovation Systems | Site K Monitoring Plan in Annual Performance Report |
| #3 Hydraulic Containment | a. Water levels for use in drawing contour maps showing capture | Northrop-Grumman Innovation Systems | Site K Monitoring Plan in Annual Performance Report |
| | b. Pumping volumes and rates for reporting | Northrop-Grumman Innovation Systems | 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 | Northrop-Grumman Innovation Systems | Site K Monitoring Plan in Annual Performance Report |
| #7 Additional Investigation | a. None (completed) | | |

**Table 9.2**

**Groundwater Quality Data**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

| | | | cis-1,2-Dichloroethene | trans-1,2-Dichloroethene | Trichloroethene |
|---|---|---|---|---|---|
| | Site K Cleanup Level[1] | | 70 (Total DCE) | | 30 |
| **Location** | **Date** | **Dup** | **µg/L** | **µg/L** | **µg/L** |
| 03U621 | 6/28/2018 | | < 1.0 | < 1.0 | < 1.0 |
| 03U621 | 6/28/2018 | D | < 1.0 | < 1.0 | < 1.0 |
| 01U128 | 7/2/2018 | | < 1.0 | < 1.0 | < 1.0 |
| 01U603 | 7/2/2018 | | 8.1 | 0.65 JP | 5.1 |
| 01U615 | 7/2/2018 | | 1400 | 110 | 1500 |
| 01U615 | 7/2/2018 | D | 1400 | 110 | 1400 |
| 01U617 | 7/2/2018 | | 4.2 | 0.38 JP | < 1.0 |
| 01U618 | 7/2/2018 | | 1.7 | 0.38 JP | 2.0 |
| 01U621 | 7/2/2018 | | < 1.0 | < 1.0 | < 1.0 |
| K04-MW (482083) | 7/2/2018 | | < 1.0 | < 1.0 | 0.39 JP |

Notes:

(1) Cleanup levels for Site K are from the OU2 ROD. Shading indicates exceedence of the cleanup level.

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

**Table 9-3**

**Groundwater Elevation Monitoring**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

| Well ID | Groundwater Elevation (June 2017) | Groundwater Elevation (Historical Maximum) | Groundwater Elevation (June 2018) |
|---|---|---|---|
| 01U047 | Abandoned | 875.75 | Abandoned |
| 01U048 | 875.50 | 876.61 | 874.20 |
| 01U052 | 876.26 | 876.64 | 875.55 |
| 01U065 | Abandoned | 874.91 | Abandoned |
| 01U128 | 876.23 | 877.07 | 875.22 |
| 01U601 | Abandoned | 886.65 | Abandoned |
| 01U602 | Abandoned | 886.37 | Abandoned |
| 01U603 | 879.81 | 882.86 | 878.26 |
| 01U604 | Abandoned | 879.79 | Abandoned |
| 01U605 | Abandoned | 879.61 | Abandoned |
| 01U607 | 885.81 | 887.56 | Damaged |
| 01U608 | Abandoned | 888.06 | Abandoned |
| 01U609 | Abandoned | 886.83 | Abandoned |
| 01U611 | Abandoned | 887.16 | Abandoned |
| 01U612 | 880.04 | 884.70 | 879.30 |
| 01U613 | Abandoned | 886.15 | Abandoned |
| 01U615 | 880.96 | 883.71 | 879.12 |
| 01U616 | Abandoned | 882.75 | Abandoned |
| 01U617 | 879.11 | 883.22 | 877.62 |
| 01U618 | 882.70 | 885.58 | 881.71 |
| 01U619 | Abandoned | 886.60 | Abandoned |
| 01U620 | Abandoned | 881.93 | Abandoned |
| 01U621 | 880.15 | 883.87 | 878.96 |
| 01U624A | Abandoned | 881.66 | Abandoned |
| 01U624B | Abandoned | 881.63 | Abandoned |
| 01U624C | Abandoned | 881.64 | Abandoned |
| 01U624D | Abandoned | 881.64 | Abandoned |
| 01U625A | 879.92 | 883.95 | 878.42 |
| 01U625B | 879.51 | 883.90 | 878.38 |
| 01U625C | Obstructed | 887.91 | Obstructed |
| 01U625D | 879.87 | 883.91 | 878.37 |
| 01U626A | 879.53 | 882.77 | 878.15 |
| 01U626B | 879.30 | 883.50 | 877.78 |
| 01U626C | 879.33 | 883.58 | 877.83 |
| 01U626D | 879.39 | 883.61 | 877.92 |
| 01U627A | 880.24 | 882.67 | 879.06 |
| 01U627B | 879.45 | 883.57 | 878.02 |
| 01U627C | 879.38 | 883.56 | 877.92 |
| 01U627D | 879.39 | 883.57 | 877.93 |
| 01U628A | Abandoned | 880.39 | Abandoned |
| 01U628B | Abandoned | 880.34 | Abandoned |

**Table 9-3**

**Groundwater Elevation Monitoring**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

| Well ID | Groundwater Elevation (June 2017) | Groundwater Elevation (Historical Maximum) | Groundwater Elevation (June 2018) |
|---|---|---|---|
| 01U628C | Abandoned | 880.25 | Abandoned |
| 01U628D | Abandoned | 880.25 | Abandoned |
| 482085 (K01MW) | Abandoned | 887.09 | Abandoned |
| 482084 (K02MW) | Abandoned | 887.41 | Abandoned |
| 482083 (K04MW) | 881.96 | 885.38 | 881.16 |
| 03U621 | 859.12 | 856.63 | 861.47 |

# Table 9.4

## Treatment System Concentrations (Organics)
## Fiscal Year 2018
## 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 | 12/6/2017 | | < 1.0 | < 1.0 | < 1.0 | 7.3 | < 1.0 | 1.1 | < 1.0 |
| Effluent | 12/6/2017 | D | < 1.0 | < 1.0 | < 1.0 | 7.3 | < 1.0 | 1.1 | < 1.0 |
| Effluent | 3/1/2018 | | < 1.0 | < 1.0 | < 1.0 | 11 | 0.74 JP | 0.78 JP | < 1.0 |
| Effluent | 3/1/2018 | D | < 1.0 | < 1.0 | < 1.0 | 11 | 0.71 JP | 0.73 JP | < 1.0 |
| Effluent | 6/11/2018 | | < 1.0 | < 1.0 | < 1.0 | 1.8 | < 1.0 | 0.33 JP | < 1.0 |
| Effluent | 6/11/2018 | D | < 1.0 | < 1.0 | < 1.0 | 1.7 | < 1.0 | 0.34 JP | < 1.0 |
| Effluent | 9/5/2018 | | < 1.0 | < 1.0 | < 1.0 | 2.3 | < 1.0 | 0.39 JP | < 1.0 |
| Effluent | 9/5/2018 | D | < 1.0 | < 1.0 | < 1.0 | 2.3 | < 1.0 | 0.42 JP | < 1.0 |
| Influent | 12/6/2017 | | < 1.0 | 0.52 JP | < 1.0 | 200 | 25 | 66 | 2.7 |
| Influent | 3/1/2018 | | < 1.0 | 0.52 JP | < 1.0 | 180 | 26 | 33 | 2.2 |
| Influent | 6/11/2018 | | < 1.0 | < 1.0 | < 1.0 | 98 | 16 | 35 | 1.2 |
| Influent | 9/5/2018 | | < 1.0 | 0.34 JP | < 1.0 | 120 | 15 | 41 | 1.2 |

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 9.5

## Treatment System Concentrations (Inorganics)
## Fiscal Year 2018
## 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 | 12/6/2017 | | 4.7 | < 10 | < 1.0 | < 0.10 | < 1.0 | 8.8 | 0.59 |
| Effluent | 3/1/2018 | | 1.5 JP | < 10 | < 1.0 | < 0.20 | < 1.0 | 6.8 | 0.26 JP |
| Effluent | 6/11/2018 | | 3.9 | < 10 | < 1.0 | < 0.10 | < 1.0 | 6.0 | < 0.50 |
| Effluent | 9/5/2018 | | 6.6 | < 10 | < 1.0 | < 0.10 | < 1.0 | 7.8 | 0.27 JP |

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 9.6**

**Summary Of Monthly VOC Removal**
**Fiscal Year 2018**
**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, 2017 | | | | | | 381.1 |
| October[(1)] | 438,637 | 294 | 8.40 | 1.08 | 0.03 | 1.05 |
| November[(1)] | 372,885 | 294 | 8.40 | 0.92 | 0.03 | 0.89 |
| December | 310,886 | 294 | 8.40 | 0.76 | 0.02 | 0.74 |
| January[(1)] | 282,314 | 242 | 12.48 | 0.57 | 0.03 | 0.54 |
| February[(1)] | 231,884 | 242 | 12.48 | 0.47 | 0.02 | 0.44 |
| March | 306,388 | 242 | 12.48 | 0.62 | 0.03 | 0.59 |
| April[(1)] | 459,751 | 150 | 2.09 | 0.58 | 0.01 | 0.57 |
| May[(1)] | 456,236 | 150 | 2.09 | 0.57 | 0.01 | 0.56 |
| June | 462,120 | 150 | 2.09 | 0.58 | 0.01 | 0.57 |
| July[(1)] | 459,441 | 178 | 2.09 | 0.68 | 0.01 | 0.67 |
| August[(1)] | 441,660 | 178 | 2.09 | 0.65 | 0.01 | 0.65 |
| September | 445,770 | 178 | 2.71 | 0.66 | 0.01 | 0.65 |
| Total - FY 2018 | 4,667,972 | | | | | 7.92 |
| Cumulative To Date | | | | | | 389.0 |

Notes:

(1) Influent and Effluent VOC concentrations from the quarterly VOC samples collected on 12/06/2017, 03/01/2018, 06/11/2018 and 09/05/2018.

## Table 9.7



**1,4-Dioxane Groundwater Sampling Results**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

| | | | 1,4-Dioxane |
|---|---|---|---|
| Screening Criteria (HRL) | | | 1.0 |
| Location | Date | | µg/L |
| 03U621 | 6/28/2018 | | 8.3 |
| 03U621 | 6/28/2018 | D | 8.4 |

Notes:

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

**Table 10-1**
**Summary of Building 102 Shallow Groundwater Monitoring Requirements**
**FY 2018 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: | 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 10-2**
**Building 102 Groundwater Quality Data**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

PIKA ARCADIS a joint venture

| Sample Location | Date | 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 [c] (µg/L) |
|---|---|---|---|---|---|---|---|
| Building 102 Cleanup Level [a] | | 5 | --- | 70 | 6 | 0.18 | 0.18 |
| MDH HRL [b] | | --- | 1 | --- | --- | --- | --- |
| 01L581 | 7/25/18 | 5.8 | < 0.07 U | 5.3 | < 1.0 U | < 1.0 U | NA |
| 01L582 | 7/27/18 | < 1.0 U | < 0.07 U | 16 | < 1.0 U | < 1.0 U | 0.26 |
| 01L583 | 7/25/18 | < 1.0 U | < 0.07 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01L584 | 7/27/18 | 10 | < 0.07 U | 8.1 | < 1.0 U | < 1.0 U | NA |
| 01U048 | 7/27/18 | < 1.0 U | < 0.07 U | < 1.0 U | < 1.0 U | < 1.0 U | 0.075 |
| 01U048 (Dup) | 7/27/18 | < 1.0 U | < 0.07 U | < 1.0 U | < 1.0 U | < 1.0 U | 0.089 |
| 01U579 | 7/25/18 | 1.5 | < 0.07 U | 0.94 J | < 1.0 U | < 1.0 U | NA |
| 01U580 | 7/25/18 | 1.2 | < 0.07 U | 2.1 | < 1.0 U | < 1.0 U | NA |
| 01U581 | 7/25/18 | 38 | < 0.07 U | 15 | < 1.0 U | < 1.0 U | NA |
| 01U582 | 7/27/18 | < 1.0 U | < 0.07 U | 0.65 J | < 1.0 U | < 1.0 U | < 0.050 U |
| 01U583 | 7/25/18 | < 1.0 U | < 0.07 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |
| 01U584 | 7/27/18 | < 1.0 U | < 0.07 U | < 1.0 U | < 1.0 U | < 1.0 U | NA |

**Footnotes:**

a. The cleanup level for Building 102 Groundwater is from page 2-13 of OU2 Record of Decision Amendment #4. Gray shading indicates exceedance of the cleanup level.

b. 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. Gray shading indicates exceedance of the HRL.

c. 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.X = 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
OU = Operable Unit
µg/L = micrograms per liter

**Table 12.1**

**Groundwater Cleanup Levels**
**TGRS, OU2**
**Arden Hills, Minnesota**

| Substance | Expected Level in Discharge (ppb) | Operable Unit 2 Rod Requirements (ppb) |
|---|---|---|
| **Volatile Organic Compounds (VOCs)** | | |
| cis-1,2-Dichloroethene plus trans-1,2-Dichloroethene | <1.0 | 70 |
| 1,1-Dichloroethene | <1.0 | 6.0 |
| 1,1,1-Trichloroethane | <1.0 | 200 |
| 1,2-Dichloroethane | <1.0 | 4.0 |
| Trichloroethene | <5.0 | 5.0 |
| 1,1-Dichloroethane | <1.0 | 70 |
| Tetrachloroethene | <1.0 | 5.0 |

**Table 12.2**

**Extraction Well Water Pumped**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | Volume of Water Pumped (gallons) | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **B1** | **B3** | **B4** | **B5** | **B6** | **B8** | **B9** | **B11** | **B13** | **SC1** | **SC2** | **SC5** | **Total** |
| October 2017 | 9,335,900 | 9,732,400 | 9,350,300 | 11,320,300 | 10,780,500 | 8,552,200 | 12,031,400 | 0 | 3,000,500 | 952,600 | 99,800 | 5,179,100 | 80,335,000 |
| (gpm) | 209 | 218 | 209 | 254 | 241 | 192 | 270 | 0 | 67 | 21 | 2 | 116 | 1,800 |
| November 2017 | 7,308,800 | 9,078,900 | 8,859,900 | 10,085,500 | 9,216,300 | 7,202,200 | 12,370,800 | 0 | 3,990,700 | 903,300 | 1,609,100 | 4,904,700 | 75,530,200 |
| (gpm) | 169 | 210 | 205 | 233 | 213 | 167 | 286 | 0 | 92 | 21 | 37 | 114 | 1,748 |
| December 2017 | 8,831,600 | 9,719,000 | 9,526,800 | 9,460,700 | 10,580,400 | 7,222,800 | 12,953,200 | 0 | 5,617,900 | 983,300 | 2,166,200 | 5,027,500 | 82,089,400 |
| (gpm) | 198 | 218 | 214 | 212 | 237 | 162 | 290 | 0 | 126 | 22 | 49 | 113 | 1,839 |
| January 2018 | 9,169,000 | 9,753,300 | 9,659,900 | 8,686,500 | 10,456,700 | 6,889,200 | 13,111,400 | 0 | 5,625,200 | 997,600 | 1,289,900 | 5,056,900 | 80,695,600 |
| (gpm) | 205 | 218 | 216 | 195 | 234 | 154 | 294 | 0 | 126 | 22 | 29 | 113 | 1,808 |
| February 2018 | 8,048,600 | 8,537,800 | 8,259,900 | 8,296,600 | 9,470,600 | 6,087,600 | 11,630,200 | 0 | 5,104,500 | 853,300 | 815,000 | 4,536,400 | 71,640,500 |
| (gpm) | 200 | 212 | 205 | 206 | 235 | 151 | 288 | 0 | 127 | 21 | 20 | 113 | 1,777 |
| March 2018 | 8,821,700 | 10,195,000 | 9,374,500 | 8,326,300 | 9,729,700 | 6,813,200 | 12,023,800 | 0 | 5,082,700 | 988,400 | 1,519,900 | 4,958,800 | 77,834,000 |
| (gpm) | 198 | 228 | 210 | 187 | 218 | 153 | 269 | 0 | 114 | 22 | 34 | 111 | 1,744 |
| April 2018 | 8,425,900 | 9,633,100 | 8,205,800 | 7,580,800 | 8,843,700 | 6,915,000 | 12,474,200 | 0 | 4,053,500 | 959,100 | 1,200,400 | 4,411,600 | 72,703,100 |
| (gpm) | 195 | 223 | 190 | 175 | 205 | 160 | 289 | 0 | 94 | 22 | 28 | 102 | 1,683 |
| May 2018 | 8,162,200 | 11,471,700 | 7,478,900 | 7,454,900 | 9,611,500 | 8,239,500 | 11,676,000 | 0 | 4,604,700 | 917,900 | 791,800 | 4,350,800 | 74,759,900 |
| (gpm) | 183 | 257 | 168 | 167 | 215 | 185 | 262 | 0 | 103 | 21 | 18 | 97 | 1,675 |
| June 2018 | 7,652,100 | 12,006,900 | 7,303,800 | 7,323,300 | 9,822,900 | 8,570,500 | 11,877,600 | 0 | 4,838,800 | 939,700 | 443,600 | 4,387,900 | 75,167,100 |
| (gpm) | 177 | 278 | 169 | 170 | 227 | 198 | 275 | 0 | 112 | 22 | 10 | 102 | 1,740 |
| July 2018 | 8,802,800 | 11,749,200 | 6,573,600 | 8,164,900 | 10,330,500 | 8,733,500 | 12,226,600 | 0 | 5,044,400 | 952,900 | 0 | 4,575,700 | 77,154,100 |
| (gpm) | 197 | 263 | 147 | 183 | 231 | 196 | 274 | 0 | 113 | 21 | 0 | 103 | 1,728 |
| August 2018 | 10,833,900 | 10,159,700 | 7,238,800 | 12,403,600 | 9,906,900 | 8,162,400 | 10,650,700 | 0 | 4,388,500 | 892,300 | 0 | 4,507,500 | 79,144,300 |
| (gpm) | 243 | 228 | 162 | 278 | 222 | 183 | 239 | 0 | 98 | 20 | 0 | 101 | 1,773 |
| September 2018 | 10,634,900 | 9,483,000 | 5,561,300 | 10,859,400 | 8,227,800 | 6,674,900 | 8,672,200 | 0 | 4,911,200 | 839,500 | 0 | 4,520,100 | 70,384,300 |
| (gpm) | 246 | 220 | 129 | 251 | 190 | 155 | 201 | 0 | 114 | 19 | 0 | 105 | 1,629 |
| **Total FY 2018** | **106,027,400** | **121,520,000** | **97,393,500** | **109,962,800** | **116,977,500** | **90,063,000** | **141,698,100** | **0** | **56,262,600** | **11,179,900** | **9,935,700** | **56,417,000** | **917,437,500** |
| 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** |
|---|---|---|---|---|
| FY18 Average Flow Rate (gpm) | 309 | 617 | 1,058 | 1,746 |
| MOS Operational Minimum (gpm) | 415 | 600 | 1,010 | 1,745 |

**Table 12.3**

**Treatment Center Water Meter Totals**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | Volume of Water Pumped (gallons) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Extraction Wells | Meter 1 | Meter 2 | Total Meters 1 & 2 | Meter 3 | Meter 4 | Total Meters 3 & 4 | Meter 5 | Meter 6 | Total Meters 5 & 6 |
| October 2017 | 80,335,000 | 0 | 0 | 0 | 54,000 | 13,507,000 | 13,561,000 | 0 | 0 | 0 |
| November 2017 | 75,530,200 | 0 | 0 | 0 | 7,000 | 68,792,000 | 68,799,000 | 0 | 0 | 0 |
| December 2017 | 82,089,400 | 0 | 0 | 0 | 2,000 | 75,966,000 | 75,968,000 | 0 | 0 | 0 |
| January 2018 | 80,695,600 | 0 | 0 | 0 | 5,000 | 73,617,000 | 73,622,000 | 0 | 0 | 0 |
| February 2018 | 71,640,500 | 0 | 0 | 0 | 0 | 65,084,000 | 65,084,000 | 0 | 0 | 0 |
| March 2018 | 77,834,000 | 0 | 0 | 0 | 0 | 69,947,000 | 69,947,000 | 0 | 0 | 0 |
| April 2018 | 72,703,100 | 0 | 0 | 0 | 2,000 | 68,245,000 | 68,247,000 | 0 | 0 | 0 |
| May 2017 | 74,759,900 | 0 | 0 | 0 | 5,000 | 71,015,000 | 71,020,000 | 0 | 0 | 0 |
| June 2018 | 75,167,100 | 0 | 0 | 0 | 5,000 | 41,094,000 | 41,099,000 | 0 | 0 | 0 |
| July 2018 | 77,154,100 | 0 | 0 | 0 | 1,000 | 23,838,000 | 23,839,000 | 0 | 0 | 0 |
| August 2018 | 79,144,300 | 0 | 0 | 0 | 56,000 | 6,736,000 | 6,792,000 | 0 | 0 | 0 |
| September 2018 | 70,384,300 | 0 | 0 | 0 | 6,000 | 4,105,000 | 4,111,000 | 0 | 0 | 0 |
| **Total FY 2018** | **917,437,500** | **0** | **0** | **0** | **143,000** | **581,946,000** | **582,089,000** | **0** | **0** | **0** |

**Table 12.3**

**Treatment Center Water Meter Totals**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | Volume of Water Pumped (gallons) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Extraction Wells | Meter 1 | Meter 2 | Total Meters 1 & 2 | Meter 3 | Meter 4 | Total Meters 3 & 4 | Meter 5 | Meter 6 | Total Meters 5 & 6 |
| FY 1989 | 1,033,353,676 | 501,826,000 | 560,836,000 | 1,062,662,000 | 383,736,000 | 587,596,000 | 971,332,000 | 493,681,000 | 582,955,000 | 1,076,636,000 |
| FY 1990 | 1,008,415,750 | 493,915,000 | 526,417,000 | 1,020,332,000 | 371,391,000 | 588,642,000 | 960,033,000 | 487,946,000 | 543,726,000 | 1,031,672,000 |
| FY 1991 | 1,382,327,590 | 666,166,000 | 708,313,000 | 1,374,479,000 | 523,702,000 | 789,947,000 | 1,313,649,000 | 601,307,000 | 649,621,000 | 1,250,928,000 |
| FY 1992 | 1,401,346,600 | 68,289,000 | 724,328,000 | 1,407,227,000 | 557,169,000 | 772,509,000 | 1,329,678,000 | 767,707,000 | 677,735,000 | 1,445,442,000 |
| FY 1993 | 1,388,206,172 | 666,814,000 | 725,341,000 | 1,392,155,000 | 504,027,000 | 651,149,000 | 1,155,176,000 | 729,078,000 | 762,791,000 | 1,491,869,000 |
| FY 1994 | 1,245,663,275 | 660,700,000 | 659,953,000 | 1,320,653,000 | 457,210,000 | 715,668,000 | 1,172,878,000 | 653,913,000 | 550,131,000 | 1,204,044,000 |
| FY 1995 | 1,369,361,500 | 706,114,000 | 683,982,000 | 1,390,096,000 | 500,275,000 | 739,744,000 | 1,240,019,000 | 495,616,000 | 274,507,000 | 770,123,000 |
| FY 1996 | 1,341,763,220 | 734,443,000 | 629,327,000 | 1,363,770,000 | 503,518,000 | 754,399,000 | 1,257,917,000 | 4,000 | 600,035,000 | 600,039,000 |
| FY 1997 | 1,213,035,110 | 688,312,000 | 568,804,600 | 1,257,116,600 | 538,625,000 | 586,515,000 | 1,125,140,000 | 13,000 | 578,900,000 | 578,913,000 |
| FY 1998 | 1,196,007,900 | 624,784,000 | 540,353,000 | 1,220,604,000 | 511,065,000 | 603,871,000 | 1,114,936,000 | 58,000 | 178,076,000 | 178,134,000 |
| FY 1999 | 1,158,224,870 | 623,500,000 | 496,773,200 | 1,177,206,200 | 398,620,000 | 718,384,000 | 1,117,004,000 | 26,000 | 17,000 | 43,000 |
| FY 2000 | 1,148,448,350 | 635,724,000 | 489,669,000 | 1,183,258,000 | 389,709,000 | 663,807,000 | 1,053,516,000 | 0 | 0 | 0 |
| FY 2001 | 1,113,163,360 | 614,341,000 | 443,167,000 | 1,113,164,000 | 318,517,000 | 718,661,000 | 1,037,178,000 | 0 | 0 | 0 |
| FY 2002 | 917,318,879 | 491,082,800 | 434,959,700 | 926,042,500 | 225,460,000 | 650,839,000 | 876,299,000 | 0 | 0 | 0 |
| FY 2003 | 904,295,450 | 545,281,000 | 345,993,000 | 891,274,000 | 125,965,000 | 750,518,000 | 876,483,000 | 0 | 0 | 0 |
| FY 2004 | 908,718,760 | 518,391,900 | 376,889,660 | 895,281,560 | 216,177,000 | 680,633,000 | 896,810,000 | 0 | 0 | 0 |
| FY 2005 | 895,339,710 | 520,073,000 | 363,275,000 | 883,348,000 | 224,823,000 | 658,405,000 | 883,228,000 | 0 | 0 | 0 |
| FY 2006 | 929,715,590 | 534,305,000 | 377,499,000 | 911,804,000 | 266,299,000 | 669,900,000 | 936,199,000 | 0 | 0 | 0 |
| FY 2007 | 945,317,300 | 447,901,000 | 487,701,000 | 935,602,000 | 281,061,000 | 833,161,000 | 1,114,222,000 | 0 | 0 | 0 |
| FY 2008 | 943,318,161 | 424,289,615 | 512,634,095 | 936,923,709 | 217,134,430 | 778,717,620 | 995,852,050 | 0 | 0 | 0 |
| FY 2009 | 925,232,745 | 357,698,000 | 552,505,000 | 910,203,000 | 173,004,000 | 795,057,000 | 968,061,000 | 0 | 0 | 0 |
| FY 2010 | 933,789,205 | 368,260,000 | 556,160,000 | 924,420,000 | 61,957,000 | 894,152,000 | 956,109,000 | 0 | 0 | 0 |
| FY 2011 | 952,379,000 | 183,460,000 | 268,747,000 | 452,207,000 | 15,479,000 | 890,850,000 | 906,329,000 | 0 | 0 | 0 |
| FY 2012 | 964,996,900 | 0 | 0 | 0 | 695,000 | 848,465,000 | 849,160,000 | 0 | 0 | 0 |
| FY 2013 | 924,550,600 | 0 | 0 | 0 | 5,503,000 | 883,772,000 | 891,338,000 | 0 | 0 | 0 |
| FY 2014 | 937,934,854 | 0 | 0 | 0 | 3,956,000 | 895,176,000 | 899,132,000 | 0 | 0 | 0 |
| FY 2015 | 920,197,600 | 0 | 0 | 0 | 8,122,000 | 724,325,000 | 732,447,000 | 0 | 0 | 0 |
| FY 2016 | 907,577,164 | 0 | 0 | 0 | 7,145,000 | 690,956,000 | 698,101,000 | 0 | 0 | 0 |
| FY 2017 | 929,926,100 | 0 | 0 | 0 | 2,349,000 | 525,834,000 | 528,183,000 | 0 | 0 | 0 |
| FY 2018 | 917,437,500 | 0 | 0 | 0 | 143,000 | 581,946,000 | 582,089,000 | 0 | 0 | 0 |

**Table 12.4**

**Pumphouse Down Time**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| Well Name | FY18 Down Time (Days) | FY17 Down Time (Days) | FY16 Down Time (Days) | FY15 Down Time (Days) | FY14 Down Time (Days) |
|---|---|---|---|---|---|
| B1 | 10.9 | 3.3 | 4.2 | 2.7 | 3.4 |
| B2 | (1) | (1) | (1) | (1) | (1) |
| B3 | 3.6 | 3.7 | 9.7 | 5.4 | 3.0 |
| B4 | 13.8 | 3.3 | 6.5 | 10.2 | 9.2 |
| B5 | 32.0 | 4.0 | 9.1 | 8.7 | 2.0 |
| B6 | 17.9 | 8.7 | 7.8 | 2.4 | 9.6 |
| B7 | (1) | (1) | (1) | (1) | (1) |
| B8 | 8.1 | 7.1 | 8.9 | 8.5 | 2.4 |
| B9 | 14.8 | 11.2 | 21.7 | 9.5 | 6.8 |
| B10 | (1) | (1) | (1) | (1) | (1) |
| B11 | (1) | (1) | (1) | (1) | (1) |
| B12 | (1) | (1) | (1) | (1) | (1) |
| B13 | 18.8 | 4.3 | 3.9 | 4.5 | 2.9 |
| SC1 | 6.2 | 3.9 | 10.7 | 2.6 | 17.0 |
| SC2 | 25.2 | 3.7 | 81.3 | 4.4 | 4.4 |
| SC3 | (1) | (1) | (1) | (1) | (1) |
| SC4 | (1) | (1) | (1) | (1) | (1) |
| SC5 | 4.3 | 20.2 | 11.7 | 6.6 | 9.4 |

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 12.5**

**Down Time By Category**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| **Category** | **Down Time (Days)** |
|---|---|
| Pumphouse Component | 7.7 |
| Treatment Center Component | 0.5 |
| Electrical Service | 4.9 |
| Miscellaneous | 0.2 |
| Preventive Maintenance | 0.5 |
| System Modification | 0.4 |
| Forcemain | 0.0 |
| **Total System Equivalent** | 14.2 |
| | |
| **Anticipated Down Time for Fiscal Year 2019** | |
| 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 12.6**

**VOC Mass Loading Summary**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| Well | Percent Contribution to VOC Mass Removal | FY 2018 Total Pounds VOCs Mass Removed |
|---|---|---|
| B1 | 2.9% | 55.8 |
| B2[1] | 0.0% | 0.00 |
| B3 | 0.2% | 3.34 |
| B4 | 3.5% | 67.8 |
| B5 | 3.5% | 66.5 |
| B6 | 1.3% | 24.7 |
| B7[1] | 0.0% | 0.00 |
| B8 | 0.3% | 5.88 |
| B9 | 2.1% | 40.0 |
| B10[1] | 0.0% | 0.00 |
| B11[1] | 0.0% | 0.00 |
| B12[1] | 0.0% | 0.00 |
| B13 | 3.2% | 61.9 |
| SC1 | 9.4% | 180 |
| SC2 | 0.2% | 4.46 |
| SC3[1] | 0.0% | 0.00 |
| SC4[1] | 0.0% | 0.00 |
| SC5 | 73.3% | 1,401 |
| **Fiscal Year 2018 Total (lbs)** | | **1,911** |
| **Daily Average (lbs/day)** | | **5.2** |

Notes:

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

**Table 12.6**

**VOC Mass Loading Summary**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

**Historical Total**

| **Fiscal Year** | | **Pounds VOC Mass Removed** |
|---|---|---|
| 2018 | | 1,911 |
| 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** | | **218,660** |

**Table 12.7**

**VOC Concentrations in TGRS Extraction Wells**
**Fiscal Year 2018**
**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 | 12/7/2017 | | 3.9 | 0.64 JP | 0.91 JP | < 1.0 | 4.3 | 1.3 | 80 |
| 03F302 | B1 | 6/8/2018 | | 2.5 | 0.43 JP | 0.65 JP | < 1.0 | 2.9 | 1.0 | 46 |
| 03F302 | B1 | 6/8/2018 | D | 2.4 | 0.42 JP | 0.63 JP | < 1.0 | 2.7 | 1.0 | 45 |
| 03F303 | B2 | 6/15/2018 | | < 1.0 | < 1.0 | 0.80 JP | 0.36 JP | 1.3 | 0.71 JP | 23 |
| 03F304 | B3 | 12/7/2017 | | < 1.0 | 0.30 JP | 0.37 JP | < 1.0 | < 1.0 | < 1.0 | 3.5 |
| 03F304 | B3 | 6/8/2018 | | < 1.0 | 0.32 JP | 0.45 JP | < 1.0 | < 1.0 | < 1.0 | 3.8 |
| 03F305 | B4 | 12/7/2017 | | 6.2 | 3.0 | 2.9 | < 1.0 | 2.0 | < 1.0 | 92 |
| 03F305 | B4 | 6/8/2018 | | 4.7 | 2.2 | 2.0 | < 1.0 | 1.5 | < 1.0 | 65 |
| 03F306 | B5 | 12/7/2017 | | 2.6 | 2.3 | 2.2 | < 1.0 | 0.85 JP | 5.5 | 79 |
| 03F306 | B5 | 12/7/2017 | D | 2.6 | 2.4 | 2.4 | < 1.0 | 0.77 JP | 5.4 | 79 |
| 03F306 | B5 | 6/11/2018 | | 2.1 | 1.9 | 1.9 | < 1.0 | 0.64 JP | 3.5 JL 74.6 | 63 |
| 03F307 | B6 | 12/7/2017 | | 0.57 JP | 0.31 JP | 0.51 JP | < 1.0 | < 1.0 | < 1.0 | 31 |
| 03F307 | B6 | 6/8/2018 | | 0.45 JP | < 1.0 | 0.41 JP | < 1.0 | < 1.0 | < 1.0 | 25 |
| 03F308 | B7 | 6/15/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.8 |
| 03F312 | B11 | 6/15/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 03F319 | B13 | 12/7/2017 | | 3.2 | 1.2 | 1.1 | < 1.0 | 7.2 | 0.50 JP | 160 |
| 03F319 | B13 | 12/7/2017 | D | 3.1 | 1.2 | 1.0 | < 1.0 | 7.2 | 0.50 JP | 160 |
| 03F319 | B13 | 6/8/2018 | | 3.8 | 0.86 JP | 0.85 JP | < 1.0 | 6.2 | 0.45 JP | 110 |
| 03U301 | SC1 | 12/7/2017 | | 28 | 5.1 | 5.4 | < 5.0 | 160 | < 5.0 | 2500 |
| 03U301 | SC1 | 6/8/2018 | | 27 | 5.2 | 4.9 | < 4.0 | 140 | < 4.0 | 1400 |
| 03U314 | SC2 | 12/7/2017 | | 17 | 1.6 | 1.0 | < 1.0 | 1.9 | < 1.0 | 46 |
| 03U314 | SC2 | 6/8/2018 | | 5.7 | 1.1 | 0.55 JP | < 1.0 | 1.3 | < 1.0 | 28 |
| 03U315 | SC3 | 6/15/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.30 JP |
| 03U316 | SC4 | 6/15/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 2.2 |
| 03U317 | SC5 | 12/7/2017 | | 760 | 20 | 37 | 1.5 JP | 7.0 | 4.5 JP | 2900 |
| 03U317 | SC5 | 6/8/2018 | | 600 | 15 | 28 | < 5.0 | 6.4 | 4.0 JP | 2200 |
| PJ#309 | B8 | 12/7/2017 | | 0.40 JP | 0.35 JP | 0.42 JP | < 1.0 | < 1.0 | < 1.0 | 9.6 |
| PJ#309 | B8 | 6/8/2018 | | 0.32 JP | 0.31 JP | 0.36 JP | < 1.0 | < 1.0 | < 1.0 | 7.9 |
| PJ#310 | B9 | 12/7/2017 | | 1.5 | 1.6 | 1.9 | < 1.0 | 0.67 JP | < 1.0 | 37 |
| PJ#310 | B9 | 6/11/2018 | | 1.1 | 1.3 | 1.5 | < 1.0 | 0.56 JP | < 1.0 JL 74.6 | 29 |
| PJ#311 | B10 | 6/15/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| PJ#313 | B12 | 6/15/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| PJ#313 | B12 | 6/15/2018 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |

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 % recovery)

**Table 12.8**

**Groundwater Quality Data**
**Fiscal Year 2018**
**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 |
| 03L002 | 6/14/2018 | | 0.38 JP | 0.36 JP | 0.59 JP | < 1.0 | < 1.0 | < 1.0 | 13 |
| 03L007 | 6/26/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 03L014 | 6/19/2018 | | 100 | 3.6 | 3.5 | < 1.0 | 2.5 | < 1.0 | 150 |
| 03L017 | 6/19/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 03L017 | 6/19/2018 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 03L018 | 6/21/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 03L020 | 6/18/2018 | | 0.30 JP | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 6.2 |
| 03L021 | 6/14/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.2 |
| 03L077 | 6/7/2018 | | 1.3 | < 1.0 | 0.86 JP | < 1.0 | < 1.0 | < 1.0 | 24 |
| 03L078 | 6/13/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 03L079 | 6/14/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.74 JP |
| 03L802 | 6/25/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 JMS 71.6 | 1.5 |
| 03L806 | 6/22/2018 | | 0.97 JP | < 1.0 | 0.53 JP | < 1.0 | < 1.0 | < 1.0 | 38 |
| 03L809 | 6/26/2018 | | 2.4 | 1.8 | 2.2 | < 1.0 | 1.1 | < 1.0 | 120 |
| 03L833 | 6/25/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.8 |
| 03L833 | 6/25/2018 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.7 |
| 03M002 | 6/14/2018 | | 0.65 JP | 1.4 | 1.4 | < 1.0 | 0.44 JP | < 1.0 | 20 |
| 03M020 | 6/18/2018 | | 1.5 | 0.36 JP | 0.30 JP | < 1.0 | < 1.0 | < 1.0 | 19 |
| 03M802 | 6/25/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 6.9 |
| 03M806 | 6/22/2018 | | 0.51 JP | 46 | 25 | 0.53 JP | 7.7 | < 1.0 | 330 |
| 03U002 | 6/19/2018 | | 1.6 | 0.38 JP | 0.57 JP | < 1.0 | 0.45 JP | < 1.0 | 16 |
| 03U003 | 6/13/2018 | | 3.8 | 0.80 JP | 1.1 | < 1.0 | 2.1 | < 1.0 | 61 |
| 03U003 | 6/13/2018 | D | 3.7 | 0.84 JP | 1.0 | < 1.0 | 2.1 | < 1.0 | 61 |
| 03U005 | 6/26/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.36 JP | < 1.0 | < 1.0 |

**Table 12.8**

**Groundwater Quality Data**
**Fiscal Year 2018**
**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 |
| 03U007 | 6/26/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 03U009 | 6/19/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 03U014 | 6/19/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 03U017 | 6/19/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.96 JP |
| 03U018 | 6/21/2018 | | 21 | 1.7 | 2.3 | < 1.0 | 7.3 | < 1.0 | 49 |
| 03U018 | 6/21/2018 | D | 21 | 1.7 | 2.3 | < 1.0 | 7.6 | < 1.0 | 50 |
| 03U020 | 6/18/2018 | | 13 | 1.2 | 2.2 | < 1.0 | 0.93 JP | < 1.0 | 50 |
| 03U021 | 6/14/2018 | | 14 | 12 | 9.3 | < 1.0 | 9.2 | < 1.0 | 230 |
| 03U027 | 6/19/2018 | | 0.38 JP | < 1.0 | < 1.0 | < 1.0 | 0.46 JP | < 1.0 | 7.1 |
| 03U028 | 6/13/2018 | | 0.38 JP | < 1.0 | < 1.0 | < 1.0 | 1.1 | < 1.0 | 21 |
| 03U029 | 6/13/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 3.1 |
| 03U030 | 6/13/2018 | | 3.8 | 0.85 JP | 1.1 | < 1.0 | 2.1 | < 1.0 | 61 |
| 03U032 | 6/22/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 03U077 | 6/7/2018 | | 1.2 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.78 JP | 27 |
| 03U078 | 6/13/2018 | | 1.4 | < 1.0 | 0.71 JP | < 1.0 | 1.1 | 11 | 46 |
| 03U079 | 6/14/2018 | | 5.6 | 0.39 JP | 1.1 | < 1.0 | 2.0 | < 1.0 | 64 |
| 03U092 | 6/21/2018 | | 0.40 JP | < 1.0 | < 1.0 | < 1.0 | 0.90 JP | < 1.0 | 8.5 |
| 03U093 | 6/21/2018 | | 50 | 0.31 JP | 3.6 | < 1.0 | 1.7 | < 1.0 | 130 |
| 03U094 | 6/21/2018 | | 200 JMS 74.5 | 8.6 | 4.3 | < 1.0 | 13 | < 1.0 | 200 |
| 03U096 | 6/21/2018 | | 5.3 | 0.58 JP | 0.92 JP | < 1.0 | < 1.0 | < 1.0 | 19 |
| 03U099 | 6/21/2018 | | 0.56 JP | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.5 |
| 03U114 | 6/21/2018 | | 0.68 JP | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 4.0 |
| 03U659 | 6/13/2018 | | 93 | 10 | 11 | < 1.0 | 140 | < 1.0 | 730 |
| 03U671 | 6/13/2018 | | 1.6 | < 1.0 | 0.62 JP | < 1.0 | < 1.0 | 16 | 45 |

**Table 12.8**

**Groundwater Quality Data**
**Fiscal Year 2018**
**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 |
| 03U677 | 6/26/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 03U701 | 6/11/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 JL 74.6 | 0.69 JP |
| 03U702 | 6/11/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 JL 74.6 | 0.44 JP |
| 03U703 | 6/13/2018 | | 0.63 JP | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 2.8 | 6.6 |
| 03U708 | 6/12/2018 | | 1.3 | < 1.0 | 0.31 JP | < 1.0 | < 1.0 | 2.7 | 20 |
| 03U709 | 6/12/2018 | | 2.4 | 0.41 JP | 0.74 JP | < 1.0 | 0.69 JP | < 1.0 | 20 |
| 03U710 | 6/19/2018 | | 3.7 | < 1.0 | 0.71 JP | < 1.0 | 0.98 JP | < 1.0 | 43 |
| 03U711 | 6/25/2018 | | 3.2 | 0.80 JP | 1.3 | < 1.0 | 0.52 JP | 0.56 JP | 31 |
| 03U715 | 6/20/2018 | | 6.7 | < 1.0 | 0.79 JP | < 1.0 | < 1.0 | < 1.0 | 21 |
| 03U801 | 6/25/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.35 JP | < 1.0 | 16 |
| 03U801 | 6/25/2018 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.40 JP | < 1.0 | 17 |
| 03U803 | 6/26/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 03U804 | 6/25/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 03U805 | 6/26/2018 | | < 1.0 | 10 | 8.4 | < 1.0 | 3.7 | 1.3 | 47 |
| 03U805 | 6/26/2018 | D | < 1.0 | 10 | 8.6 | < 1.0 | 3.7 | 1.3 | 49 |
| 03U806 | 6/22/2018 | | < 1.0 | 0.56 JP | 0.38 JP | < 1.0 | < 1.0 | 0.54 JP | 35 |
| 04J077 | 6/7/2018 | | 0.91 JP | 2.0 | 2.0 | < 1.0 | 0.79 JP | < 1.0 | 60 |
| 04J077 | 6/7/2018 | D | 0.88 JP | 2.0 | 2.0 | < 1.0 | 0.76 JP | < 1.0 | 59 |
| 04J702 | 6/11/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 JL 74.6 | 1.1 |
| 04J708 | 6/12/2018 | | 0.78 JP | 1.1 | 0.78 JP | < 1.0 | < 1.0 | < 1.0 | 9.7 |
| 04J713 | 6/12/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 JL 74.6 | < 1.0 |
| 04U002 | 6/14/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.1 |
| 04U007 | 6/26/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 04U020 | 6/18/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.4 |

**Table 12.8**

**Groundwater Quality Data**
**Fiscal Year 2018**
**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** |
| 04U077 | 6/7/2018 | | 1.2 | 0.55 JP | 1.2 | < 1.0 | 0.35 JP | < 1.0 | 33 |
| 04U510 | 6/19/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 04U701 | 6/11/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 JL 74.6 | 2.5 |
| 04U702 | 6/11/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 JL 74.6 | 1.2 |
| 04U702 | 6/11/2018 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 JL 74.6 | 1.1 |
| 04U708 | 6/12/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 JMS 73.8 | < 1.0 |
| 04U709 | 6/12/2018 | | 0.67 JP | 0.40 JP | 0.93 JP | < 1.0 | < 1.0 | < 1.0 | 16 |
| 04U711 | 6/25/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 04U713 | 6/12/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 JL 74.6 | < 1.0 |
| 04U802 | 6/25/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.30 JP |
| 04U806 | 6/22/2018 | | 0.86 JP | 2.0 | 1.8 | < 1.0 | 0.59 JP | < 1.0 | 49 |
| 04U833 | 6/25/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.39 JP |
| PJ#806 | 6/22/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 12 |

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 reporting limit |
| JL# | - Result is qualified as estimated due to outlying LCS recovery. The following numerical value is the associated %LCS recovery. |
| JMS# | - Result is qualified as estimated due to outlying MS recovery. The following numerical value is the associated % MS recovery. |

**Table 12.9**

**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 | Northrop-Grumman Innovation Systems | Deep groundwater monitoring plan in Annual Report |
| | b. Pumping volumes and rates for comparison to design rates | Northrop-Grumman Innovation Systems | Deep groundwater monitoring plan in Annual Report |
| | c. Influent and extraction well water quality for overall mass removal calculations | Northrop-Grumman Innovation Systems | Deep groundwater monitoring plan in Annual Report |
| #2 Groundwater Treatment | • Outlined below | | |
| #3 Treated Water Discharge | • Effluent monitoring to verify attainment of treatment requirements | Northrop-Grumman Innovation Systems | 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 | Northrop-Grumman Innovation Systems | Deep groundwater monitoring plan in Annual Report |
| | b. Groundwater quality to verify attainment of clean up goals | Northrop-Grumman Innovation Systems | Deep groundwater monitoring plan in Annual Report |
| Overall Remedy | a. Groundwater quality to verify attainment of clean up goals | Northrop-Grumman Innovation Systems | Deep groundwater monitoring plan in Annual Report |

**Table 12.10**

**1,4-Dioxane Concentrations in TGRS and Extraction Wells**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | | | | 1,4-Dioxane |
|---|---|---|---|---|
| | | | Screening Criteria (HRL) | 1.0 |
| **Location** | **Alias** | **Date** | **Dup** | **µg/L** |
| 03F302 | B1 | 6/8/2018 | | 1.4 |
| 03F302 | B1 | 6/8/2018 | D | 1.5 |
| 03F303 | B2 | 6/15/2018 | | 0.26 |
| 03F304 | B3 | 6/8/2018 | | 5.5 |
| 03F305 | B4 | 6/8/2018 | | 23.9 |
| 03F306 | B5 | 6/11/2018 | | 11.8 |
| 03F307 | B6 | 6/8/2018 | | 10.9 |
| 03F308 | B7 | 6/15/2018 | | 12.5 |
| 03F312 | B11 | 6/15/2018 | | 0.73 |
| 03F319 | B13 | 6/8/2018 | | 4.1 |
| 03U301 | SC1 | 6/8/2018 | | 24.8 |
| 03U314 | SC2 | 6/8/2018 | | 15.4 |
| 03U315 | SC3 | 6/15/2018 | | 9.1 |
| 03U316 | SC4 | 6/15/2018 | | 9.3 |
| 03U317 | SC5 | 6/8/2018 | | 16 |
| PJ#309 | B8 | 6/8/2018 | | 9.5 |
| PJ#310 | B9 | 6/11/2018 | | 12.4 |
| PJ#311 | B10 | 6/15/2018 | | 12.5 |
| PJ#313 | B12 | 6/15/2018 | | 6.9 |
| PJ#313 | B12 | 6/15/2018 | D | 6.7 |
| TGRSE | | 6/11/2018 | | 10 |
| TGRSE | | 6/11/2018 | D | 9.9 |
| TGRSI | | 6/18/2018 | | 11.1 |

Notes:

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

D - Field Duplicate

**Table 12.11**

**1,4-Dioxane Concentrations in TGRS and Extraction Wells**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | | | 1,4-Dioxane |
|---|---|---|---|
| | Screening Criteria (HRL) | | 1.0 |
| **Location** | **Date** | **Dup** | **µg/L** |
| 03L002 | 6/14/2018 | | 13 |
| 03L007 | 6/26/2018 | | 0.043 JP |
| 03L014 | 6/19/2018 | | 107 |
| 03L017 | 6/19/2018 | | 12 |
| 03L017 | 6/19/2018 | D | 12.2 |
| 03L018 | 6/21/2018 | | 11.3 |
| 03L020 | 6/18/2018 | | 10 |
| 03L021 | 6/14/2018 | | 9.6 |
| 03L077 | 6/7/2018 | | 13.8 |
| 03L078 | 6/13/2018 | | 3 |
| 03L079 | 6/14/2018 | | 0.73 |
| 03L802 | 6/25/2018 | | 0.26 |
| 03L806 | 6/22/2018 | | 14.2 |
| 03L809 | 6/26/2018 | | 15.7 |
| 03L833 | 6/25/2018 | | 13.2 |
| 03L833 | 6/25/2018 | D | 12.9 |
| 03M002 | 6/14/2018 | | 14 |
| 03M020 | 6/18/2018 | | 10.8 |
| 03M802 | 6/25/2018 | | 0.13 |
| 03M806 | 6/22/2018 | | 15.4 |
| 03U002 | 6/19/2018 | | 7 |
| 03U003 | 6/13/2018 | | 0.25 |
| 03U003 | 6/13/2018 | D | 0.22 |
| 03U005 | 6/26/2018 | | 0.055 JP |
| 03U007 | 6/26/2018 | | 0.042 JP |
| 03U009 | 6/19/2018 | | < 0.07 |
| 03U014 | 6/19/2018 | | 10.7 |
| 03U017 | 6/19/2018 | | 11.3 |
| 03U018 | 6/21/2018 | | 0.53 |
| 03U018 | 6/21/2018 | D | 0.51 |
| 03U020 | 6/18/2018 | | 2.7 |
| 03U021 | 6/14/2018 | | 96 |

**Table 12.11**

**1,4-Dioxane Concentrations in TGRS and Extraction Wells**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | | | 1,4-Dioxane |
|---|---|---|---|
| **Screening Criteria (HRL)** | | | **1.0** |
| **Location** | **Date** | **Dup** | **µg/L** |
| 03U027 | 6/19/2018 | | 0.091 |
| 03U028 | 6/13/2018 | | 0.12 |
| 03U029 | 6/13/2018 | | 0.76 |
| 03U030 | 6/13/2018 | | 0.11 |
| 03U032 | 6/22/2018 | | 6.2 |
| 03U077 | 6/7/2018 | | 5.8 |
| 03U078 | 6/13/2018 | | 0.16 |
| 03U079 | 6/14/2018 | | 0.24 |
| 03U092 | 6/21/2018 | | 4.4 |
| 03U093 | 6/21/2018 | | 2.3 |
| 03U094 | 6/21/2018 | | 157 |
| 03U096 | 6/21/2018 | | 6.9 |
| 03U099 | 6/21/2018 | | < 0.07 |
| 03U114 | 6/21/2018 | | < 0.07 |
| 03U659 | 6/13/2018 | | 35.9 |
| 03U671 | 6/13/2018 | | 1.4 |
| 03U677 | 6/26/2018 | | 0.32 |
| 03U701 | 6/11/2018 | | 8.7 |
| 03U702 | 6/11/2018 | | 8.8 |
| 03U703 | 6/13/2018 | | 0.067 JP |
| 03U708 | 6/12/2018 | | 0.29 |
| 03U709 | 6/12/2018 | | 4.3 |
| 03U710 | 6/19/2018 | | 0.18 JMS157 |
| 03U711 | 6/25/2018 | | 3.4 |
| 03U715 | 6/20/2018 | | 8.3 |
| 03U801 | 6/25/2018 | | 0.1 |
| 03U801 | 6/25/2018 | D | 0.14 |
| 03U803 | 6/26/2018 | | < 0.070 UB 0.02 |
| 03U804 | 6/25/2018 | | < 0.07 |
| 03U805 | 6/26/2018 | | 3 |
| 03U805 | 6/26/2018 | D | 2.8 |
| 03U806 | 6/22/2018 | | 7.7 |

**Table 12.11**

**1,4-Dioxane Concentrations in TGRS and Extraction Wells**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | | | **1,4-Dioxane** |
|---|---|---|---|
| | **Screening Criteria (HRL)** | | **1.0** |
| **Location** | **Date** | **Dup** | **µg/L** |
| 04J077 | 6/7/2018 | | 13 |
| 04J077 | 6/7/2018 | D | 12.5 |
| 04J702 | 6/11/2018 | | 12.7 |
| 04J708 | 6/12/2018 | | 7 |
| 04J713 | 6/18/2018 | | 6 |
| 04U002 | 6/14/2018 | | 12.1 |
| 04U020 | 6/18/2018 | | 9.5 |
| 04U077 | 6/7/2018 | | 12.3 |
| 04U510 | 6/19/2018 | | < 0.07 |
| 04U701 | 6/11/2018 | | 12 |
| 04U702 | 6/11/2018 | | 12 |
| 04U702 | 6/11/2018 | D | 11.4 |
| 04U708 | 6/12/2018 | | 7.3 |
| 04U709 | 6/12/2018 | | 12.4 |
| 04U711 | 6/25/2018 | | 7.3 |
| 04U713 | 6/12/2018 | | 11.3 |
| 04U802 | 6/25/2018 | | 0.4 |
| 04U806 | 6/22/2018 | | 13.5 |
| 04U833 | 6/25/2018 | | 13.2 |
| PJ#806 | 6/22/2018 | | 13.5 |

Notes:

HRL - Health Risk Limit (Minnesota Department of Health). Shading indicates exceedence of the HRL
D - Field Duplicate
JP - Result is qualified as estimated since the detection is below the laboratory reporting limit
UB# - Result is qualified as non-detect. The following numerical value is the associated blank conentration
JMS# - Result is qualified as estimated due to outlying MS recovery The following numerical value is the associated % MS recovery

**Table 13.1**

**Groundwater Quality Data**
**Fiscal Year 2018**
**Operable Unit 3**

| | | | 1,1,1-Trichloroethane | 1,1,2-Trichloroethane | 1,1-Dichloroethane | 1,1-Dichloroethene | cis-1,2-Dichloroethene | Trichloroethene |
|---|---|---|---|---|---|---|---|---|
| **OU3 Cleanup Level(1)** | | | **200** | **3.0** | **70** | **6.0** | **70** | **5.0** |
| **Location** | **Date** | **Dup** | **µg/L** | **µg/L** | **µg/L** | **µg/L** | **µg/L** | **µg/L** |
| 03L673 | 6/29/2018 | | < 1.0 | < 1.0 | 0.30 JP | < 1.0 | 4.1 | 63 |
| 03L848 | 6/28/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.37 JP | 3.3 |
| 03L854 | 6/28/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 03L854 | 6/28/2018 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 03M848 | 6/28/2018 | | < 1.0 | < 1.0 | 0.53 JP | 0.74 JP | 7.3 | 110 |
| 03U673 | 6/29/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 04J866 | 6/27/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 04U414 | 6/27/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 04U414 | 6/27/2018 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 04U673 | 6/29/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.89 JP | 22 |
| 04U832 | 6/28/2018 | | 0.97 JP | < 1.0 | 3.2 | 3.6 | 4.2 | 59 |
| 04U845 | 6/27/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.41 JP | 7.4 |
| 04U848 | 6/28/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 3.0 |
| 04U851 | 6/27/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 |
| 04U854 | 6/28/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.38 JP | 7.2 |
| 03L859 | 6/28/2018 | | 1.2 | < 1.0 | 4.2 | 7.0 | 1.1 | 4.8 |
| 04U859 | 6/28/2018 | | 1.9 | < 1.0 | 2.5 | 3.2 | 1.2 | 25 |
| 04U860 | 6/29/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.43 JP |
| 04U860 | 6/29/2018 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.35 JP |
| 04U863 | 6/27/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.93 JP |
| 04U866 | 6/27/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 0.33 JP |

Notes:

(1) Cleanup levels for OU3 are from the OU3 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 13.2**

**Mann-Kendall Statistical Summary**
**Fiscal Year 2018**
**Operable Unit 3**

| | Well | Kendall S | Number of Data Points | Raw Trend | Confidence | Coefficient of Variance | Raw Trend Decision | MAROS Conclusion | TRCLE Concentration 2018 |
|---|---|---|---|---|---|---|---|---|---|
| | **Edge of Plume Wells** | | | | | | | | |
| * | 03L673 | -12 | 6 | Decreasing | 98.19% | 0.2258 | Definite | Decreasing | 63 |
| * | 03L848 | -11 | 6 | Decreasing | 97.20% | 0.1632 | Definite | Decreasing | 3.3 |
| * | 04U673 | -13 | 6 | Decreasing | 99.17% | 0.2965 | Definite | Decreasing | 22 |
| * | 04U832 | 8 | 6 | Increasing | 89.81% | 0.1021 | Stable or No Trend | No Trend | 59 |
| * | 04U845 | -3 | 6 | Decreasing | 64.00% | 0.3458 | Stable or No Trend | Stable | 7.4 |
| * | 04U848 | -9 | 6 | Decreasing | 93.20% | 0.1961 | Probable | Decreasing | 3 |
| * | 04U854 | -9 | 6 | Decreasing | 93.20% | 0.1777 | Probable | Decreasing | 7.2 |
| | **Center of Plume Wells** | | | | | | | | |
| * | 03L859 | -12 | 6 | Decreasing | 98.19% | 0.2240 | Definite | Decreasing | 4.8 |
| * | 03M848 | -12 | 6 | Decreasing | 98.19% | 0.1912 | Definite | Decreasing | 110 |
| * | 04U859 | -14 | 6 | Decreasing | 99.51% | 0.2864 | Definite | Decreasing | 25 |

Notes:

* - Denotes sample results collected in FY 201

## Table 13.3



**Summary Of Groundwater Monitoring Requirements**
**Operable Unit 3**

| | Remedy Component | | Monitoring Requirements | Implementing Party | Documents Containing the Monitoring Plan |
|---|---|---|---|---|---|
| #1 | Monitored Natural Attenuation | | Outlined below. | | |
| #2 | Groundwater Monitoring | a. | Water levels for use in drawing contour maps. | Northrop-Grumman Innovation Systems | OU3 Monitoring Plan in Annual Report |
| | | b. | Groundwater sampling to track progress of clean-up and attenuation of plume. | Northrop-Grumman Innovation Systems | OU3 Monitoring Plan in Annual Report |
| #3 | Drilling Advisories | a. | Verification that drilling advisories are in place and functioning as intended. | Army/MDH | NA |
| OR: | Overall Remedy | a. | Water quality monitoring to verify attainment of clean-up goals. | Northrop-Grumman Innovation Systems | OU3 Monitoring Plan in Annual Report |

**Table 13.4**

**1,4-Dioxane Groundwater Sampling Results**
**Fiscal Year 2018**
**Operable Unit 3**

| | | | **1,4-Dioxane** |
|---|---|---|---|
| **Screening Criteria (HRL)** | | | **1.0** |
| **Location** | **Date** | **Dup** | **µg/L** |
| 03L673 | 6/29/2018 | | 2.0 |
| 03L848 | 6/28/2018 | | 0.71 |
| 03L854 | 6/28/2018 | | < 0.074 UB 0.02 |
| 03L854 | 6/28/2018 | D | < 0.070 |
| 03L859 | 6/28/2018 | | 3.1 |
| 03M848 | 6/28/2018 | | 0.53 |
| 03U673 | 6/29/2018 | | < 0.070 |
| 04J866 | 6/27/2018 | | < 0.07 |
| 04U414 | 6/27/2018 | | 0.057 JP |
| 04U414 | 6/27/2018 | D | < 0.07 |
| 04U673 | 6/29/2018 | | 0.58 |
| 04U832 | 6/28/2018 | | 3.3 |
| 04U845 | 6/27/2018 | | 0.41 |
| 04U848 | 6/28/2018 | | 0.68 |
| 04U851 | 6/27/2018 | | < 0.07 |
| 04U854 | 6/28/2018 | | < 0.56 UB 10.2 |
| 04U859 | 6/28/2018 | | 4.6 |
| 04U860 | 6/29/2018 | | 0.15 |
| 04U860 | 6/29/2018 | D | 0.14 |
| 04U863 | 6/27/2018 | | 0.1 |
| 04U866 | 6/27/2018 | | 0.061 JP |

Notes:

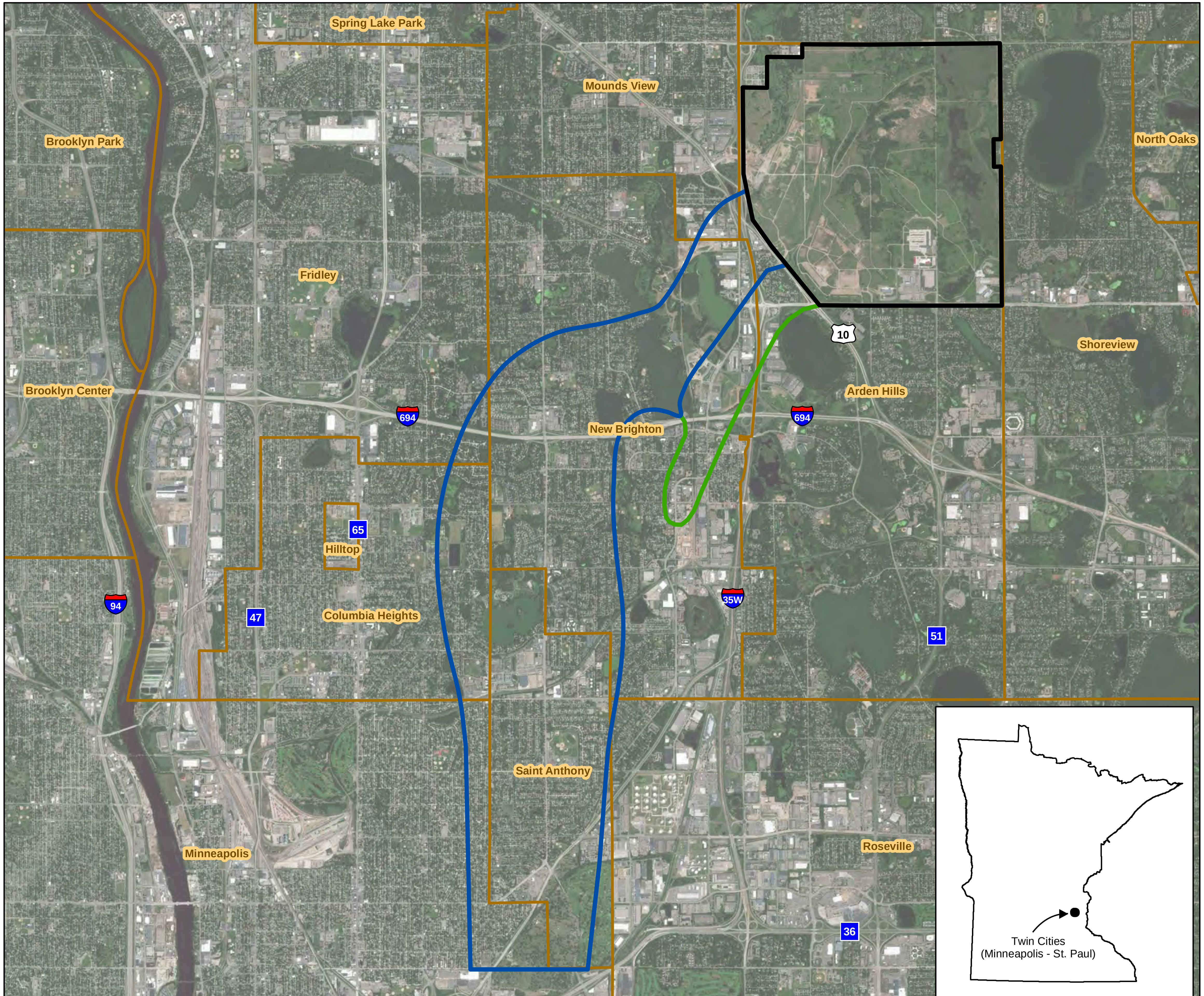
HRL Health Risk Limit (Minnesota Department of Health). Shading indicates exceedence of the HRL.

D - Field Duplicate

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

UB # - Result is qualified as non-detect. The following numerical value is the associated blank conentration.

# FIGURES




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

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

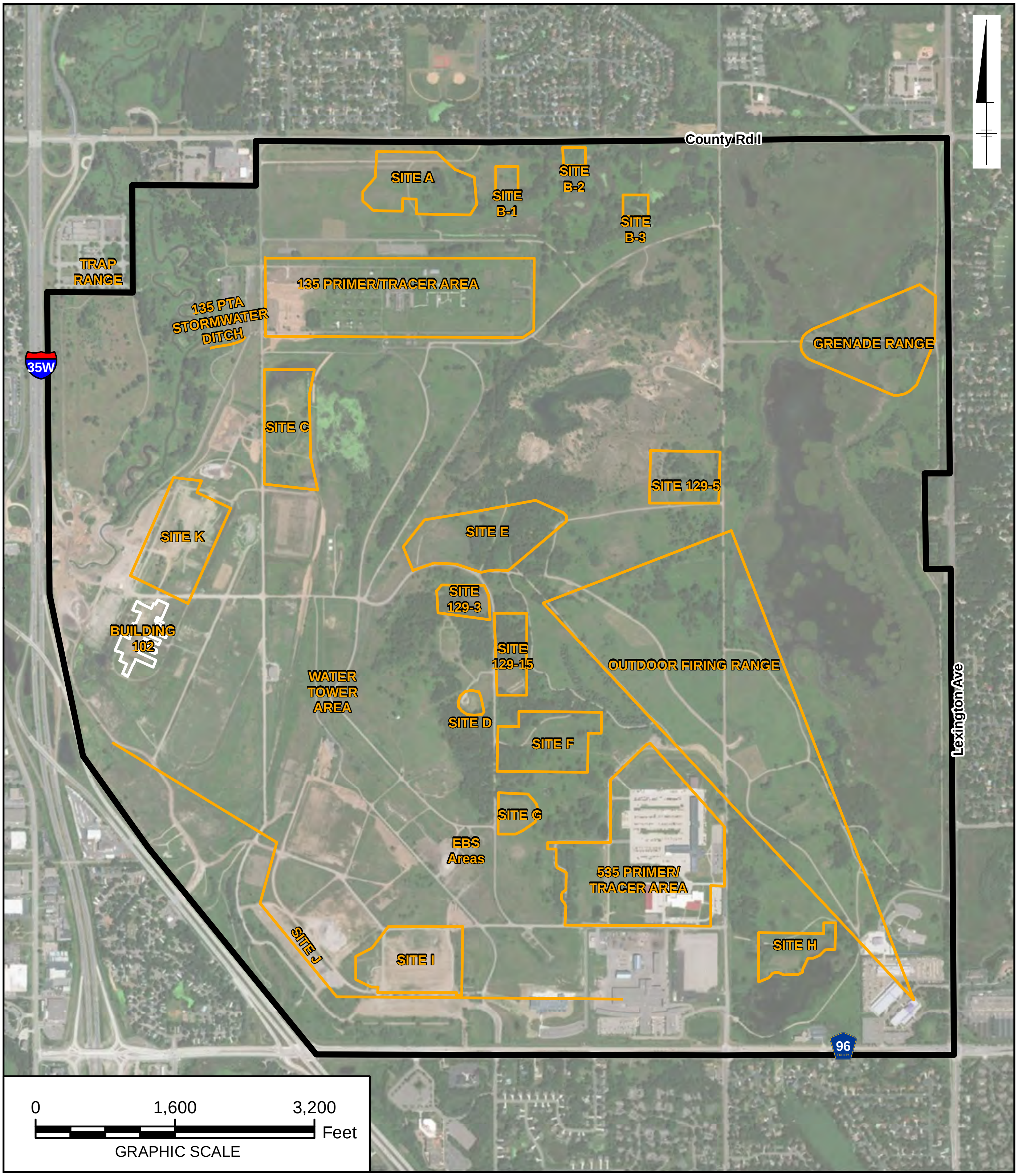
**ANNUAL PERFORMANCE REPORT**

## Conceptual Illustration of Operable Units

PIKA ARCADIS
a joint venture

FIGURE
**2-1**

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




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

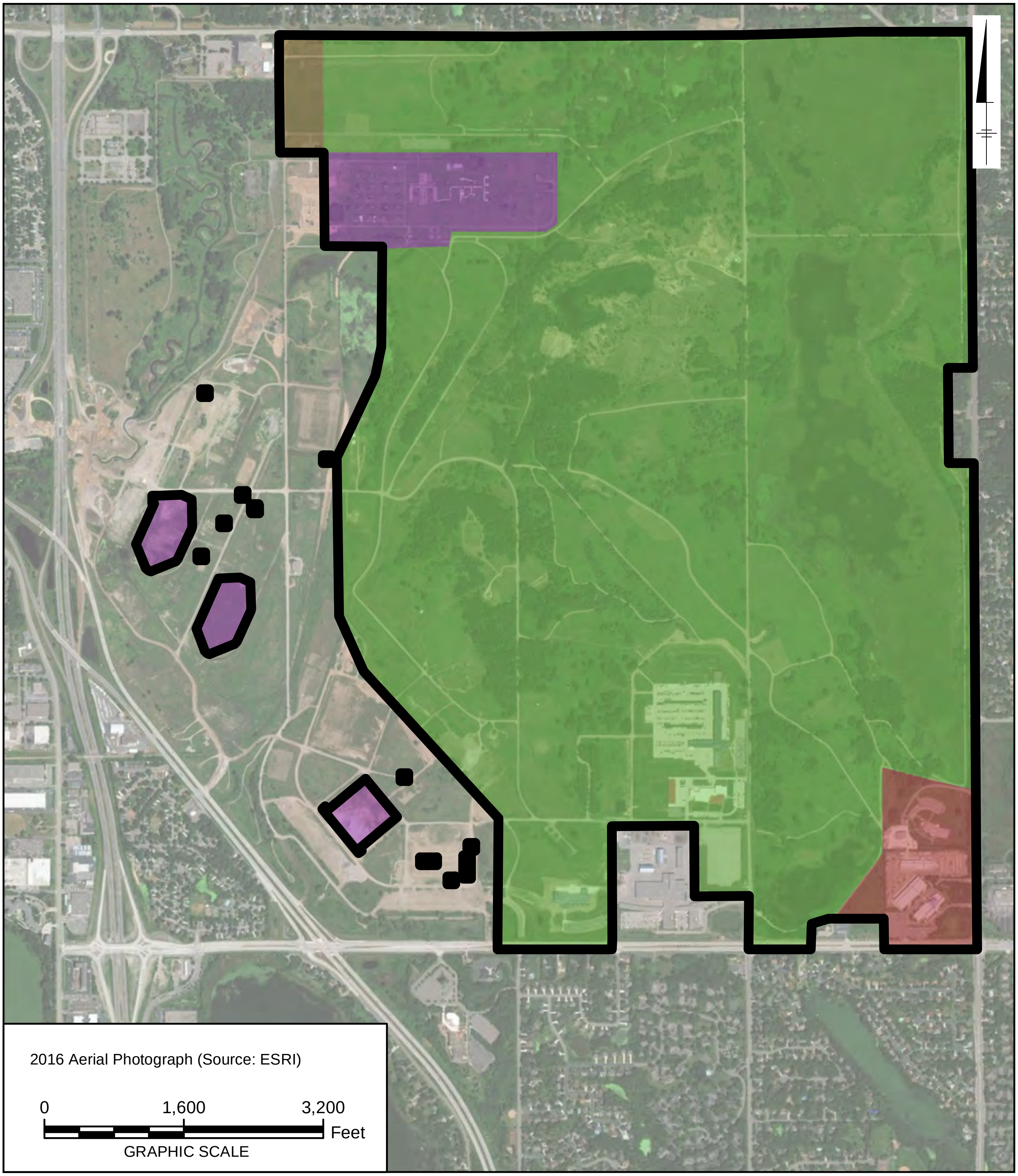
**ANNUAL PERFORMANCE REPORT**

# Operable Unit 2
# Site Boundaries

PIKA ARCADIS a joint venture

FIGURE **2-2**

City: Minneapolis Div/Group: IMDV Created By: MG Last Saved By: mgress
TCAAP
Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-01APR_2017\General_Locations_OU2_Sites_FY2017.mxd 2/1/2018 8:04:23 AM




LEGEND:

- Federally - owned property controlled by the U.S. Army
- Control Delegated to the Base Realignment and Closure Division (what remains of TCAAP)
- Control Delegated to the U.S. Army Reserve
- Control Delegated to the National Guard Bureau, who in turn has licensed use of the property to the Minnesota Army National Guard
- Easement to Ramsey County

TWIN CITIES ARMY AMMUNITION PLANT
ARDEN HILLS, MINNESOTA

**ANNUAL PERFORMANCE REPORT**

# Federally - Owned Property Within Operable Unit 2

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FIGURE
**2-3**

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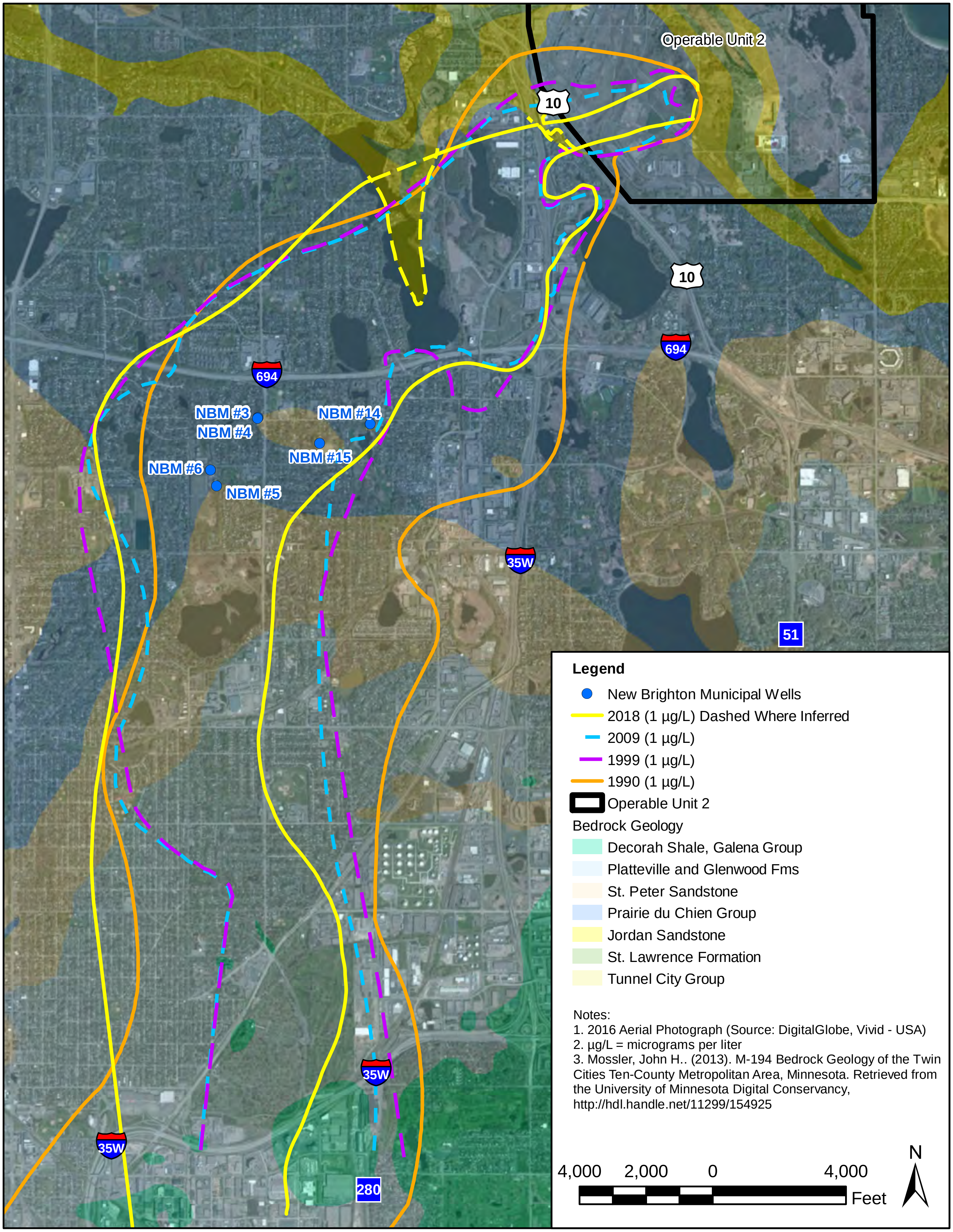



ANNUAL PERFORMANCE REPORT

Upper Unit 4,

1 µg/L Trichloroethene Isoconcentration Map

PIKA ARCADIS a joint venture

FY 2018

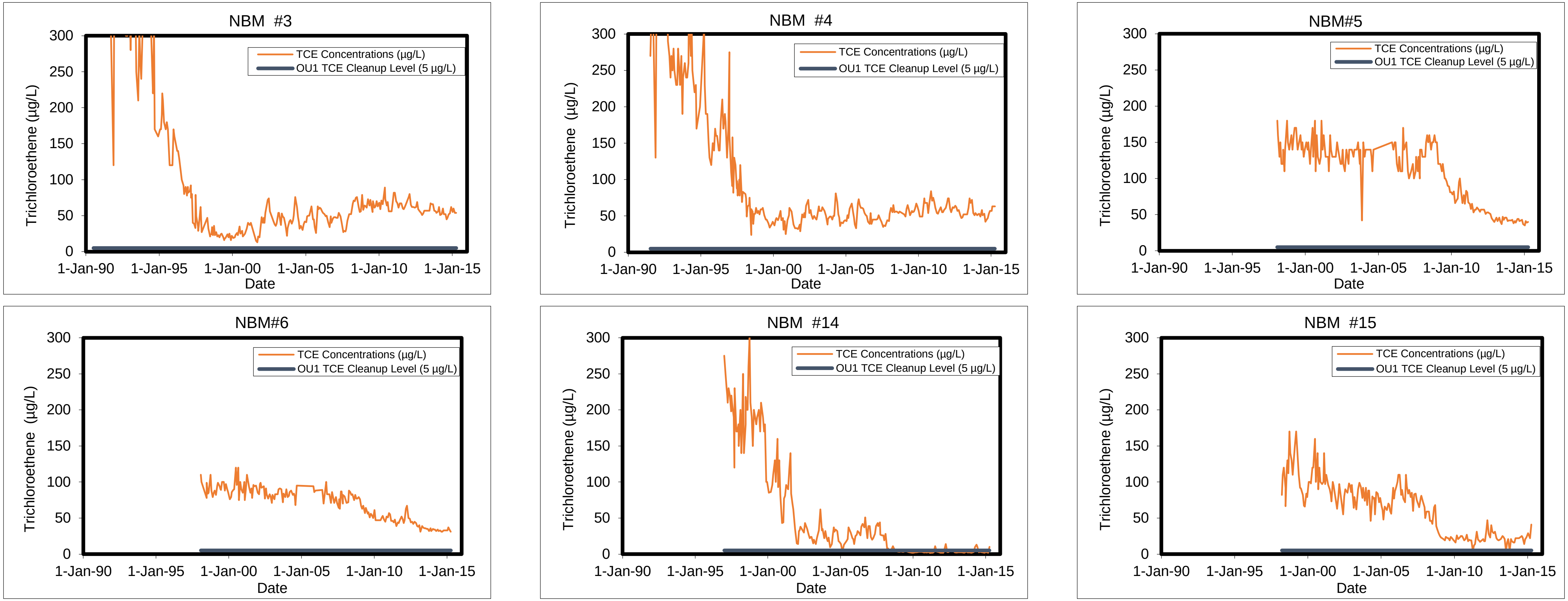
Figure 3-1

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2019-01\Figure_3-1 Upper Unit 4 1ug TCE_FY2018.mxd
Date: 1/17/2019 Time: 7:35:34 AM User: kgpeters

# Figure 3-2
## New Brighton Municipal Wells: Trichloroethene Water Quality Trends

Twin Cities Army Ammunitions Plant
Arden Hills, MN

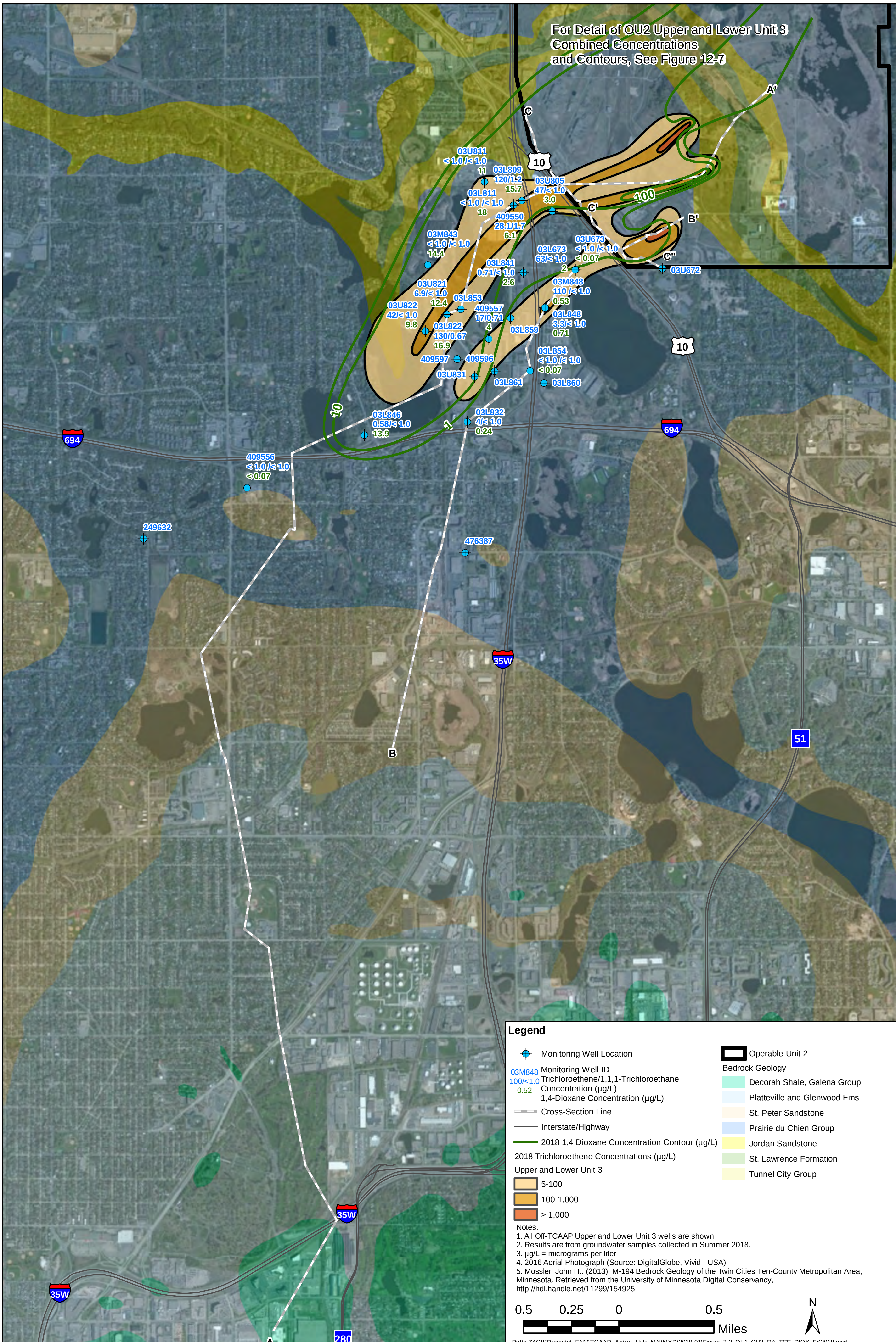
PIKA
ARCADIS
a joint venture



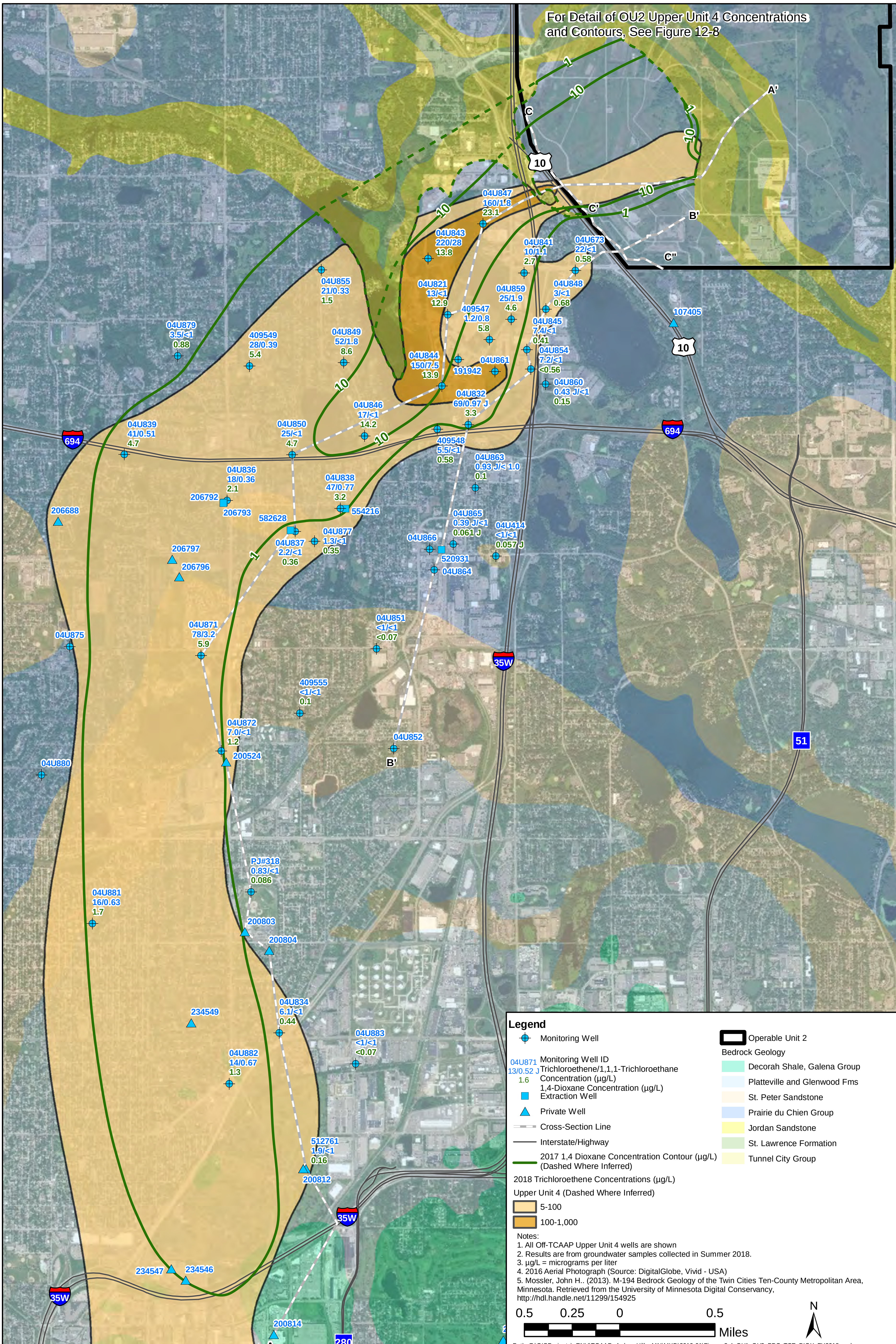

Notes:

1. 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.

Acronyms and Abbreviations:
TCE = Trichloroethene
µg/L = micrograms per liter




| ANNUAL PERFORMANCE REPORT | PIKA ARCADIS a joint venture | FY 2018 |
|---|---|---|
| OU1 & OU3, Upper and Lower Unit 3 Combined, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2018 | | Figure 3-3 |



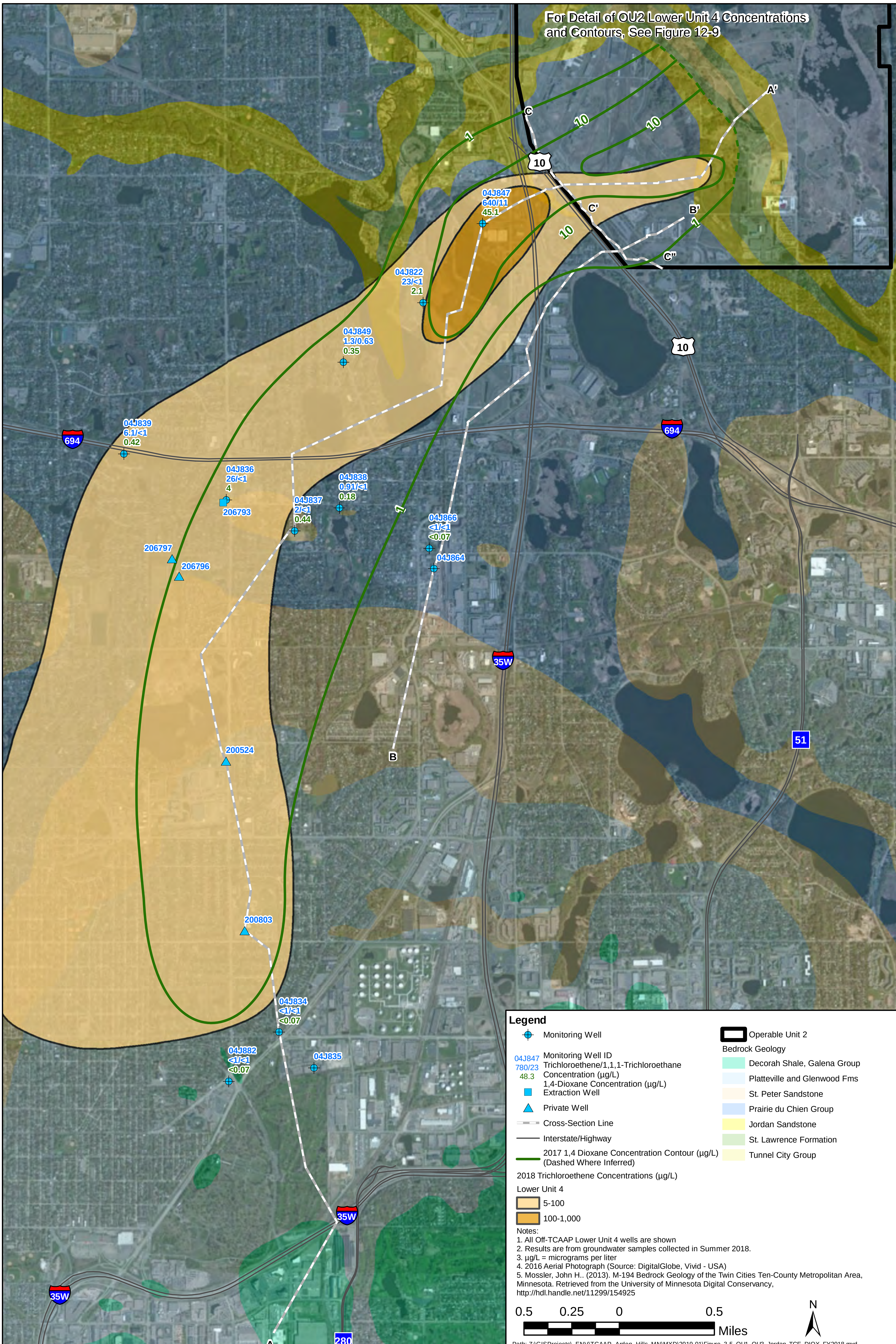

ANNUAL PERFORMANCE REPORT

OU1 & OU3, Upper Unit 4, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2018

PIKA ARCADIS a joint venture

FY 2018

Figure 3-4




ANNUAL PERFORMANCE REPORT

OU1 & OU3, Lower Unit 4, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2018

PIKA ARCADIS a joint venture

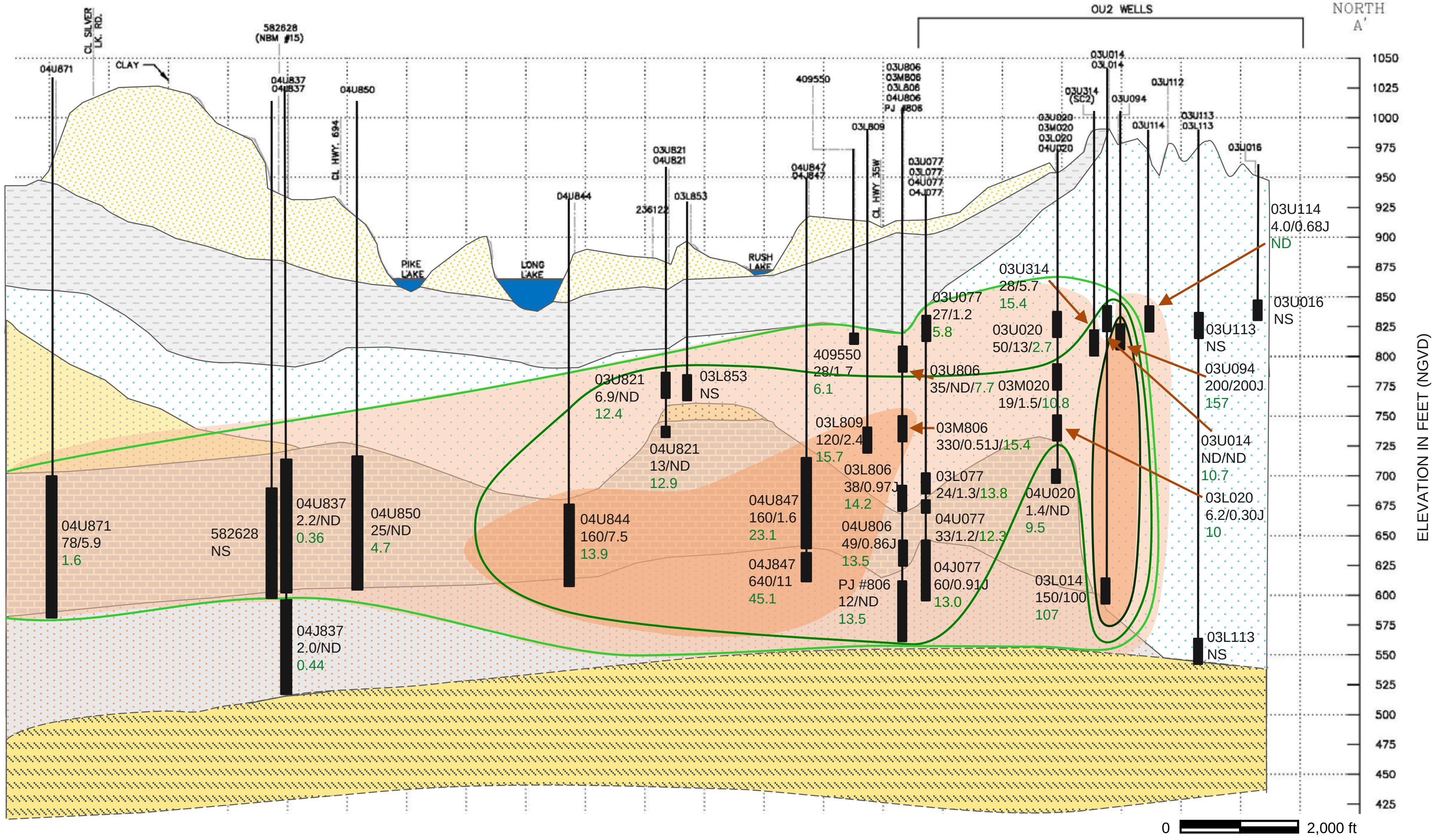
FY 2018

Figure 3-5

## Figure 3-6
## 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)
- 5-100
- 100-1000

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

**Figure 3-7**
**OU2-OU1 Trichloroethene**
**Cross Section A-A' (South Half)**

U.S Army - TCAAP
Arden Hills, Minnesota

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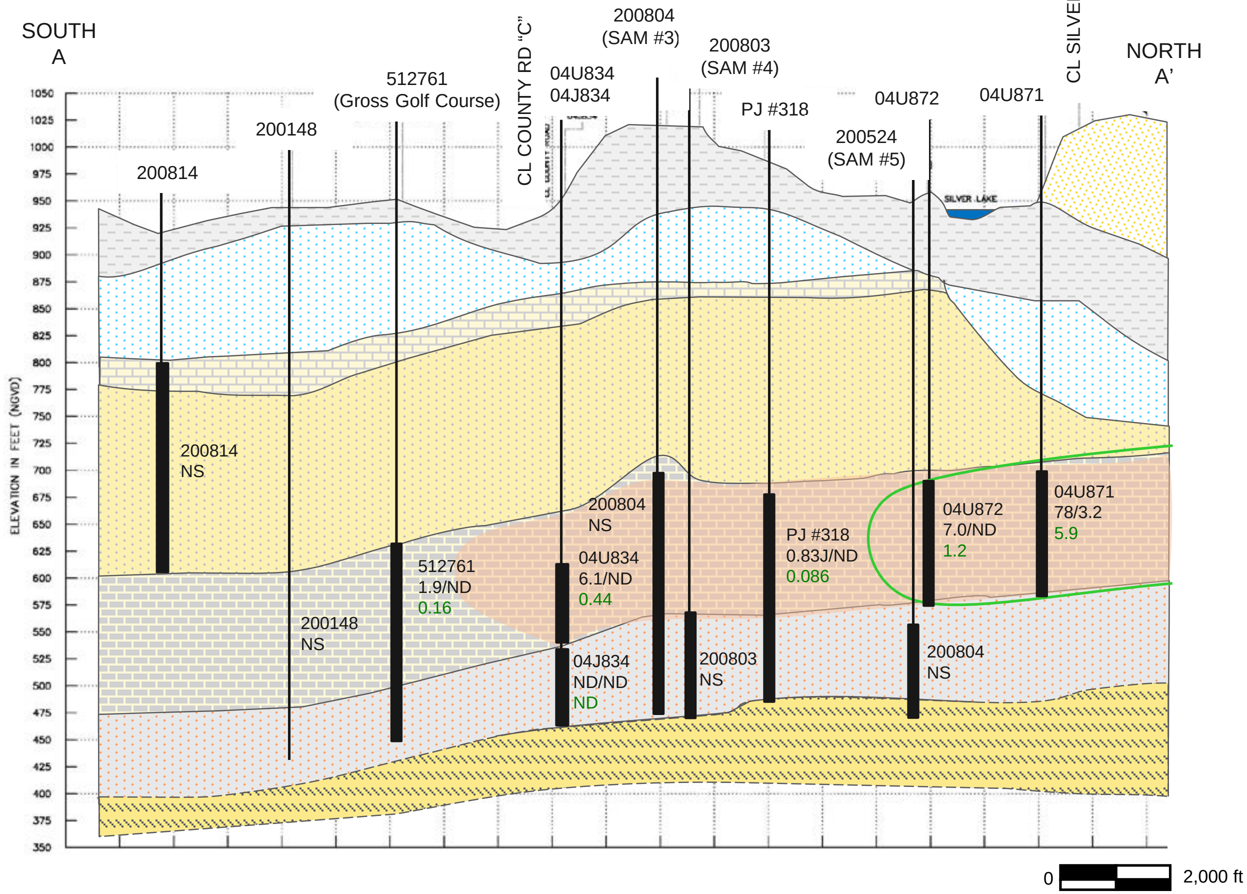


## Legend

| | |
|---|---|
| 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)

5-100

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

**Figure 3-8**
**OU2-OU3 Trichloroethene**
**Cross Section B-B'**

U.S Army - TCAAP
Arden Hills, Minnesota

PIKA
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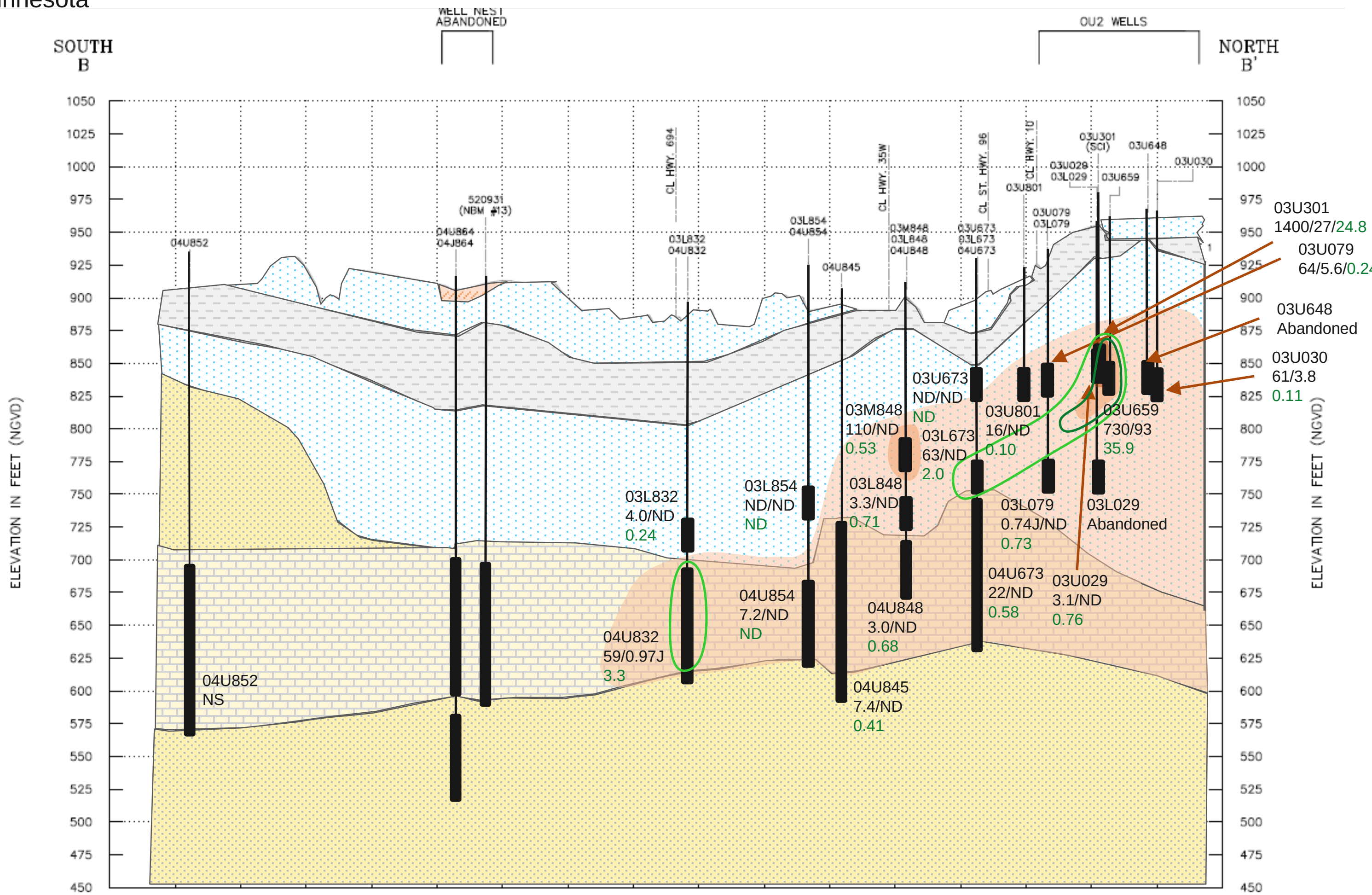
a joint venture



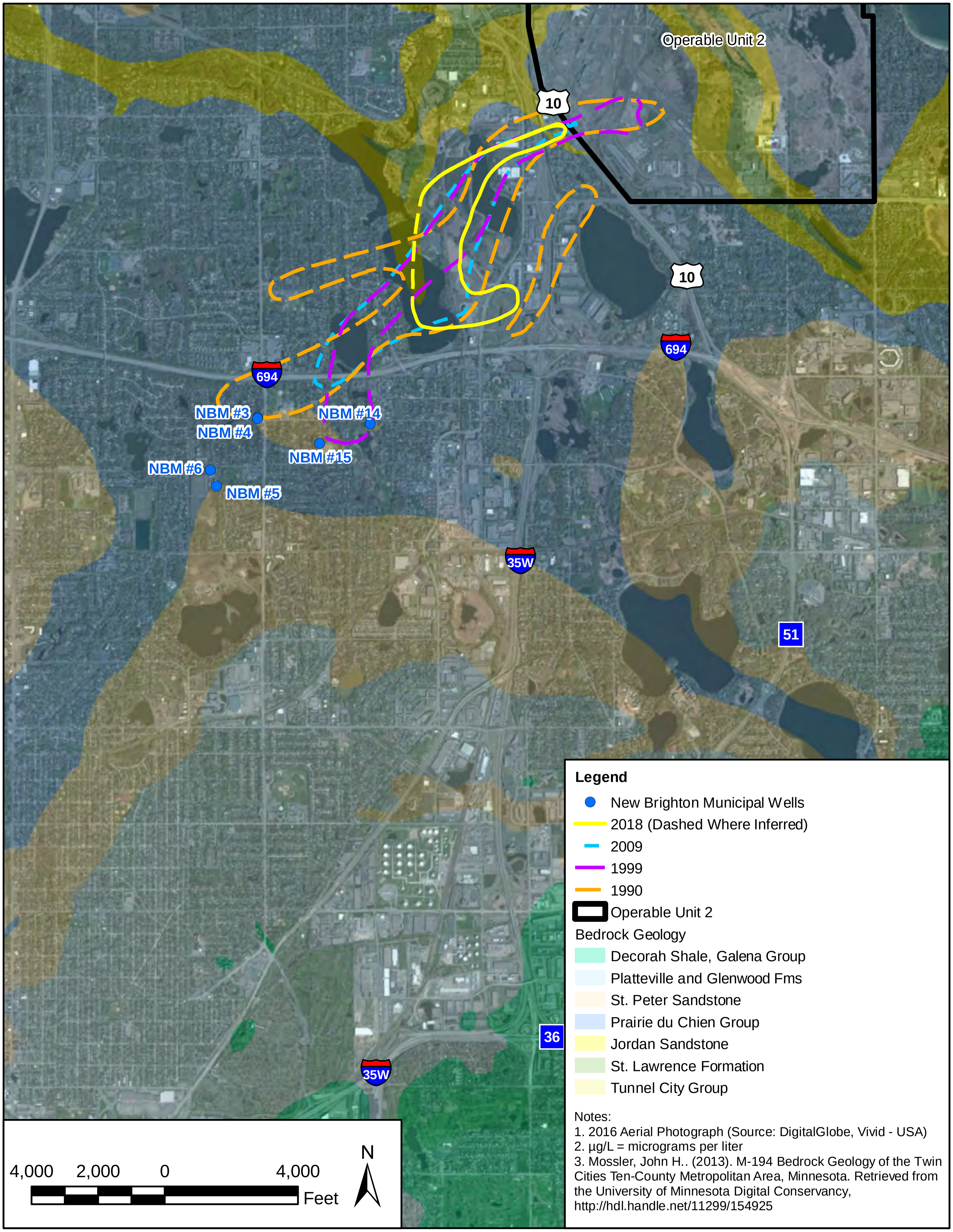

## Legend

| | |
|---|---|
| 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) |
| J | Reported value is between the method detection limit and reporting limit |
| — | Geologic Contact (inferred where dashed) |
| ▌ | Screened Interval |

Trichloroethene Concentration (µg/L)
- 5-100
- 100-1000
- > 1000

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

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




**Legend**

- New Brighton Municipal Wells
- 2018 (Dashed Where Inferred)
- 2009
- 1999
- 1990
- Operable Unit 2

Bedrock Geology

- Decorah Shale, Galena Group
- Platteville and Glenwood Fms
- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Tunnel City Group

Notes:
1. 2016 Aerial Photograph (Source: DigitalGlobe, Vivid - USA)
2. µg/L = micrograms per liter
3. 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

ANNUAL PERFORMANCE REPORT

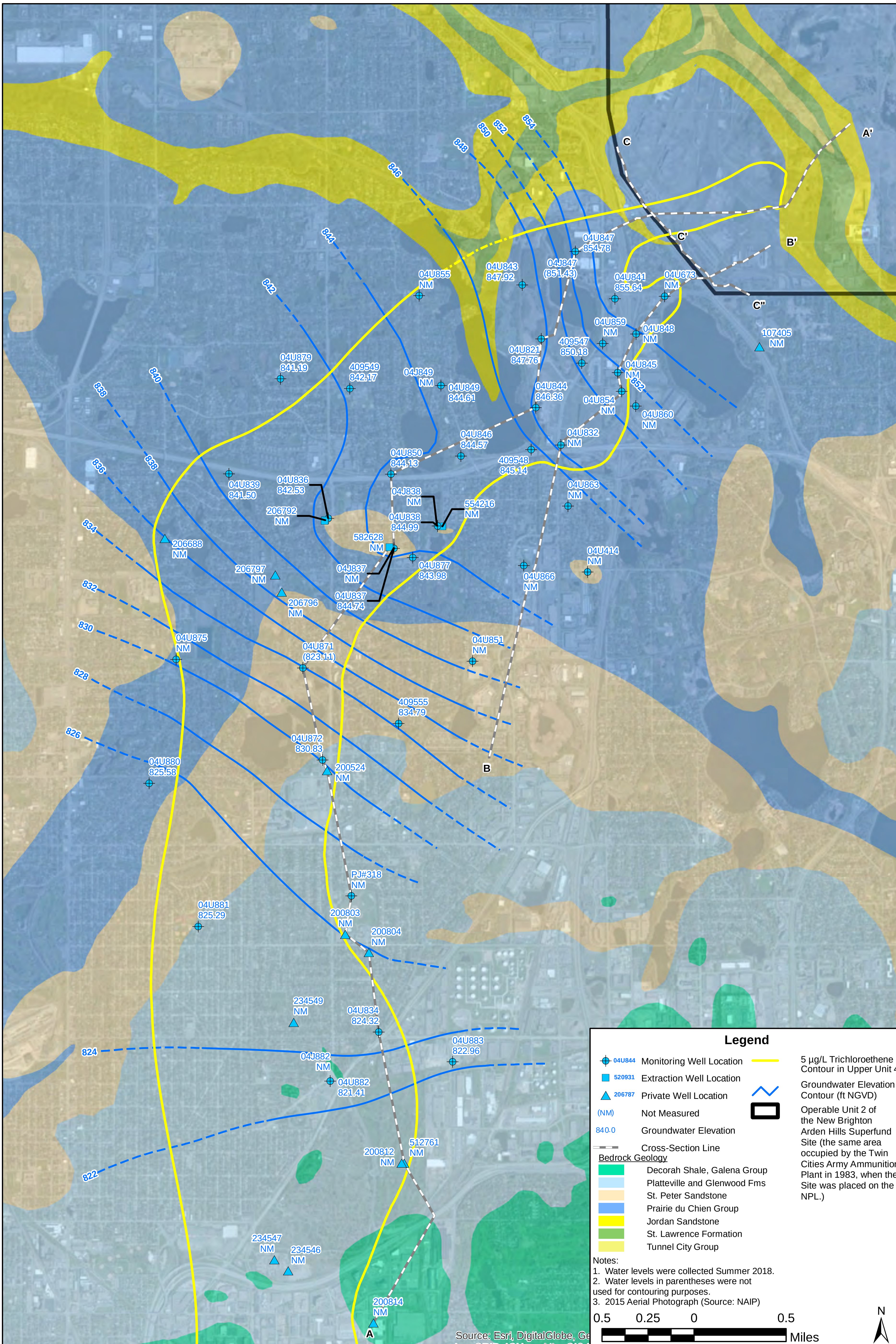
Upper Unit 4,
100 µg/L Trichloroethene Isoconcentration Map

PIKA ARCADIS a joint venture

FY 2018

Figure 3-9

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2019-01\Figure_3-9_Upper Unit 4 100ug TCE_FY2018.mxd
Date: 1/17/2019 Time: 7:38:48 AM User: kgpeters




ANNUAL PERFORMANCE REPORT

OU1 & OU3, Upper Unit 4, Potentiometric Map, Summer 2018

PIKA ARCADIS a joint venture

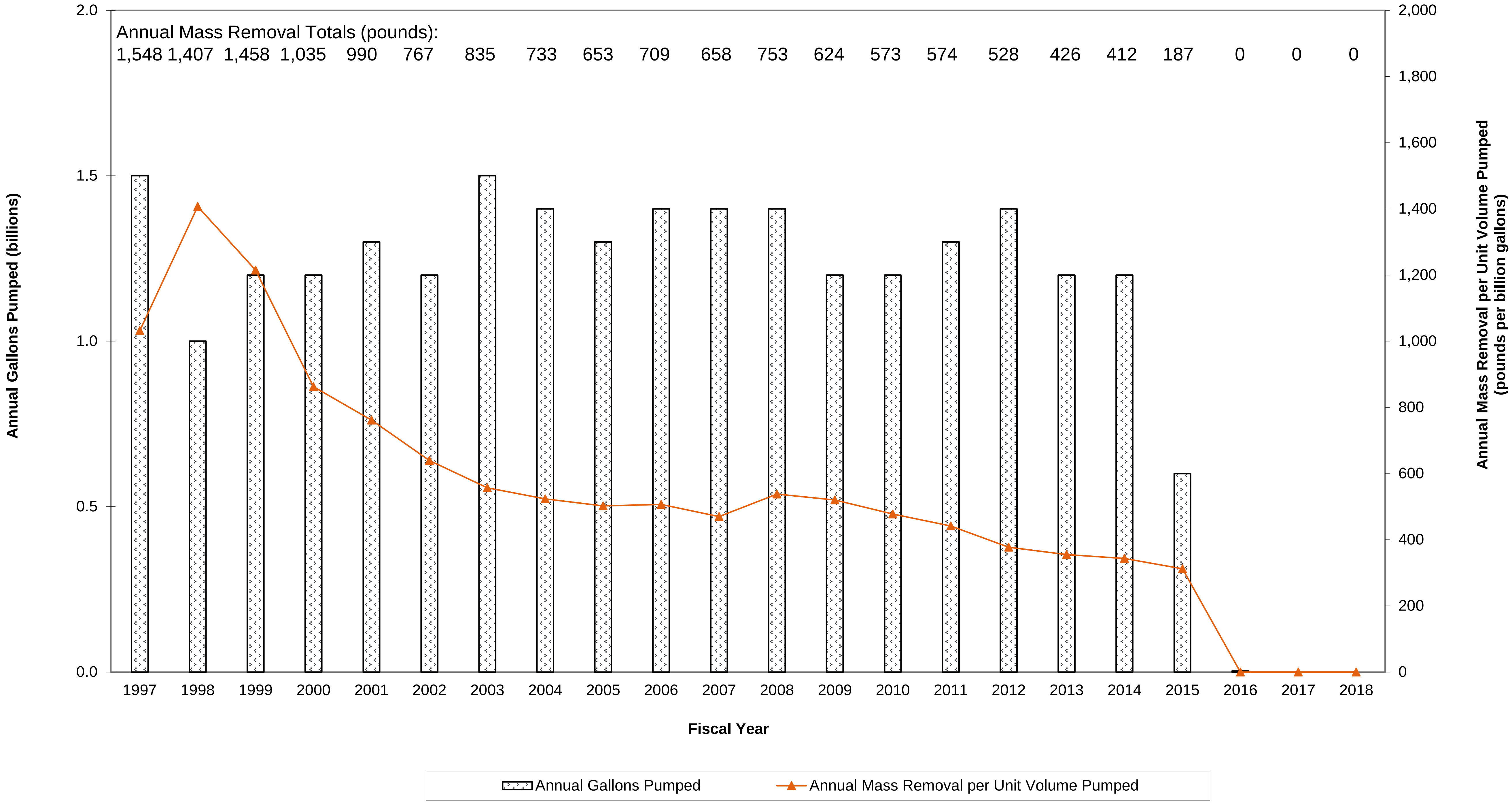
FY 2018

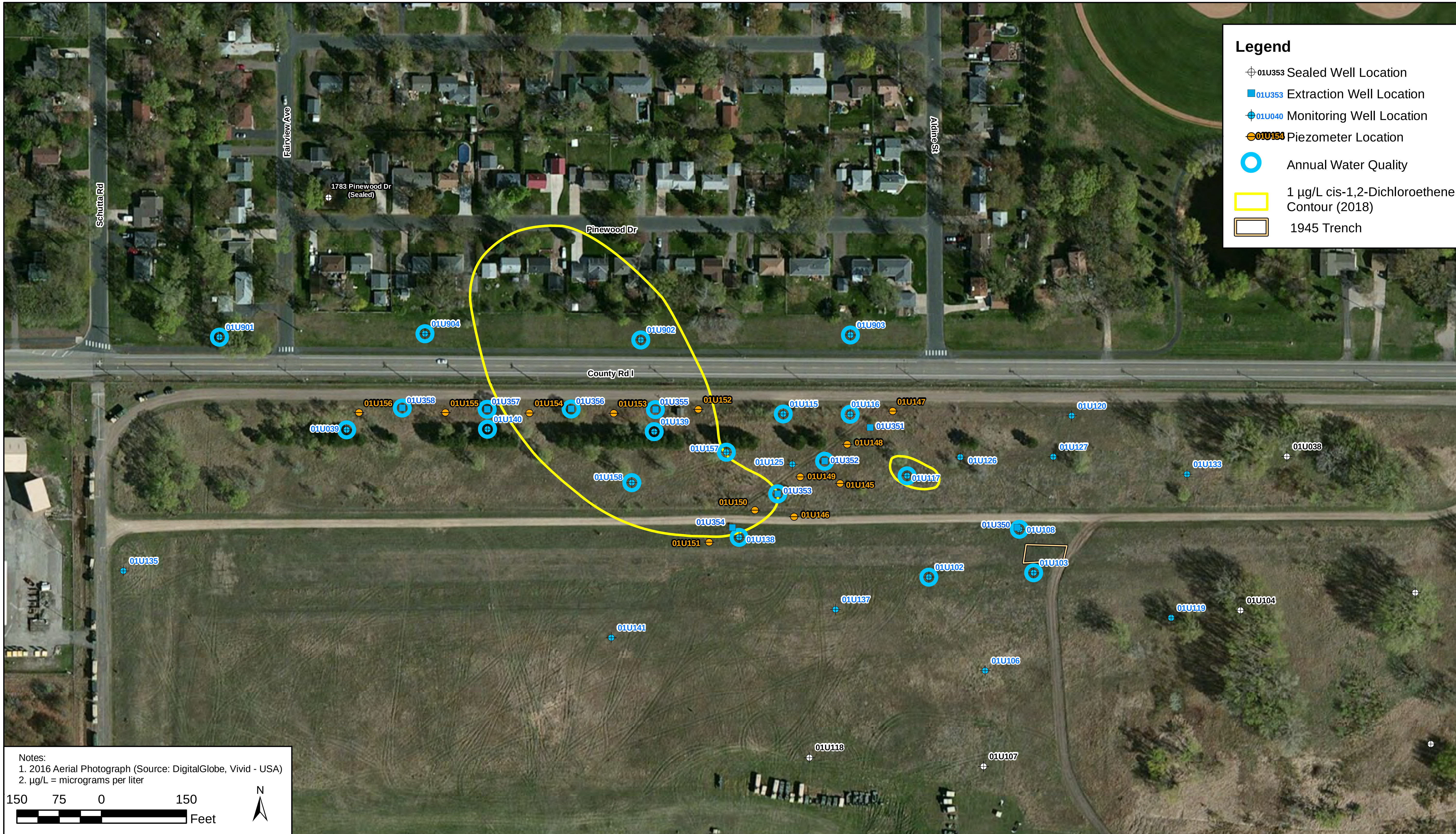
Figure 3-10

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2019-01\Figure_3-10_OU1 OU3 Upper Unit 4 Potentiometric_FY2018.mxd
Date: 1/30/2019 Time: 10:47:31 AM User: kgpeters

**Figure 3-11**
**NBCGRS History**

Twin Cities Army Ammunitions Plant
Arden Hills, MN






ANNUAL PERFORMANCE REPORT

Site A, Groundwater Monitoring Plan

PIKA ARCADIS a joint venture

FY 2018

Figure 6-1

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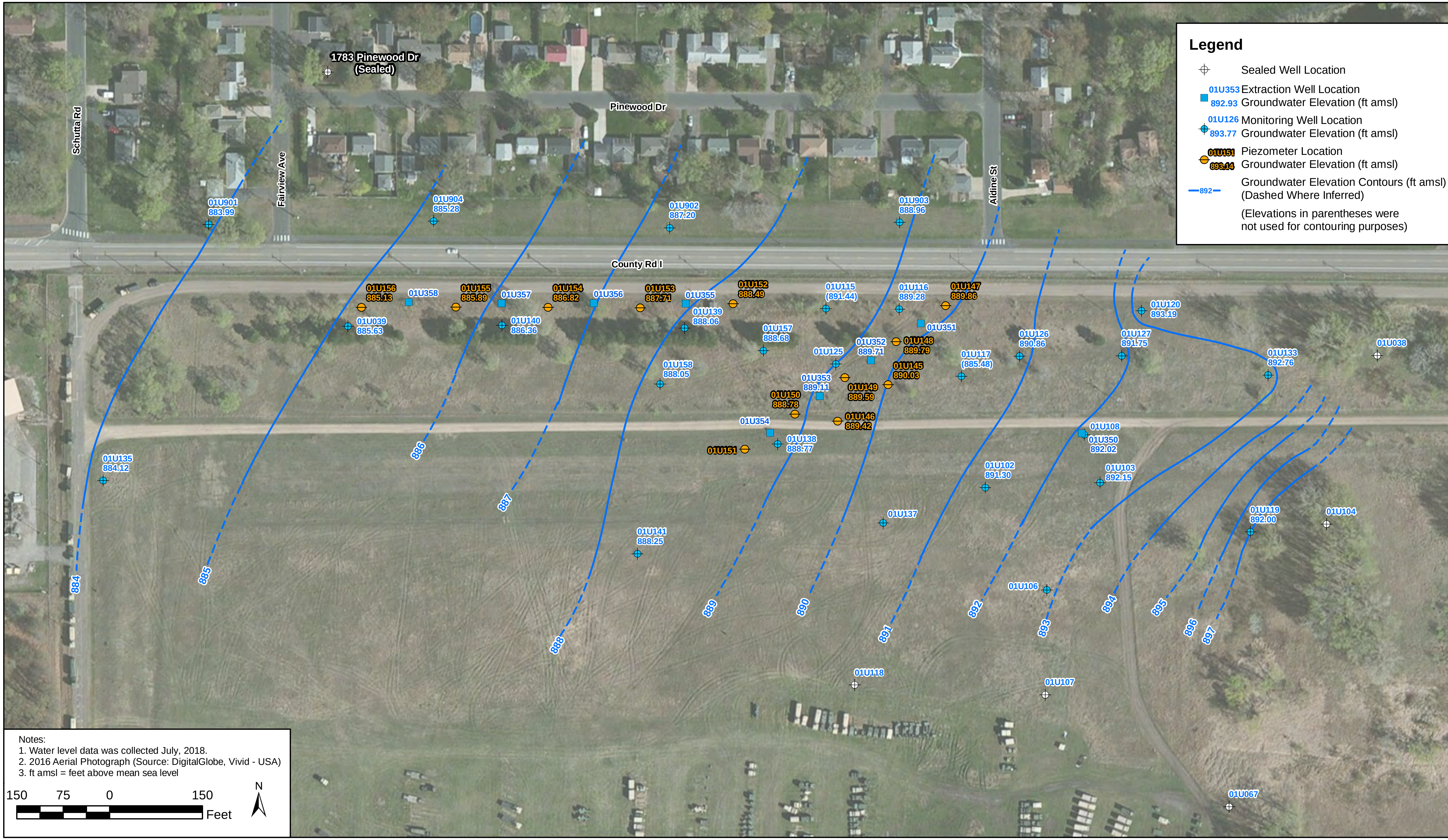


ANNUAL PERFORMANCE REPORT

Site A, Unit 1, Potentiometric Map, Summer 2018

PIKA ARCADIS a joint venture

FY 2018

Figure 6-2

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-12\MXD\Fig_6-2_Site A Potentiometric Map_FY2018.mxd
Date: 1/17/2019 Time: 6:50:50 AM User: kgpeters


ANNUAL PERFORMANCE REPORT

Site A, Unit 1, Tetrachloroethene Isoconcentration Map, Summer 2018

PIKA ARCADIS a joint venture

FY 2018

Figure 6-3

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-12\MXD\Fig_6-3_Site A Tetra Plume Map_FY2018.mxd
Date: 1/17/2019 Time: 5:42:46 AM User: kgpeters


ANNUAL PERFORMANCE REPORT

Site A, Unit 1, cis-1,2-Dichloroethene Isoconcentration Map, Summer 2018

PIKA ARCADIS a joint venture

FY 2018

Figure 6-4

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-12\MXD\Fig_6-4_Site A cis-1,2 DCE Plume Map_FY2018.mxd
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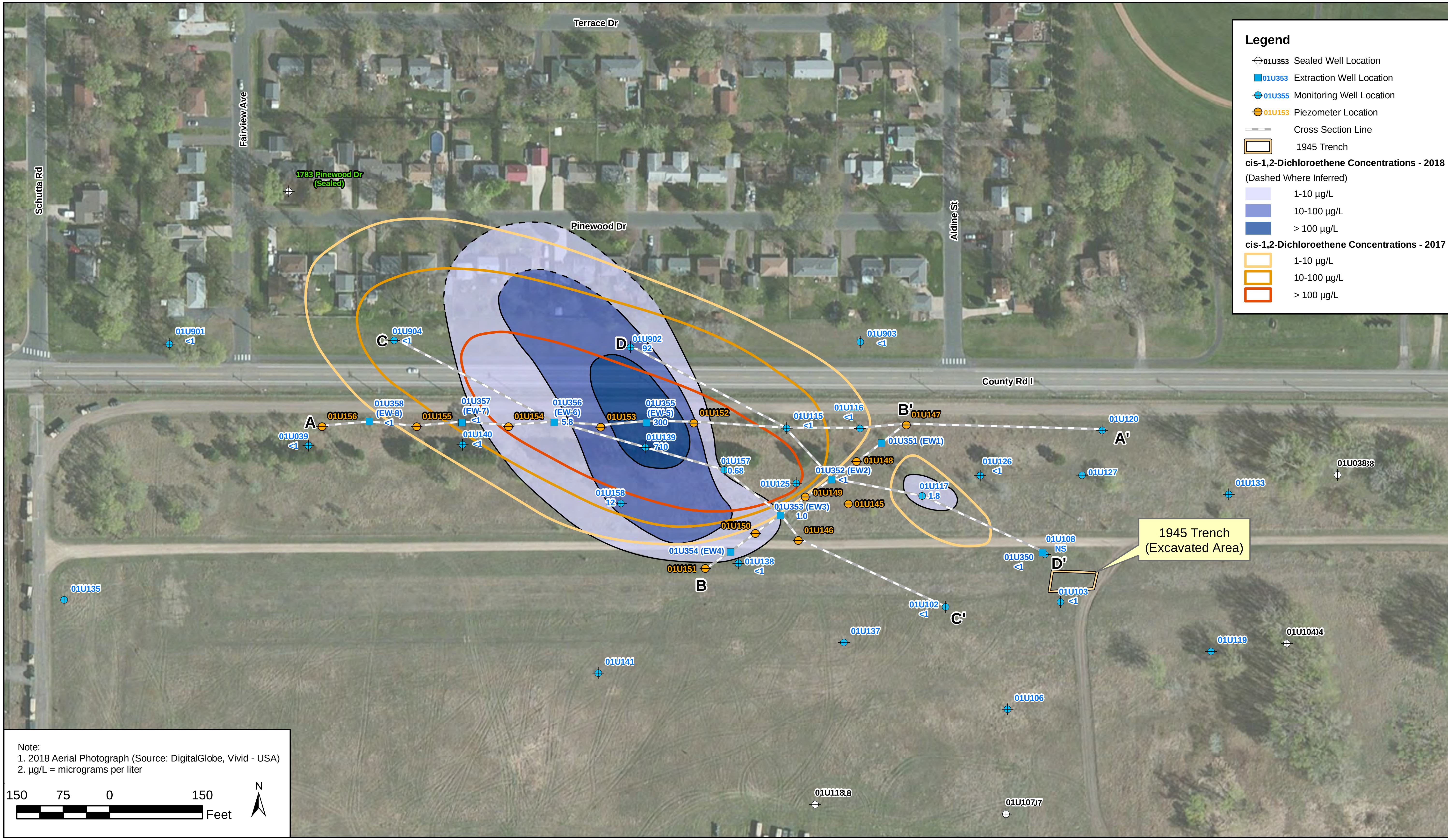


ANNUAL PERFORMANCE REPORT

Site A, Unit 1, cis-1,2-Dichloroethene Plume Comparison

PIKA ARCADIS a joint venture

FY 2018

Figure 6-5

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-12\MXD\Fig_6-5_Site A cis-1,2 DCE Plume Comparison Map_FY2018.mxd
Date: 1/17/2019 Time: 5:39:14 AM User: kgpeters

**Figure 6-6**
**cis-1,2-Dichloroethene Cross Sections A, B, C, D**

U.S Army - TCAAP
Arden Hills, Minnesota

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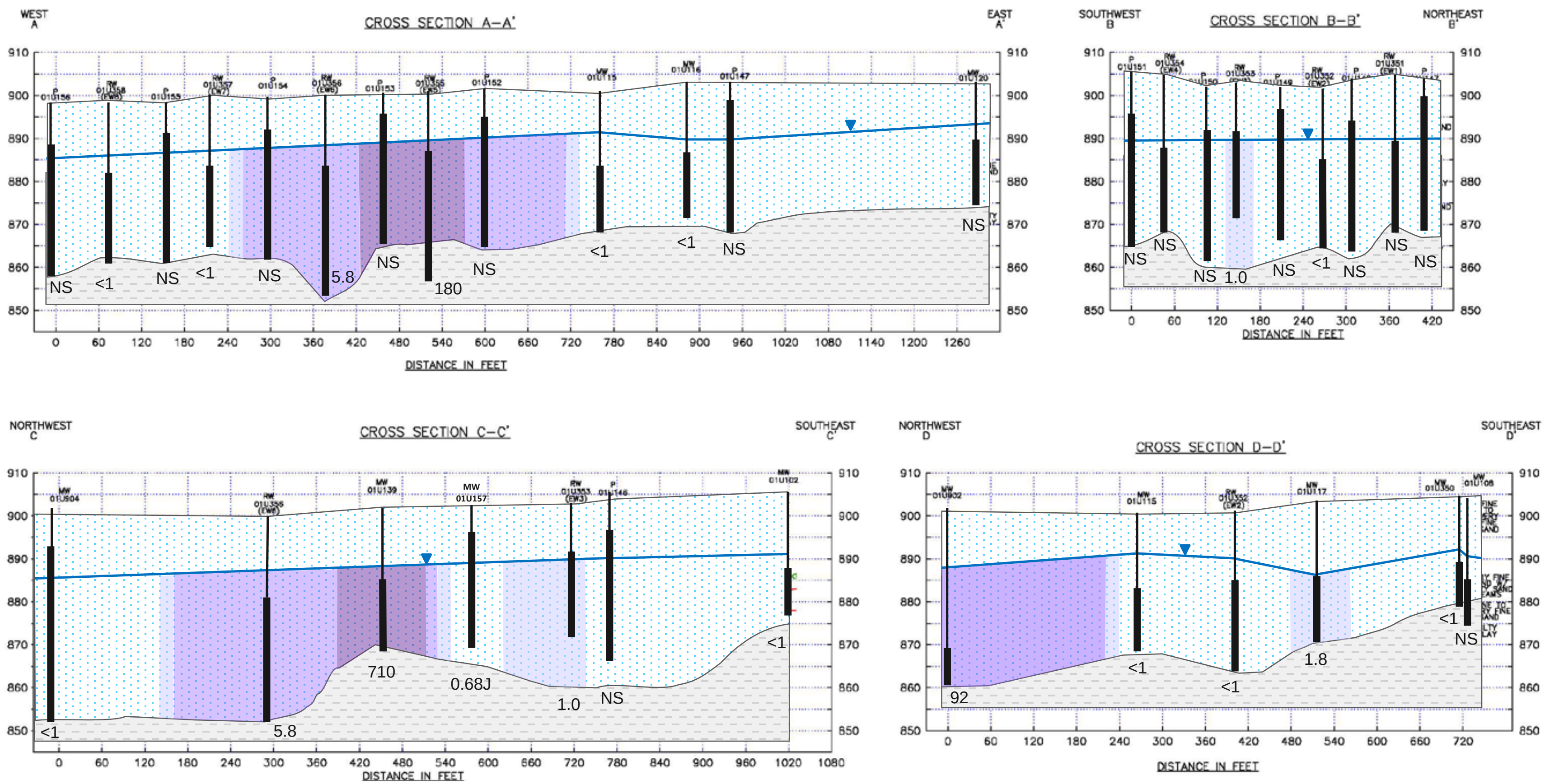



## Legend

cis-1,2-Dichloroethene Plume Concentration (µg/L)

- 1-10
- 10-100
- > 100

µg/L Micrograms per Liter

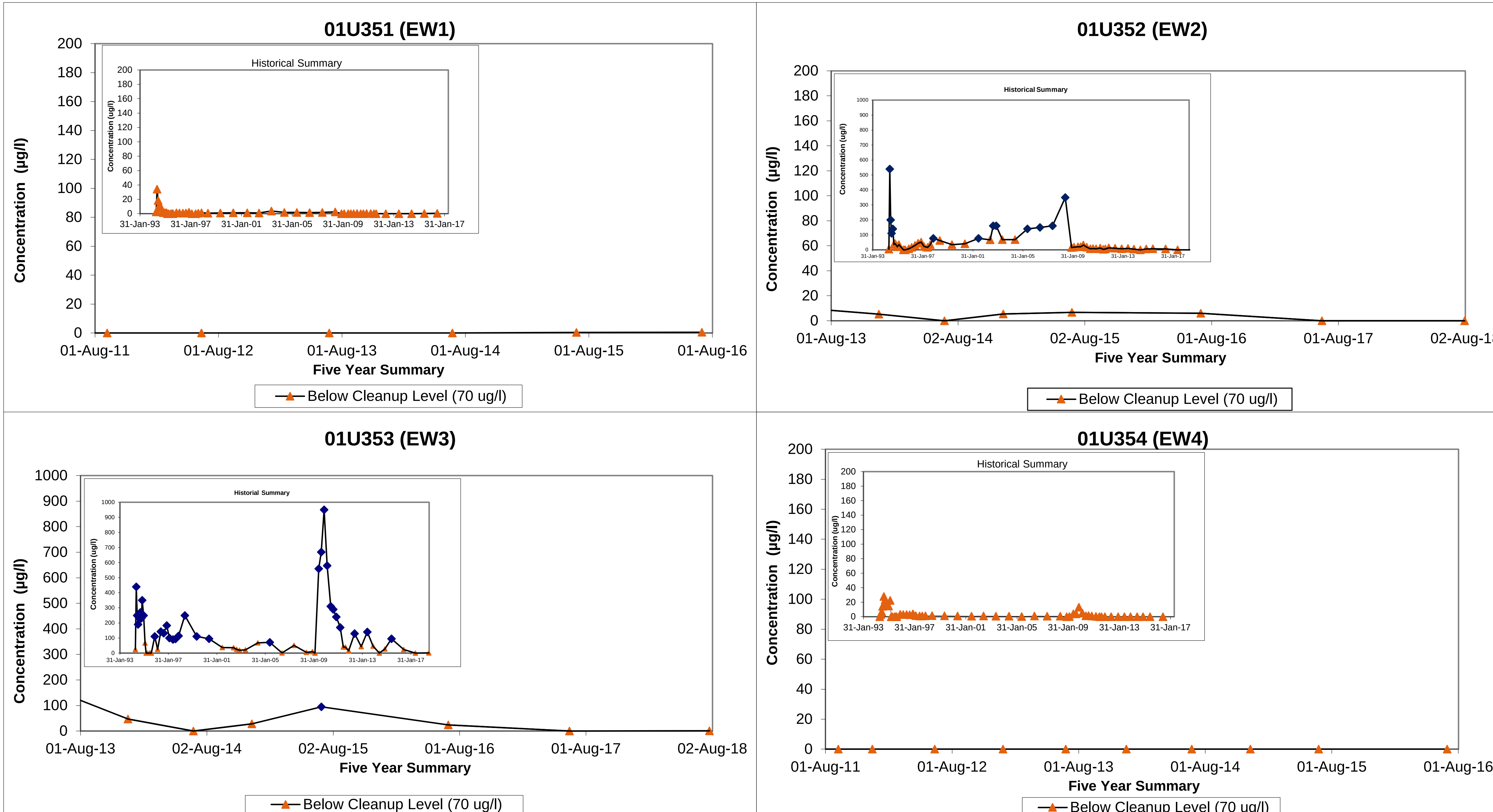
24 cis-1,2-Dichloroethene Concentration (µg/L) – Summer 2018

Water Table

Screened Interval

**Figure 6-7**
**Site A, cis-1,2-Dichloroethene Water Quality Trends: Extraction Wells 1-4**

Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

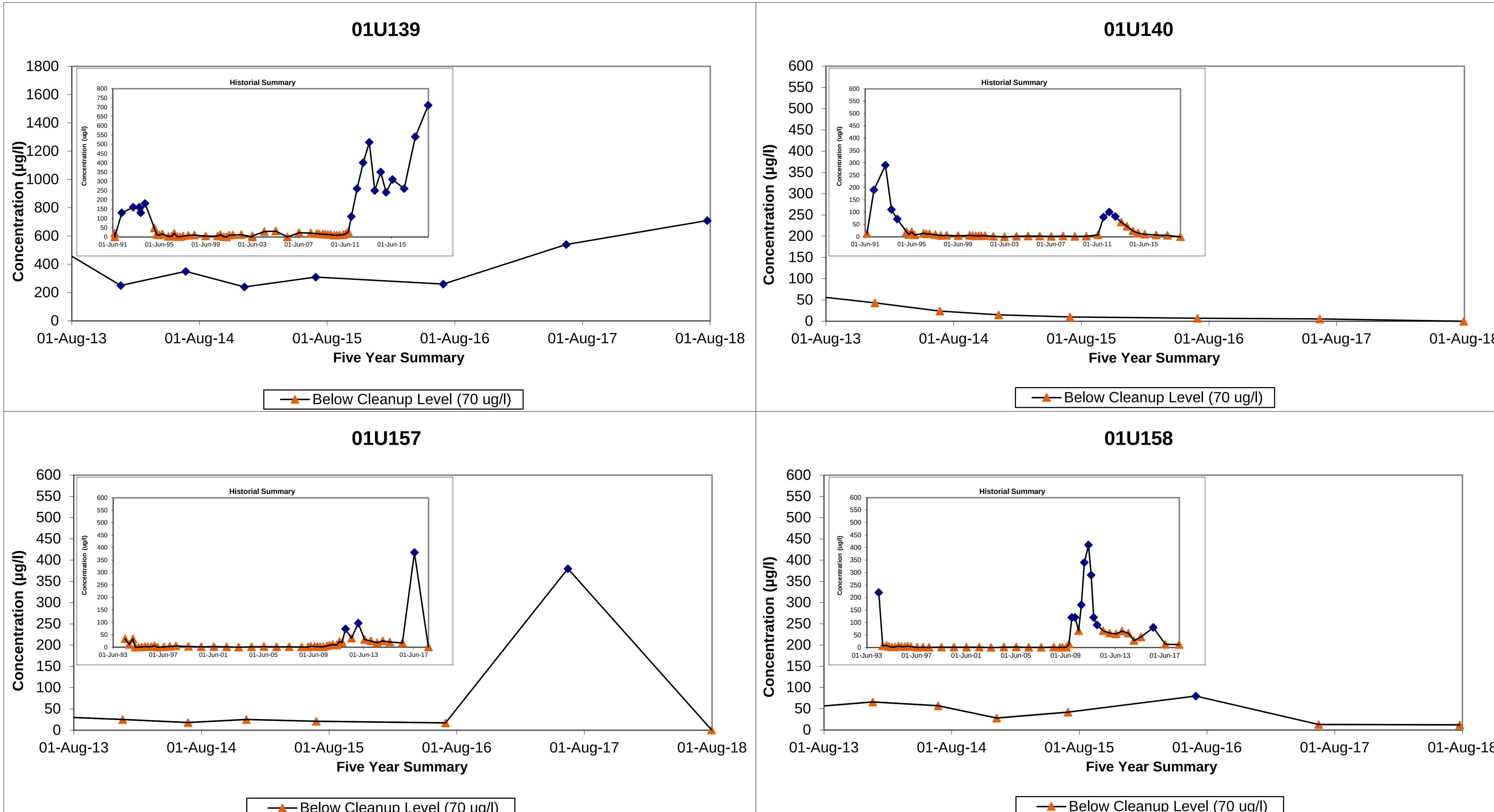



Acronyms and Abbreviations:
EW = Extraction Well
µg/L = micrograms per liter

**Figure 6-8**
**Site A, cis-1,2-Dichloroethene Water Quality Trends: Monitoring Wells**

Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

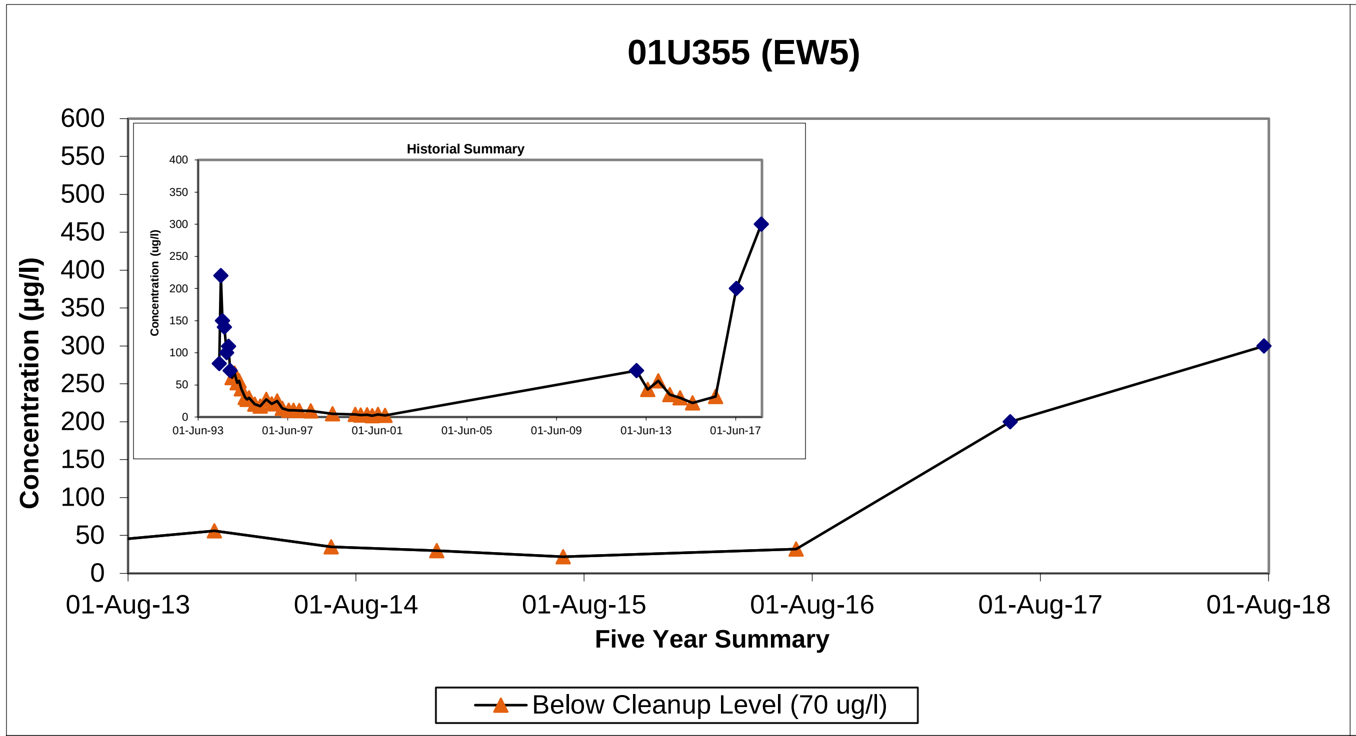
PIKA ARCADIS a joint venture

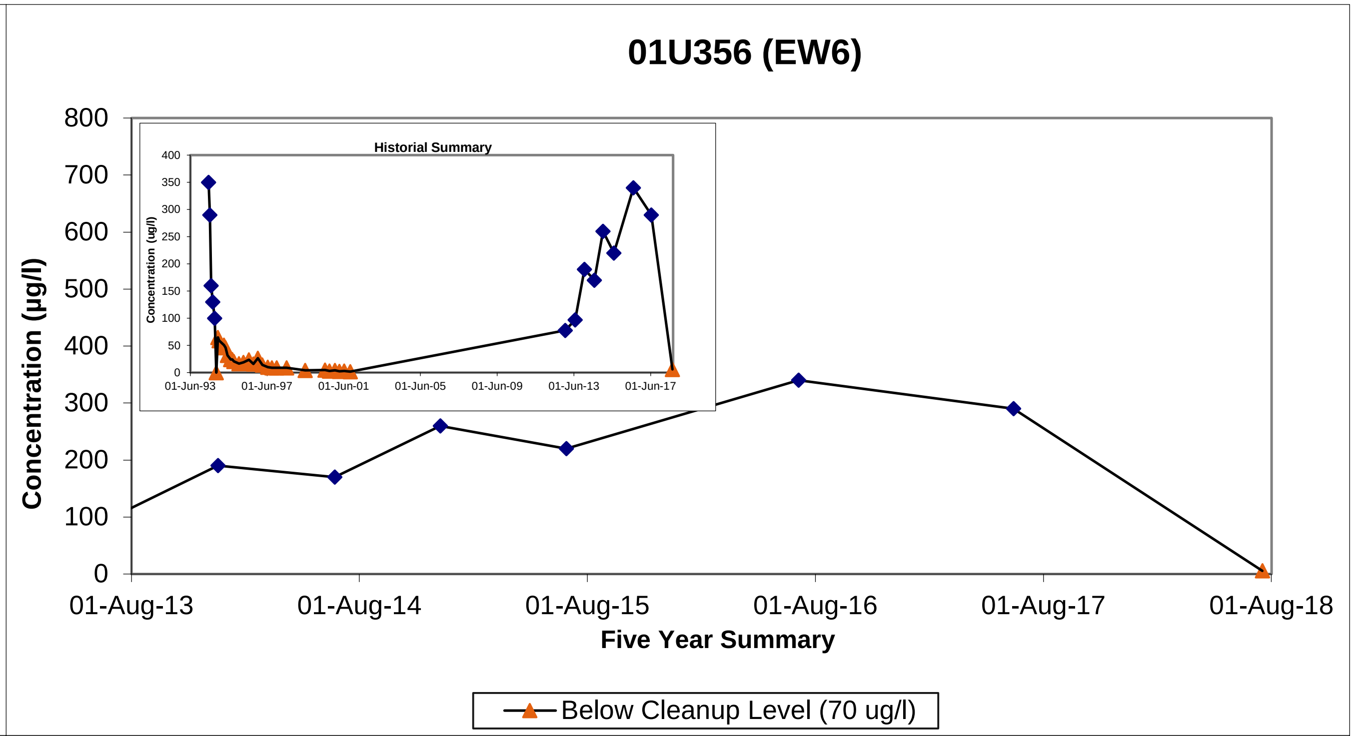


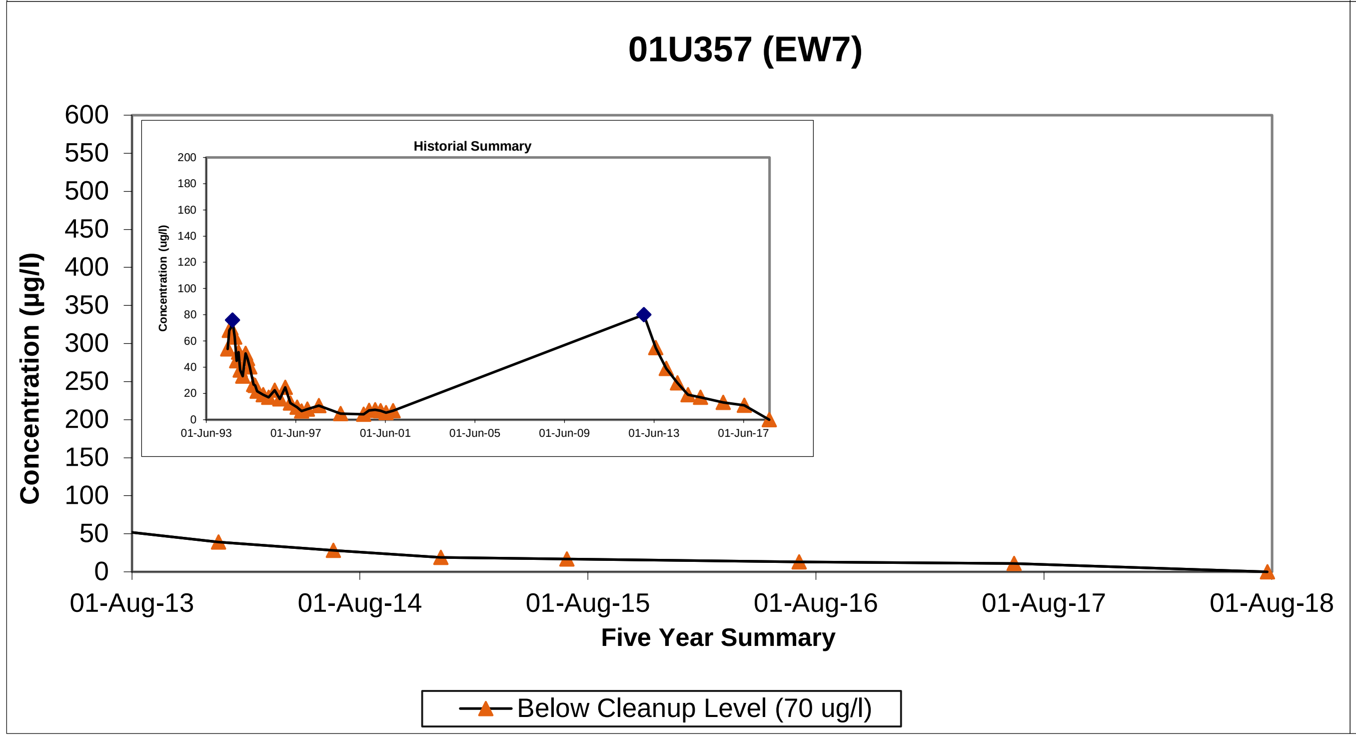

Acronyms and Abbreviations:
µg/L = micrograms per liter

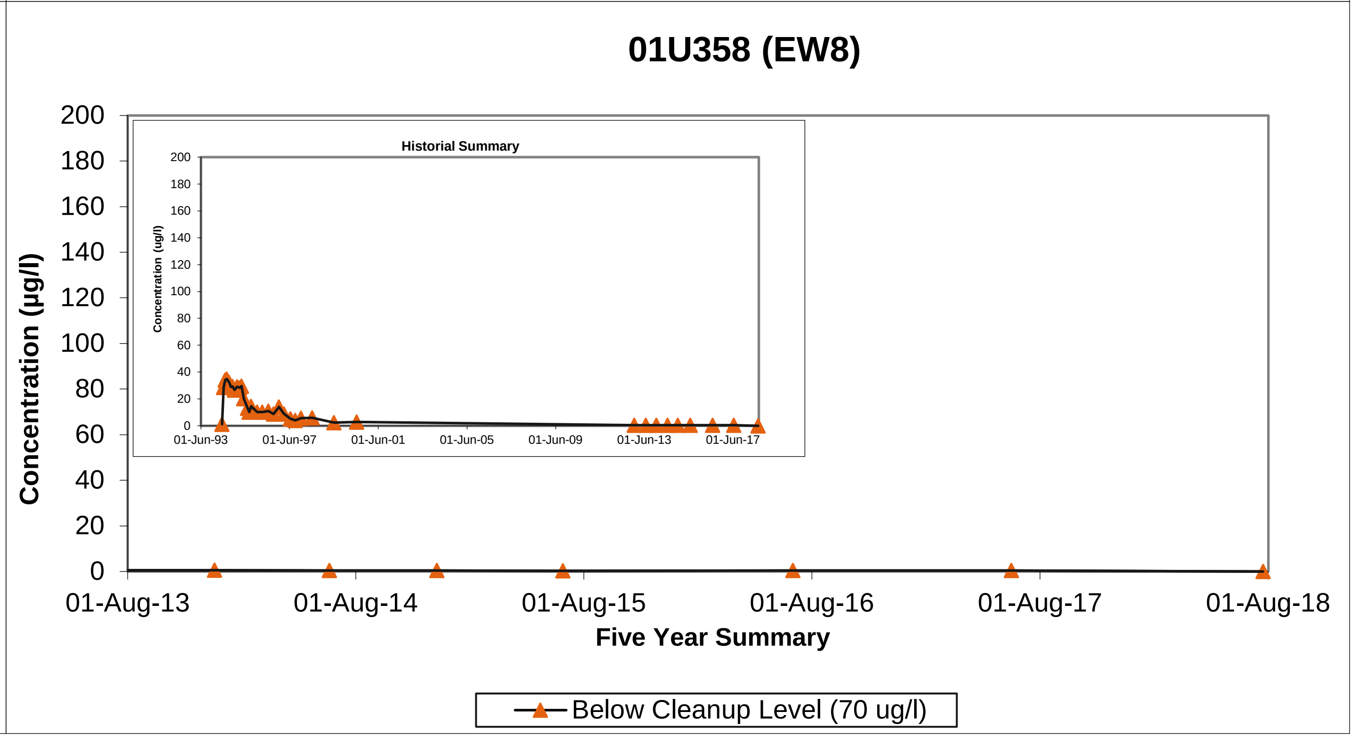
**Figure 6-9**
**Site A, cis-1,2-Dichloroethene Water Quality Trends: Extraction Wells 5-8**
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

PIKA ARCADIS
a joint venture



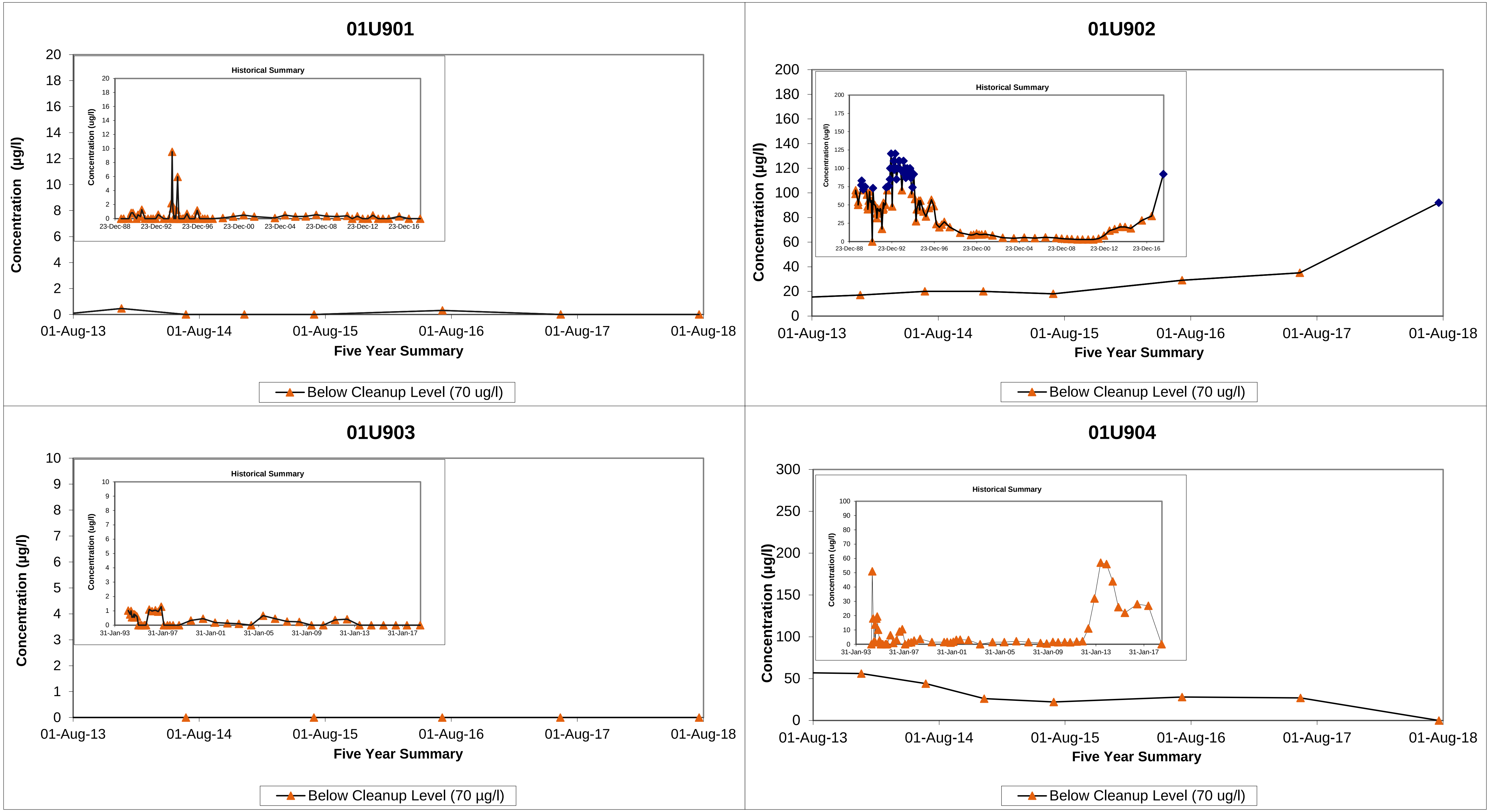



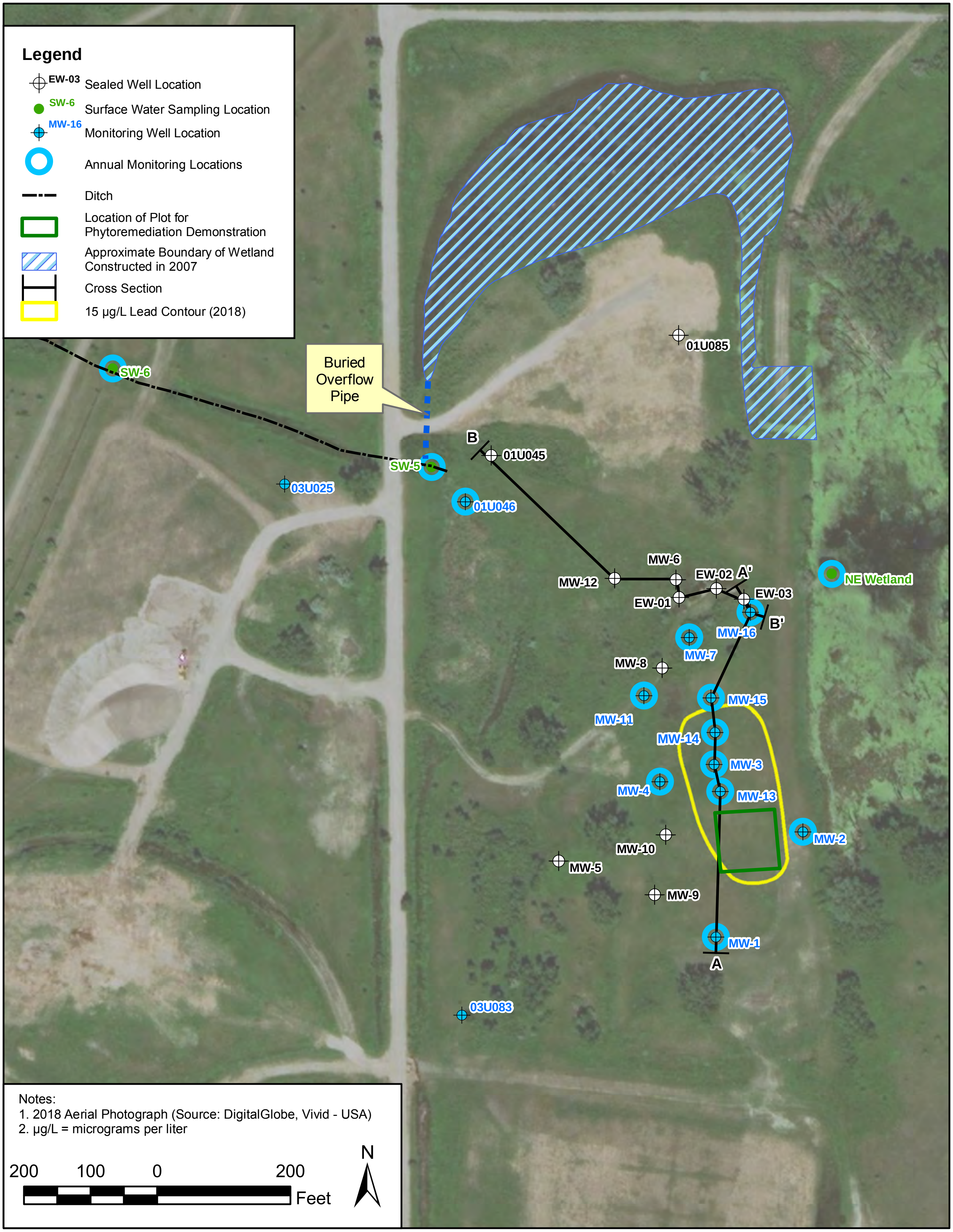

Acronyms and Abbreviations:
EW = Extraction Well
µg/L = micrograms per liter

**Figure 6-10**
**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




ANNUAL PERFORMANCE REPORT

Site C Monitoring Plan

PIKA ARCADIS a joint venture

FY 2018

Figure 7-1

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-12\MXD\Fig_7-1_Site C Site Plan_FY2018.mxd
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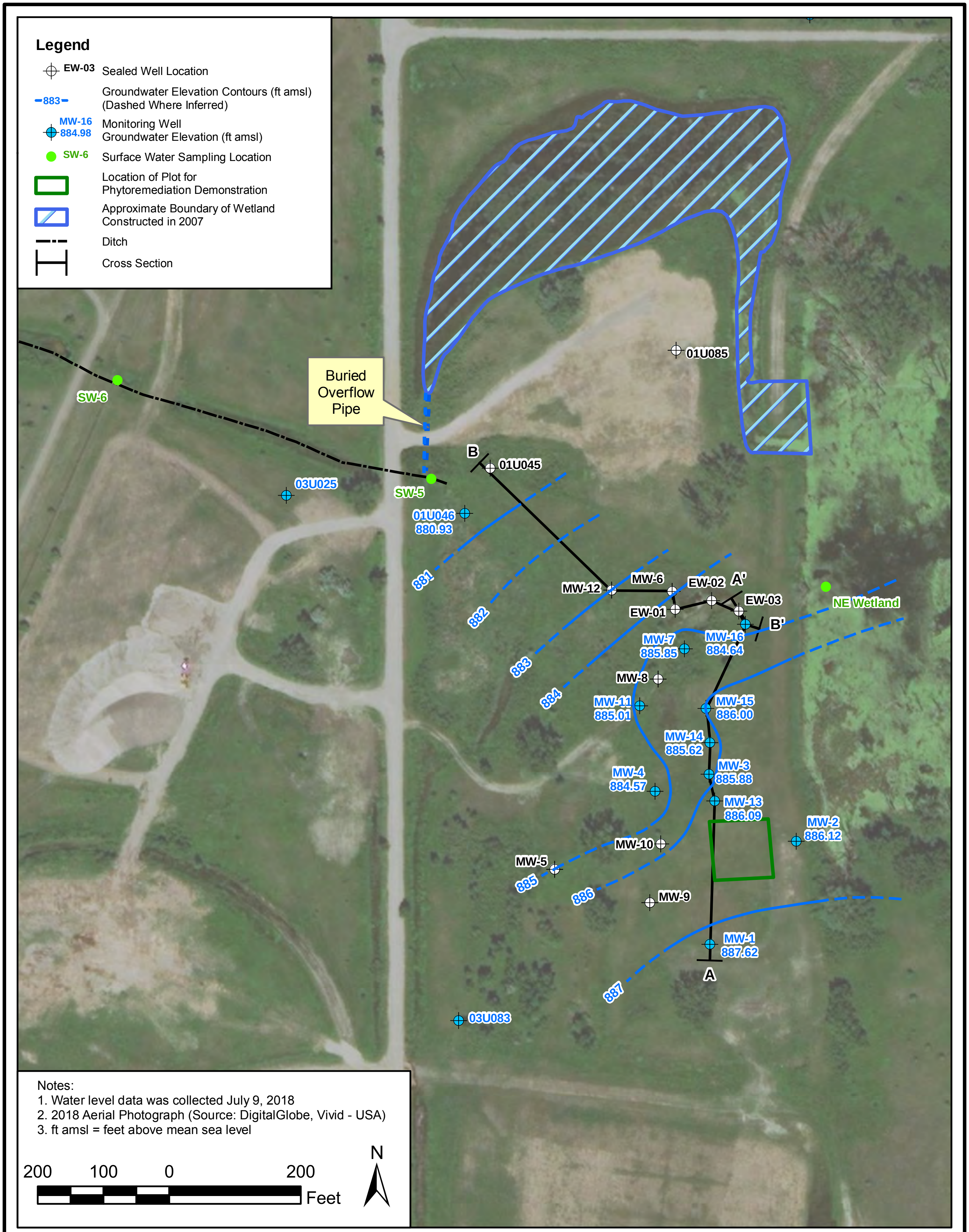



ANNUAL PERFORMANCE REPORT

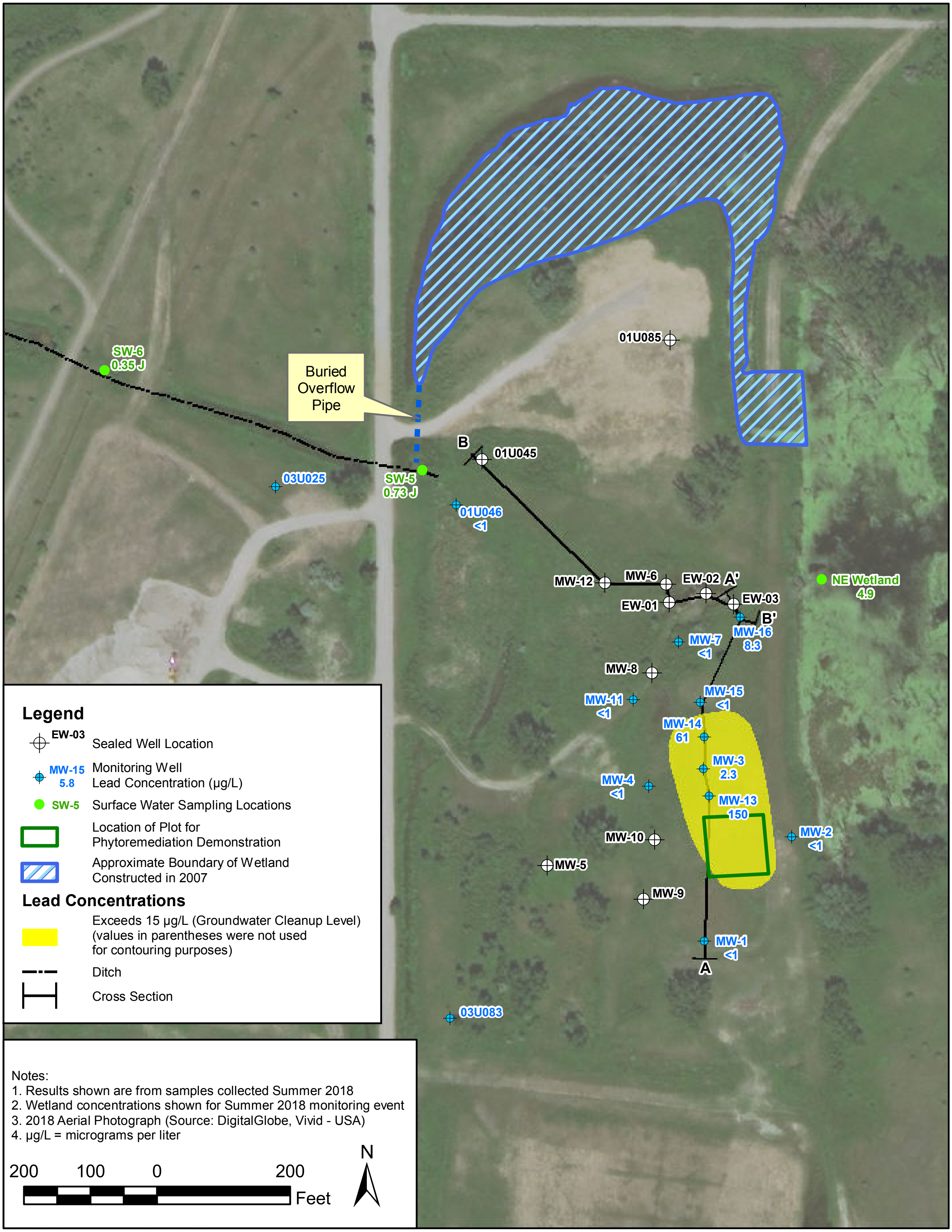
Site C, Unit 1, Potentiometric Map, Summer 2018

PIKA ARCADIS a joint venture

FY 2018

Figure 7-2

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-12\MXD\Fig_7-2_Site C Potentiometric Map_FY2018.mxd
Date: 1/30/2019 Time: 12:16:18 PM User: kgpeters




ANNUAL PERFORMANCE REPORT

Site C, Unit 1, Lead Results, Summer 2018

PIKA ARCADIS a joint venture

FY 2018

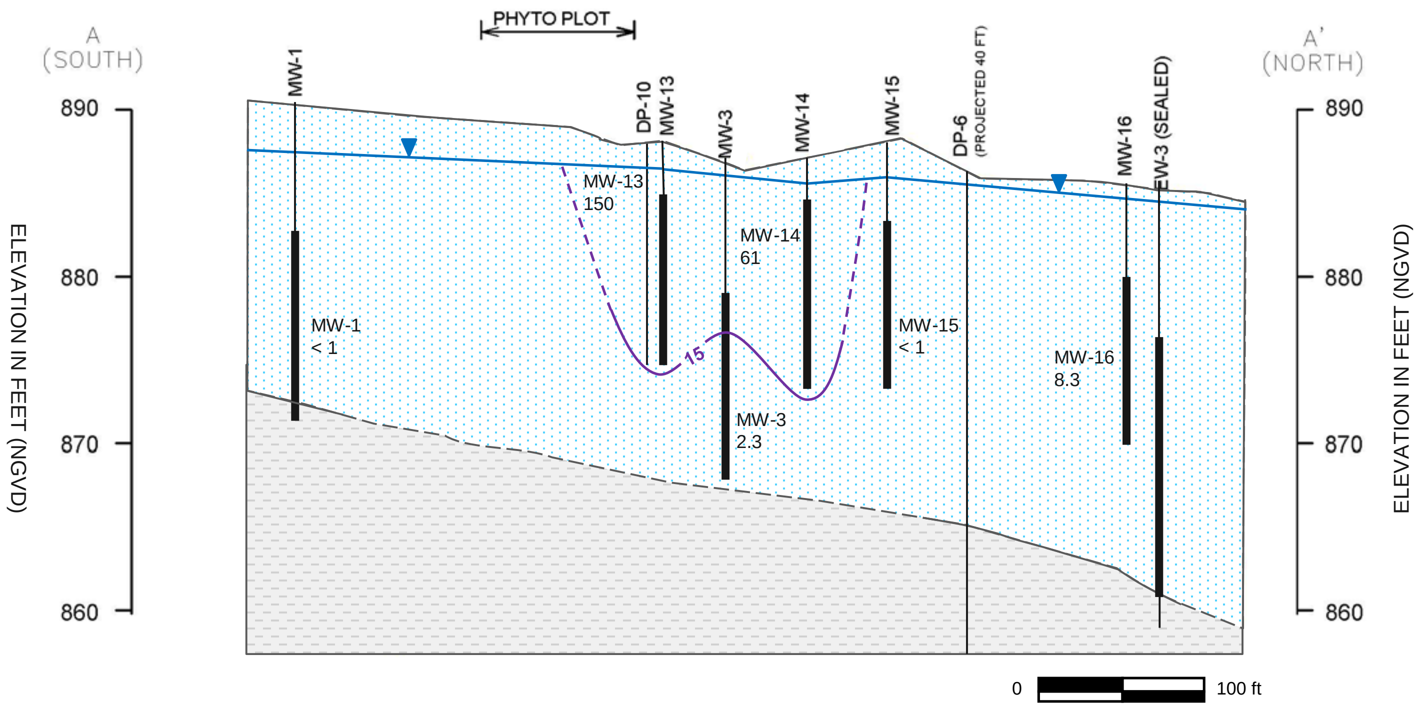
Figure 7-3

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-12\MXD\Fig_7-3_Site C Lead in GW_FY2018.mxd
Date: 5/23/2019 Time: 2:30:32 PM User: kgpeters

## Figure 7-4
## Site C Cross Section A-A'

U.S Army - TCAAP
Arden Hills, Minnesota

PIKA
ARCADIS
a joint venture

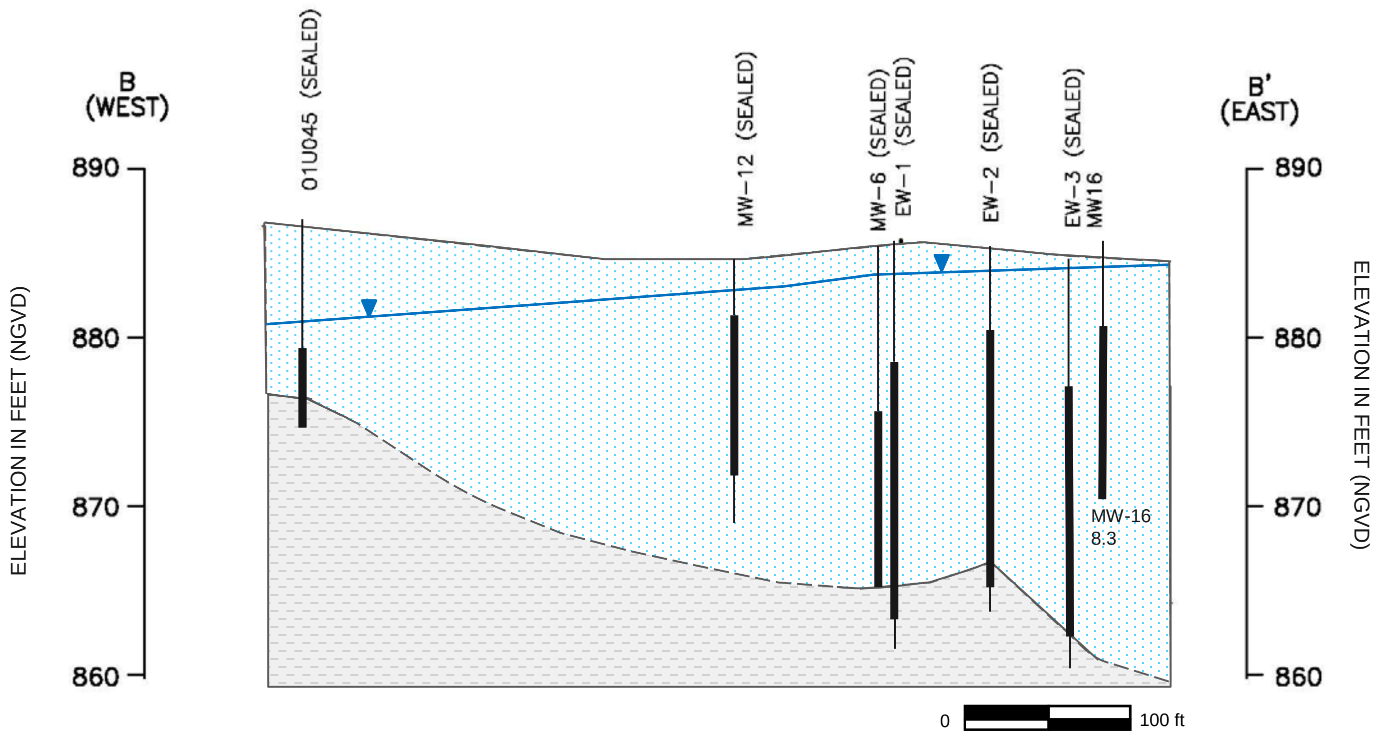



### Legend

| | | | | | |
|---|---|---|---|---|---|
| | Upper Unit 1 | | Geologic Contact (inferred where dashed) | | 15 µg/L Dissolved Lead Concentration Contour (Groundwater Cleanup Level) dashed where inferred |
| | Upper Unit 2 | | | | |
| | Water Table | MW-3 | Well ID | 1.6 | Dissolved Lead (µg/L) – Summer 2018 |
| | Screened Interval | µg/L | Micrograms per Liter | NGVD | National Geodetic Vertical Datum |

## Figure 7-5
## Site C Cross Section B-B'

U.S Army - TCAAP
Arden Hills, Minnesota

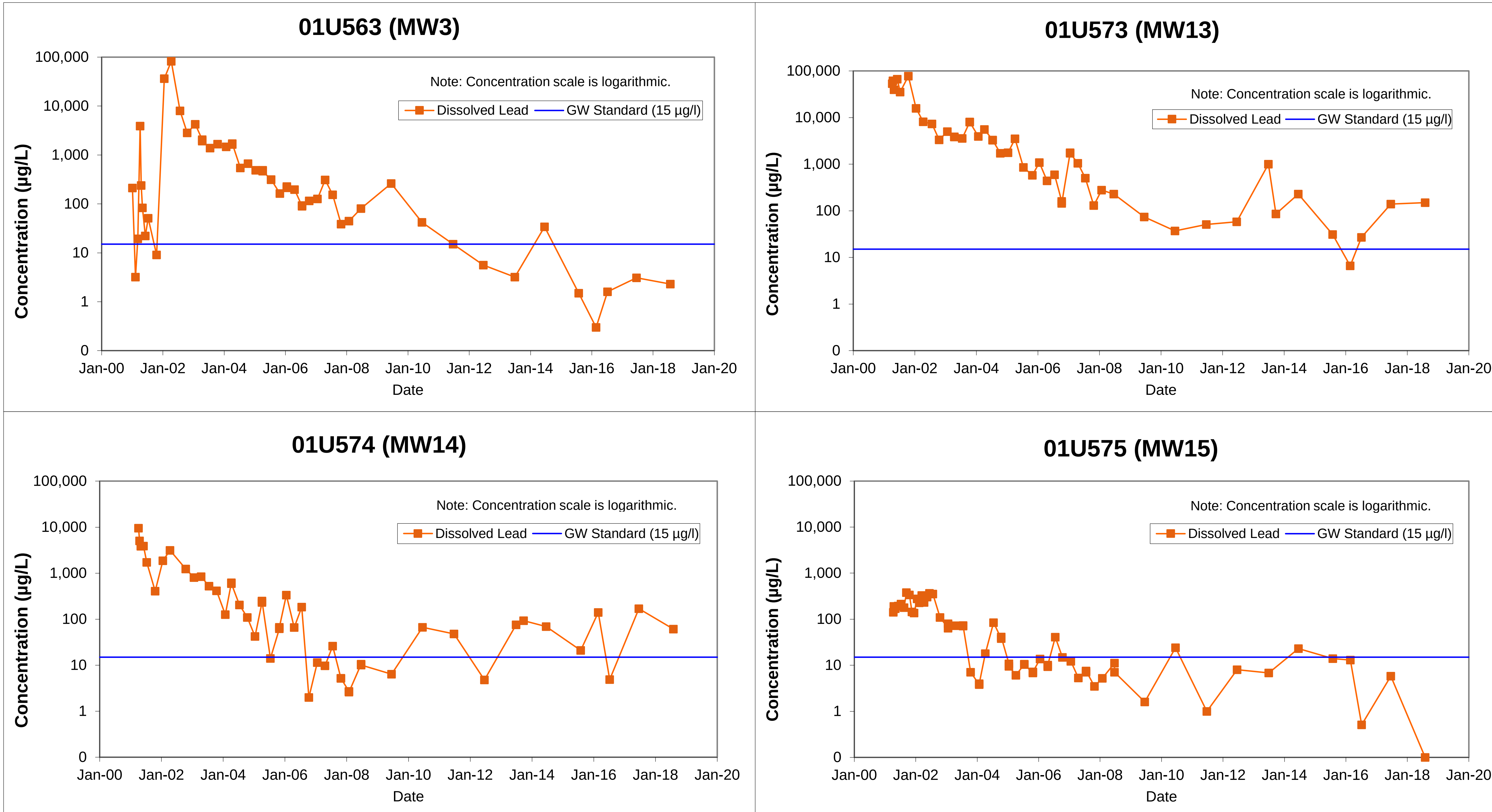



### Legend

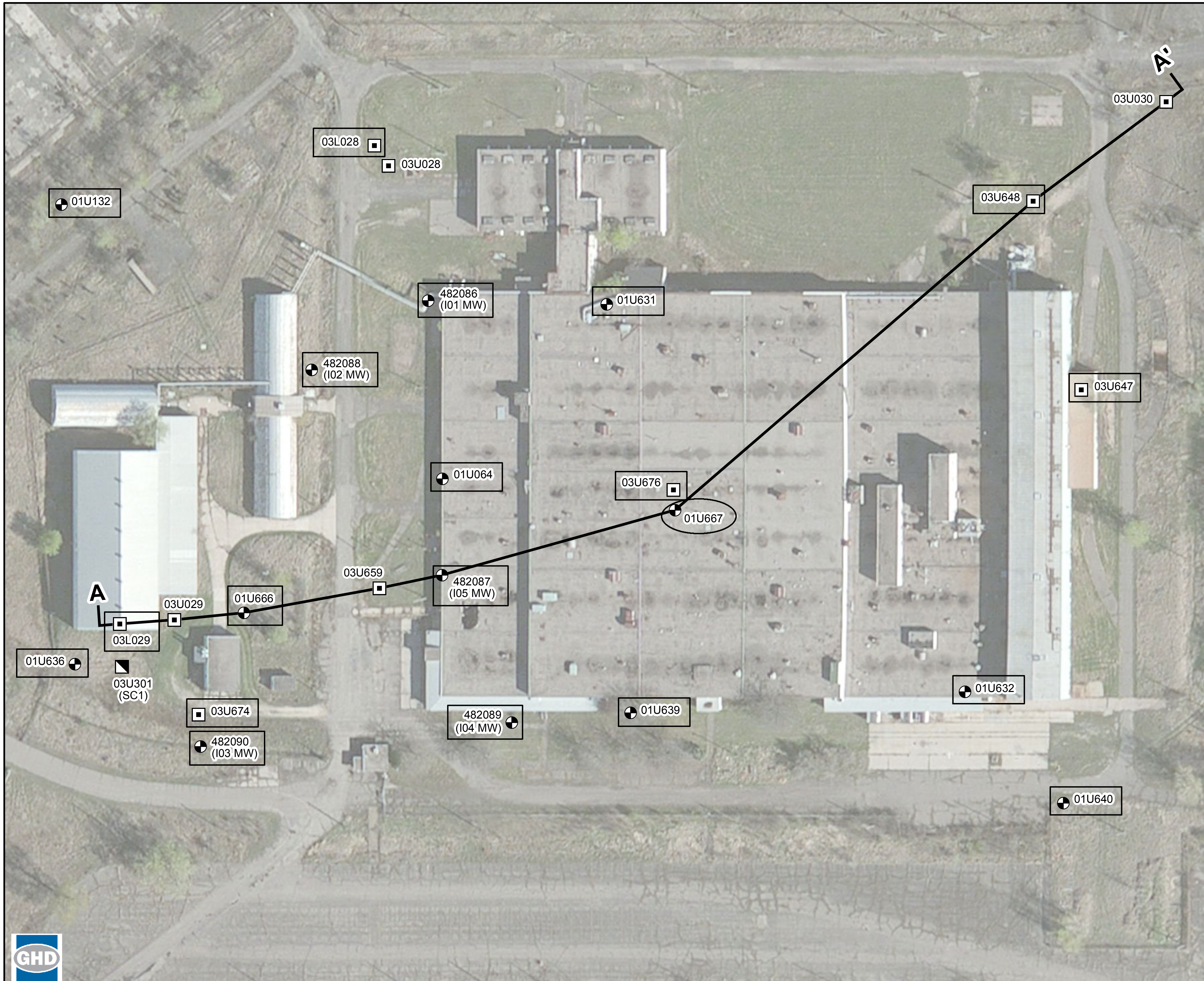
| | | | | | |
|---|---|---|---|---|---|
| | Upper Unit 1 | — | Geologic Contact (inferred where dashed) | 0.30 U | Dissolved Lead (µg/L) – Summer 2018 |
| | Upper Unit 2 | | | NGVD | National Geodetic Vertical Datum |
| — | Water Table | MW-6 | Well ID | | |
| ▌ | Screened Interval | µg/L | Micrograms per Liter | | |

**Figure 7-6**
**Dissolved Lead**

Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota




Acronyms and Abbreviations:
MW = monitoring well
µg/L = micrograms per liter




N

0 50 100 ft

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

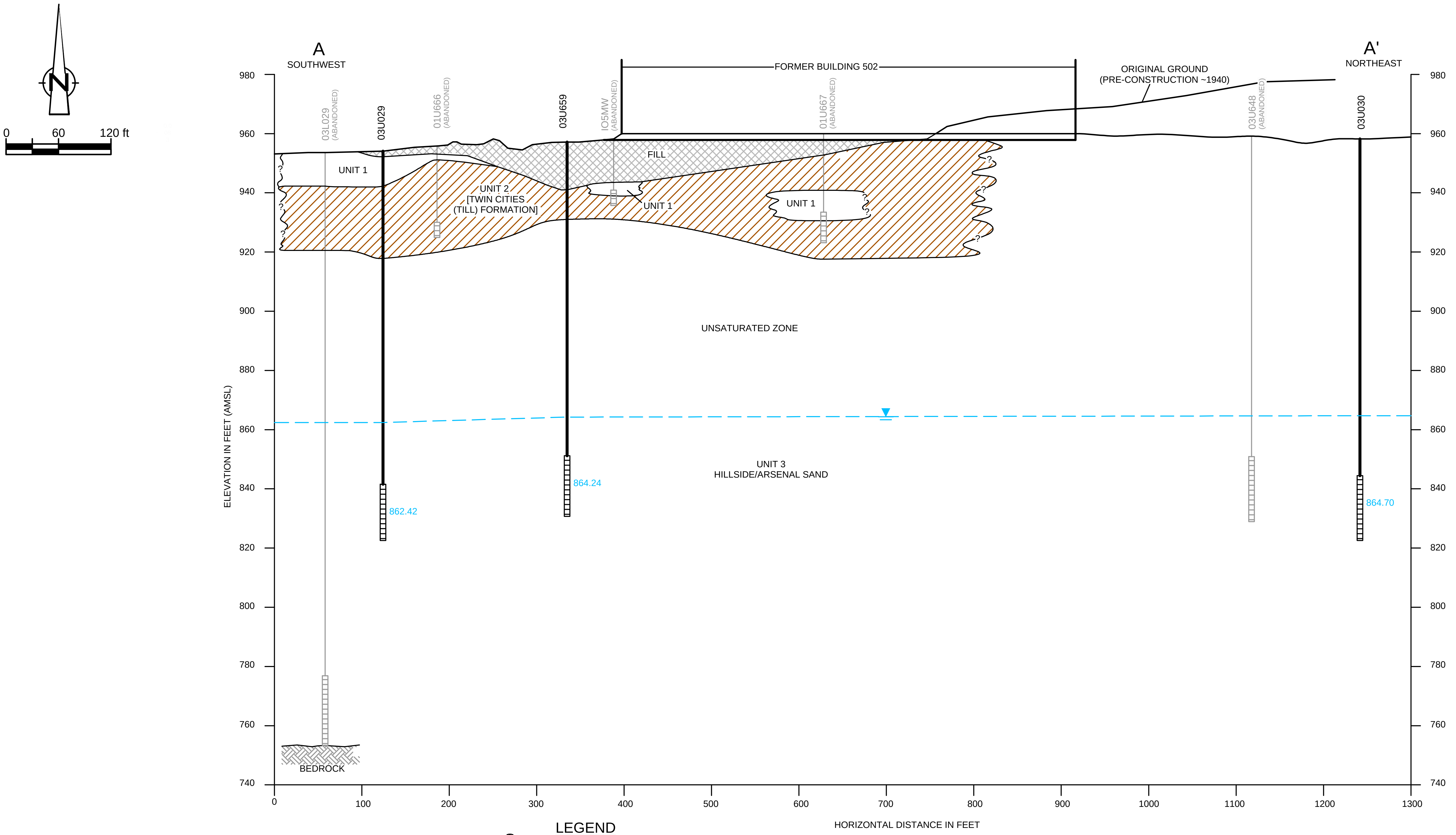
GEOLOGIC CROSS SECTION LOCATION

NOTE: BUILDING 502 DEMOLISHED IN 2014

figure 8-1

SITE PLAN
SITE I, OU2
*Arden Hills, Minnesota*

11187055-43(001)GIS-SP001 JAN 11/2019




## LEGEND

03L029 — WELL DESIGNATION

GROUND SURFACE

WELL INSTALLATION

STRATIGRAPHIC BOUNDARY

WATER TABLE

862.42 GROUNDWATER ELEVATION (ft AMSL) - JUNE 2018

SCREENED INTERVAL

BOTTOM OF BORING

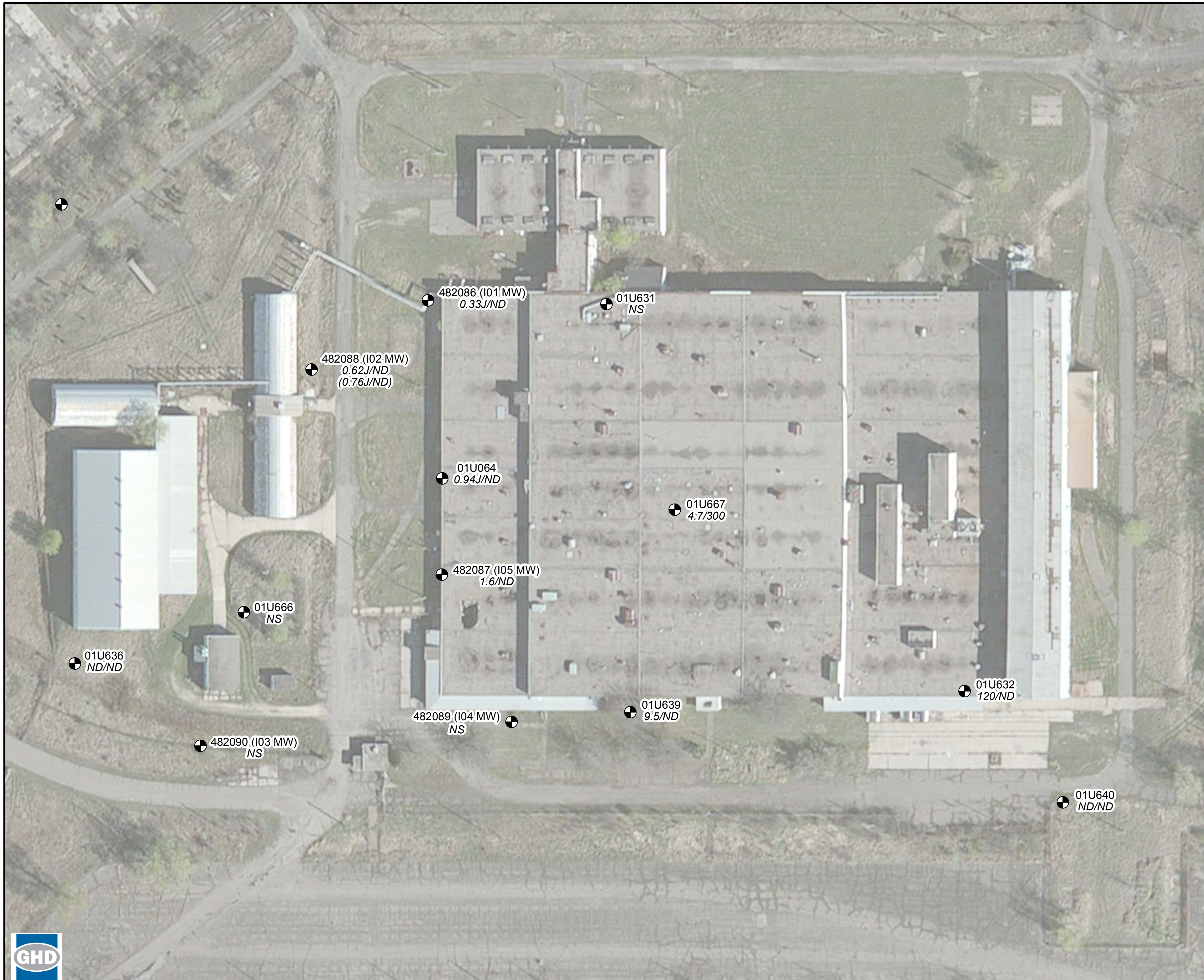
GHD

SOURCE: STANTEC, SITE I CROSS SECTION DWG FILE

figure 8-2

GEOLOGIC CROSS SECTION A-A'
SITE I, OU2
*Arden Hills, Minnesota*

P:\drawings\11187000s\11187055\11187055-REPORT\11187055-43(001)\11187055-43(001)GN\11187055-43(001)GN-WA001.DWG Plot Date: JAN 11, 2019




LEGEND

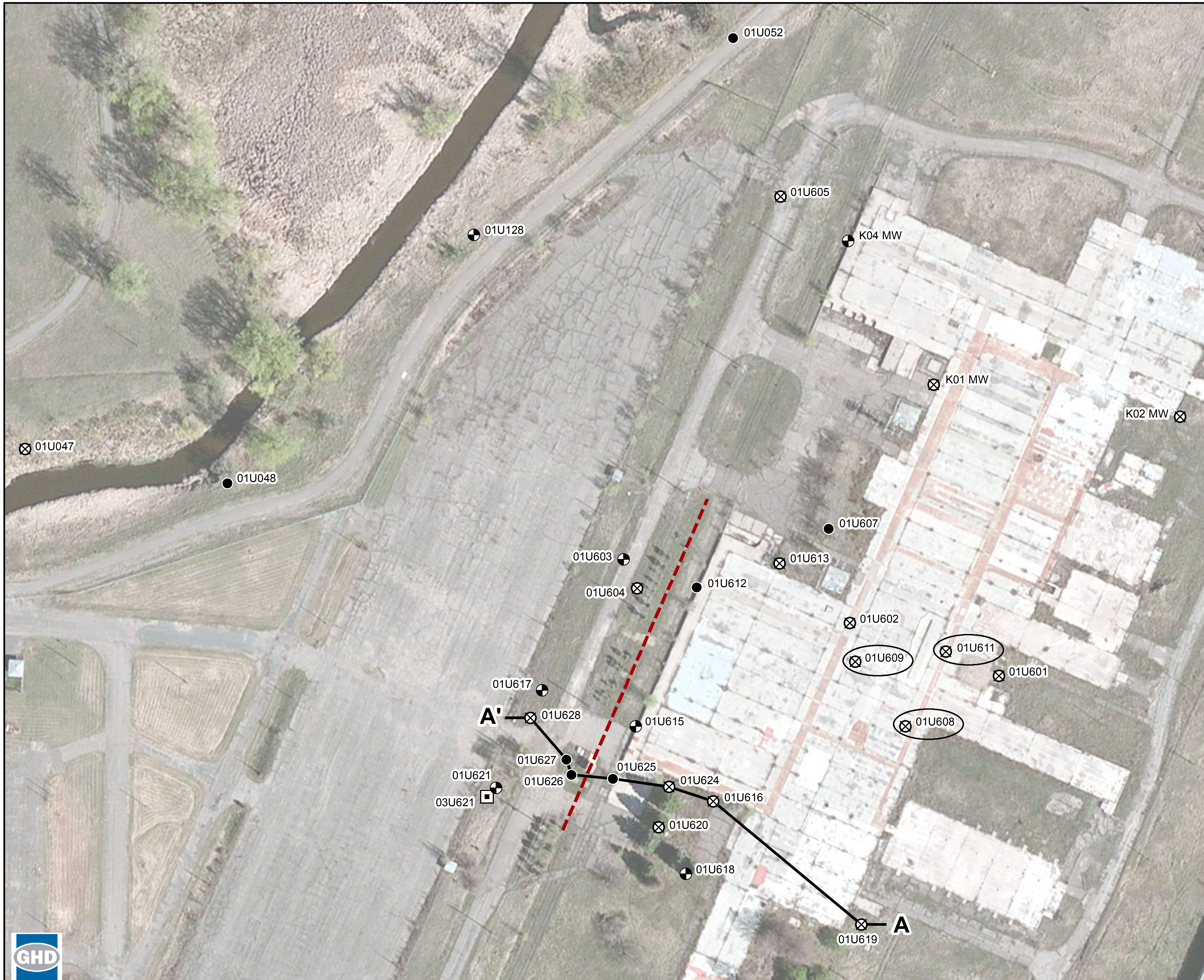
| | |
|---|---|
| *4.7/300* | FY 2013 TCE / VINYL CHLORIDE CONCENTRATION (µg/L) |
| *J* | ESTIMATED CONCENTRATION |
| *( )* | DUPLICATE RESULTS |
| *ND* | ANALYTE NOT DETECTED |
| *NS* | WELL NOT SAMPLED |
| ◉ | UNIT 1 MONITORING WELL |

NOTE: BUILDING 502 DEMOLISHED IN 2014

figure 8-3

TCE AND VINYL CHORIDE CONCENTRATIONS - FY 2013
SITE I, OU2
*Arden Hills, Minnesota*

11187055-43(001)GIS-SP002 JAN 11/2019




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

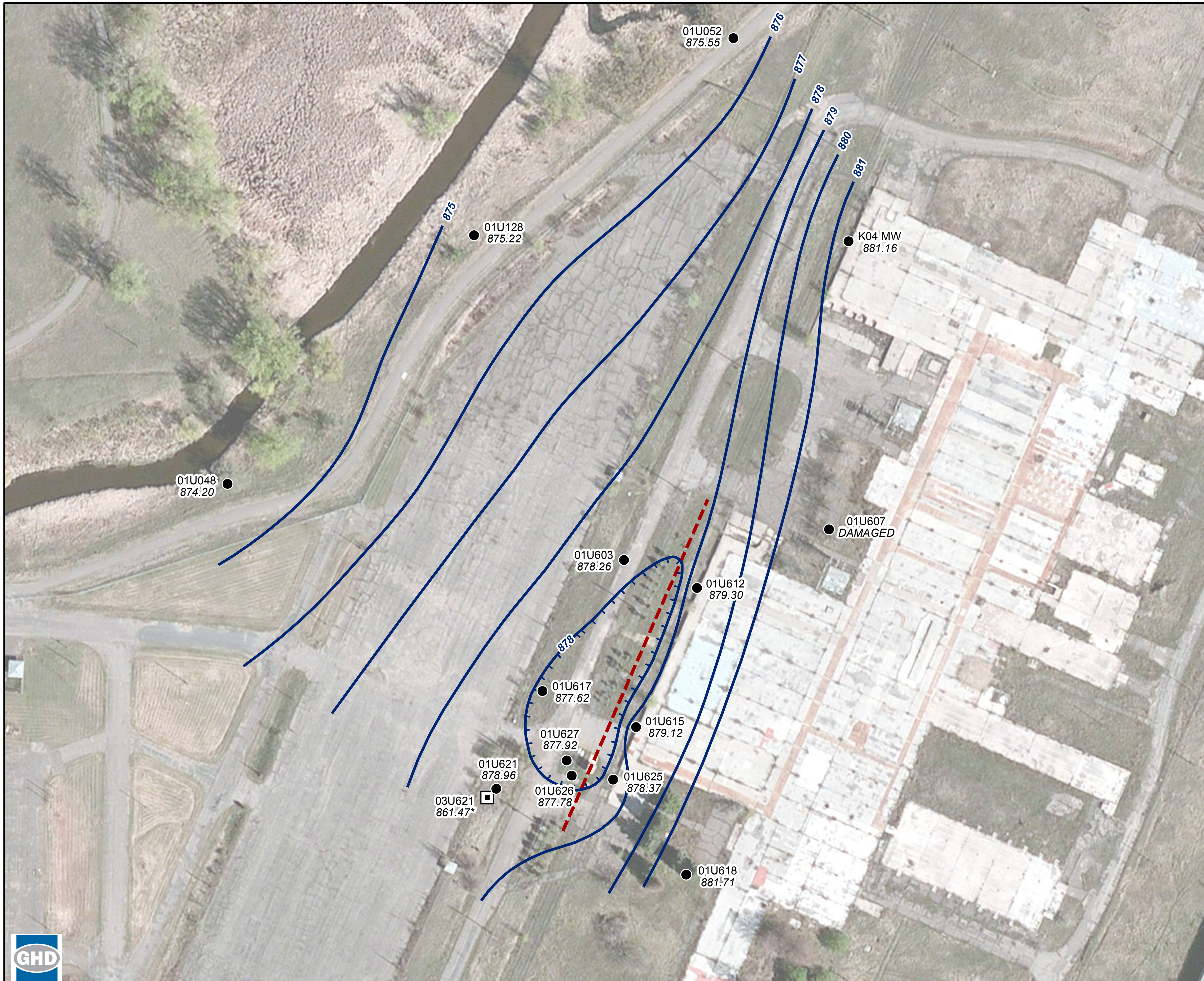
HYDROGEOLOGIC CROSS SECTION LOCATION

NOTE:
BUILDING 103 DEMOLISHED IN 2006;
CONCRETE SLAB REMOVED IN 2014

figure 9-1

SITE PLAN
SITE K, OU2
*Arden Hills, Minnesota*

11187055-43(001)GIS-SP003 JAN 11/2019




N

0 40 80 120 ft

LEGEND

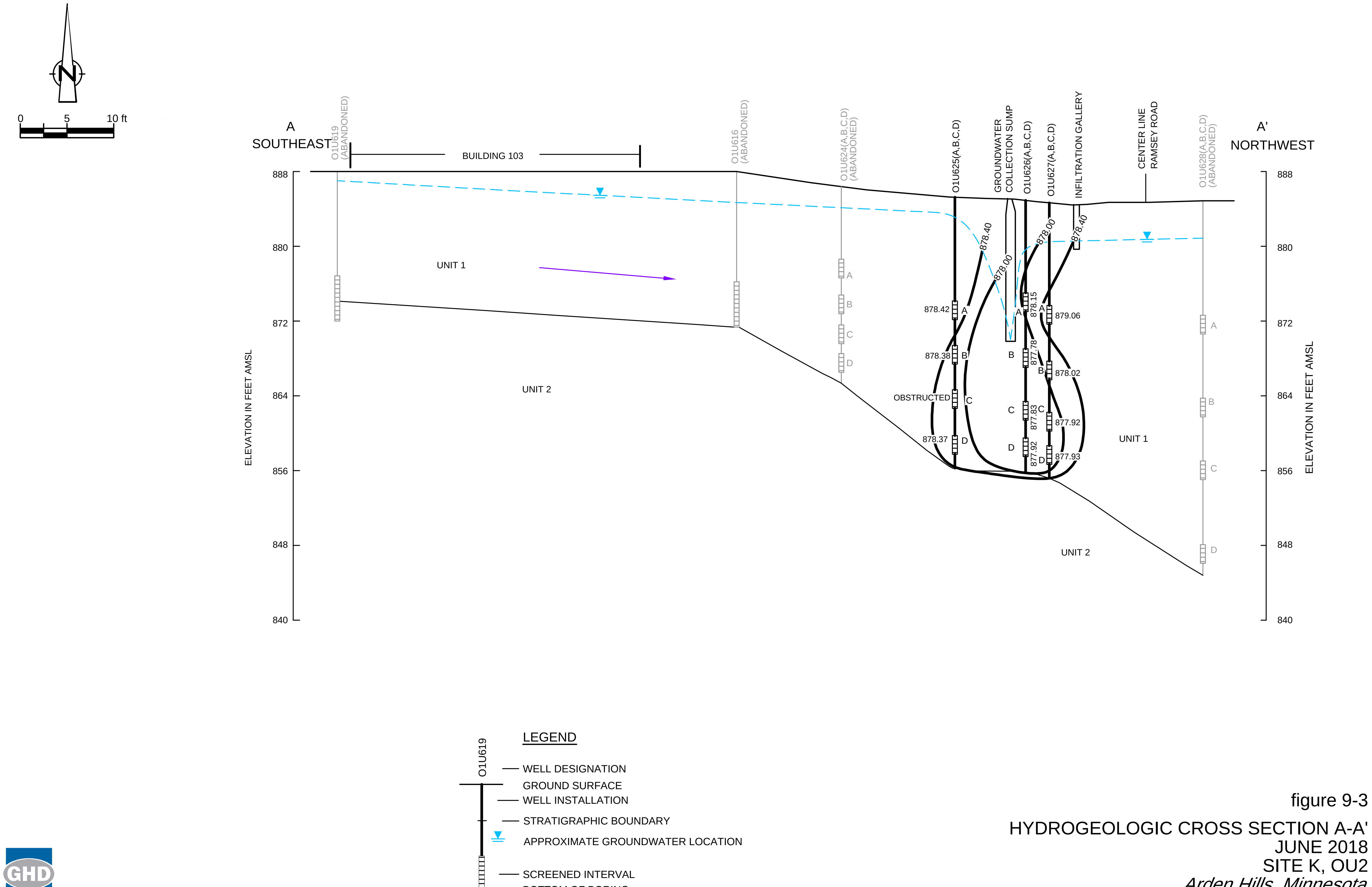
| | |
|---|---|
| *882.16* | GROUNDWATER ELEVATION |
| * | NOT USED FOR CONTOURING |
| | GROUNDWATER ELEVATION CONTOUR |
| | ANNUAL UNIT 1 WATER LEVEL MONITORING WELL LOCATION |
| | UNIT 3 SENTINAL WELL LOCATION |
| | SITE K COLLECTION TRENCH LOCATION |

NOTE:
BUILDING 103 DEMOLISHED IN 2006;
CONCRETE SLAB REMOVED IN 2014

figure 9-2

GROUNDWATER CONTOURS
UNIT 1 - JUNE 2018
SITE K, OU2
*Arden Hills, Minnesota*

11187055-43(001)GIS-SP004 JAN 17/2019




SOURCE: STANTEC, SITE K CROSS SECTION DWG FILE

figure 9-3

HYDROGEOLOGIC CROSS SECTION A-A'
JUNE 2018
SITE K, OU2
*Arden Hills, Minnesota*

P:\drawings\11187000s\11187055\11187055-REPORT\11187055-43(001)\11187055-43(001)GN\11187055-43(001)GN-WA001.DWG Plot Date: JAN 11, 2019


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 |
| | ABANDONED WELL |
| | GEOPROBE BORING LOCATION FROM 2014 INVESTIGATION |
| | SITE K COLLECTION TRENCH LOCATION |

NOTE:
BUILDING 103 DEMOLISHED IN 2006;
CONCRETE SLAB REMOVED IN 2014

figure 9-4

TCE CONCENTRATIONS
UNIT 1 - JUNE 2018
SITE K, OU2
*Arden Hills, Minnesota*

GHD

11187055-43(001)GIS-SP005 JAN 11/2019

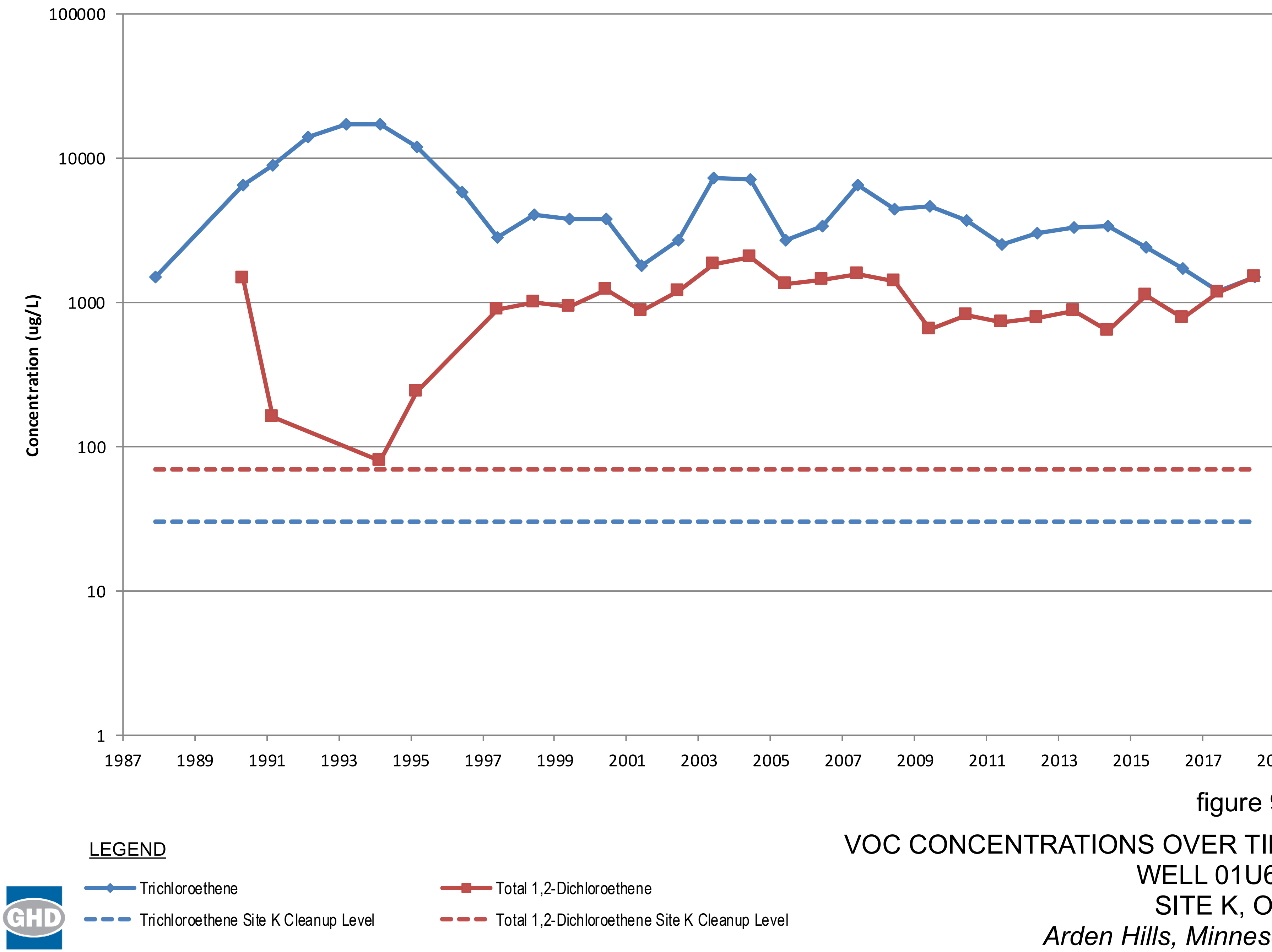
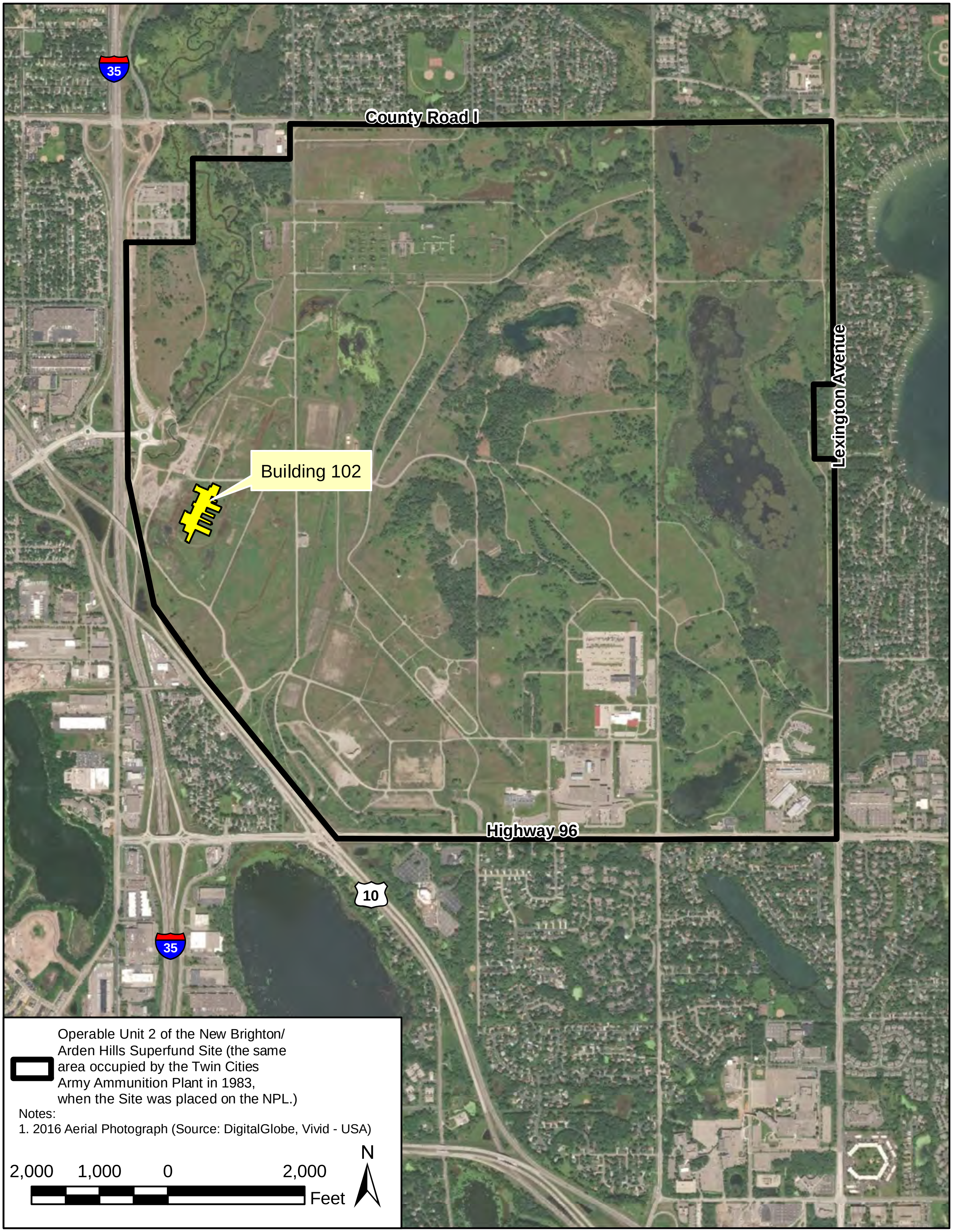



figure 9-5

VOC CONCENTRATIONS OVER TIME
WELL 01U615
SITE K, OU2
*Arden Hills, Minnesota*

11187055-43(001)GIS-SP006 JAN 11/2019




ANNUAL PERFORMANCE REPORT

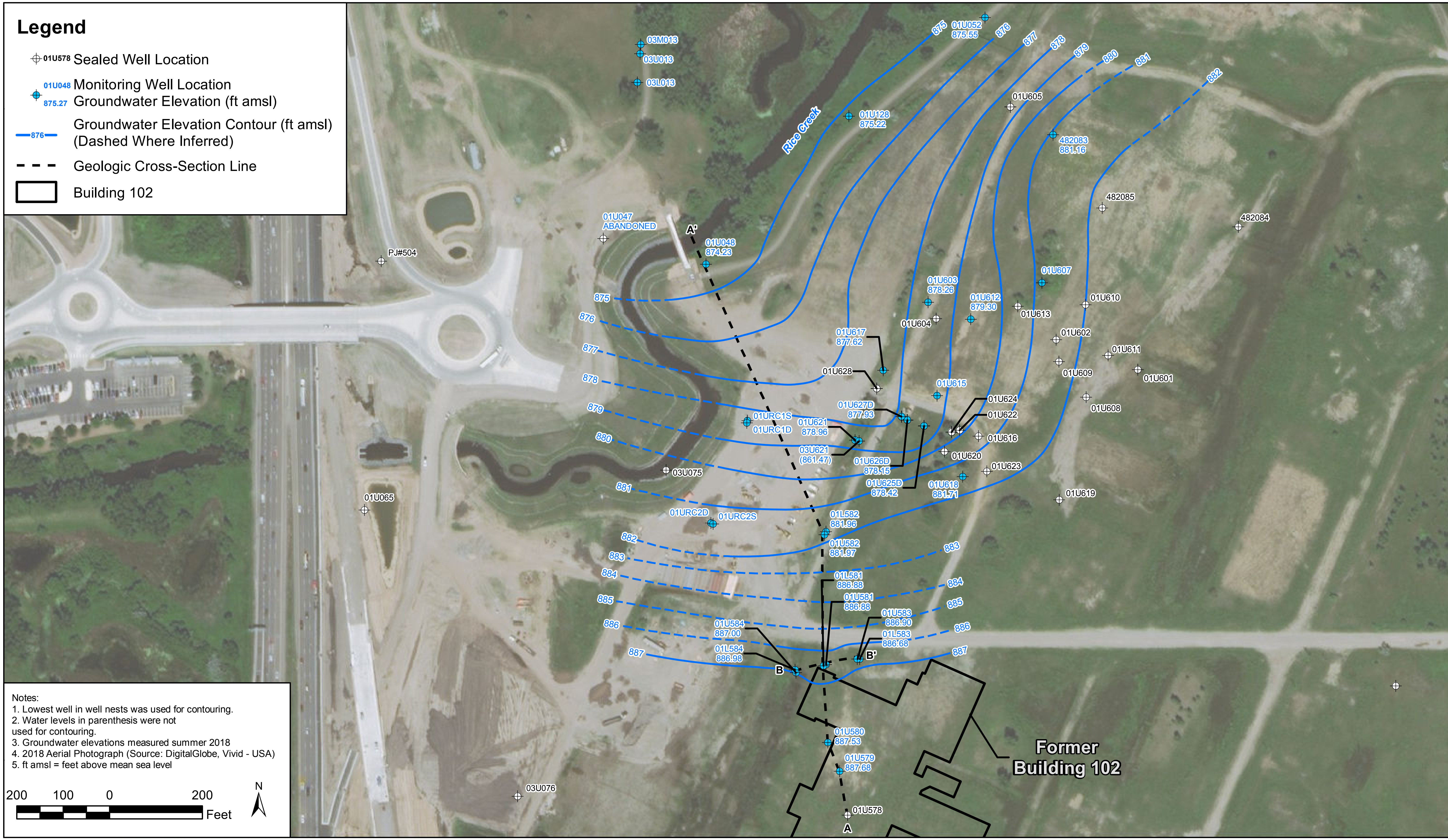
Location of Building 102

PIKA ARCADIS a joint venture

FY 2018

Figure 10-1

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2019-01\Figure_10-1_Bldg 102 Location Map_FY2018.mxd
Date: 1/17/2019 Time: 4:04:46 AM User: kgpeters




ANNUAL PERFORMANCE REPORT

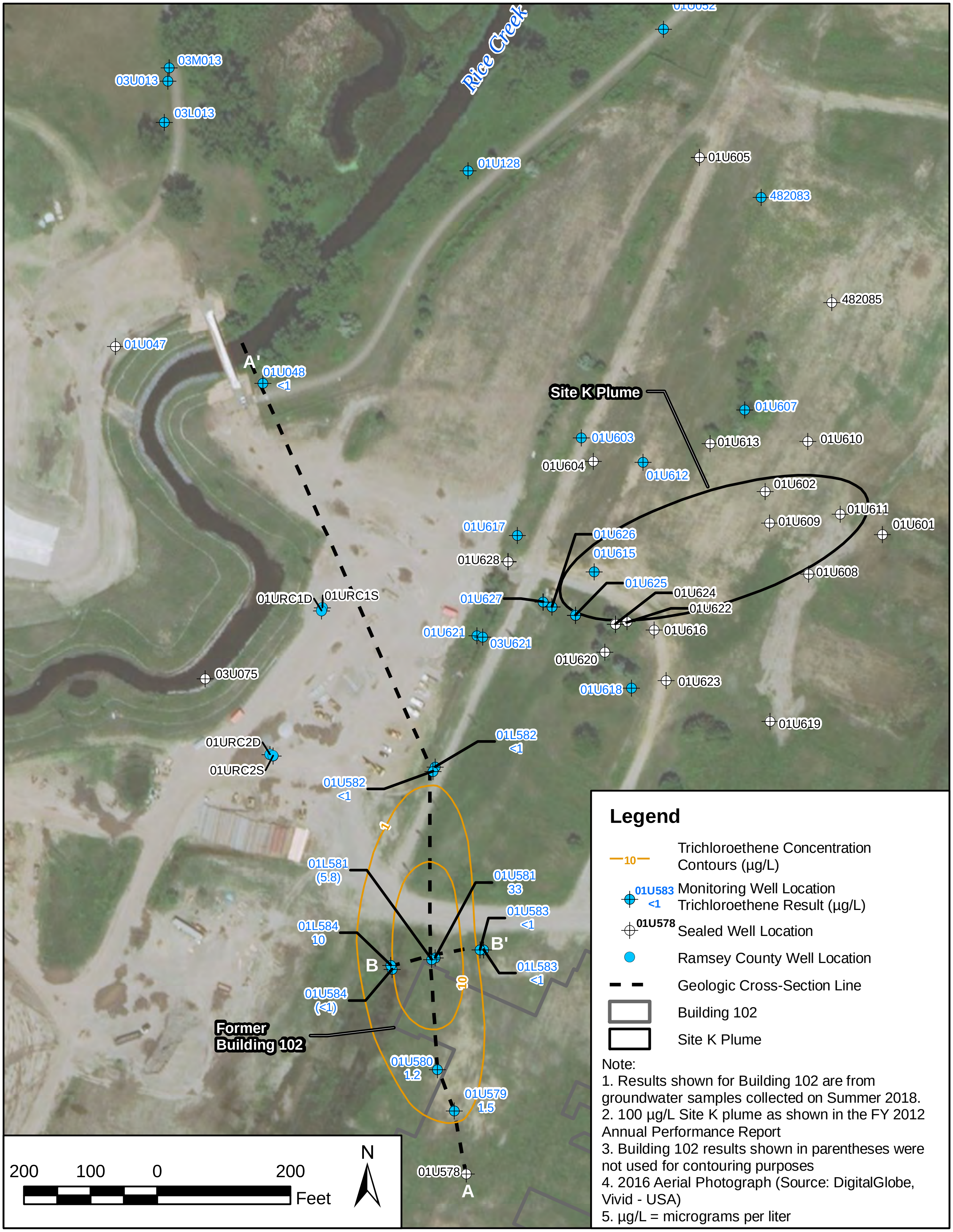
Building 102, Unit 1, Potentiometric Map, Summer 2018

PIKA ARCADIS a joint venture

FY 2018

Figure 10-2

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2018-12\MXD\Fig_10-2_Bldg 102 Potentiometric Map_FY2018.mxd
Date: 5/23/2019 Time: 2:55:23 PM User: kgpeters




ANNUAL PERFORMANCE REPORT

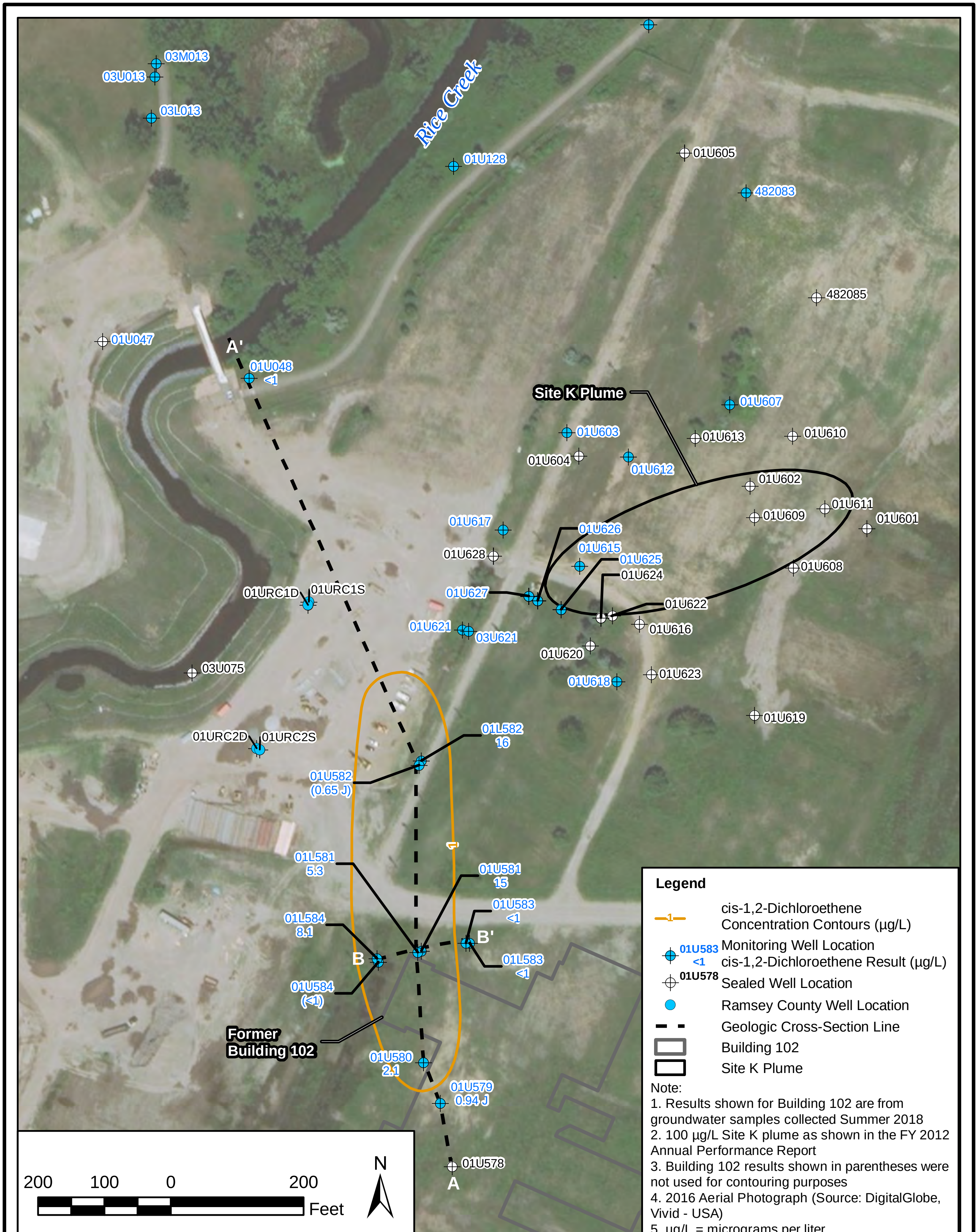
Building 102, Unit 1,
Trichloroethene Results, Summer 2018

PIKA ARCADIS a joint venture

FY 2018

Figure 10-3

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2019-01\Figure_10-3_Bldg 102 Trichloroethene Results_FY2018.mxd
Date: 1/17/2019 Time: 5:12:08 AM User: kgpeters




ANNUAL PERFORMANCE REPORT

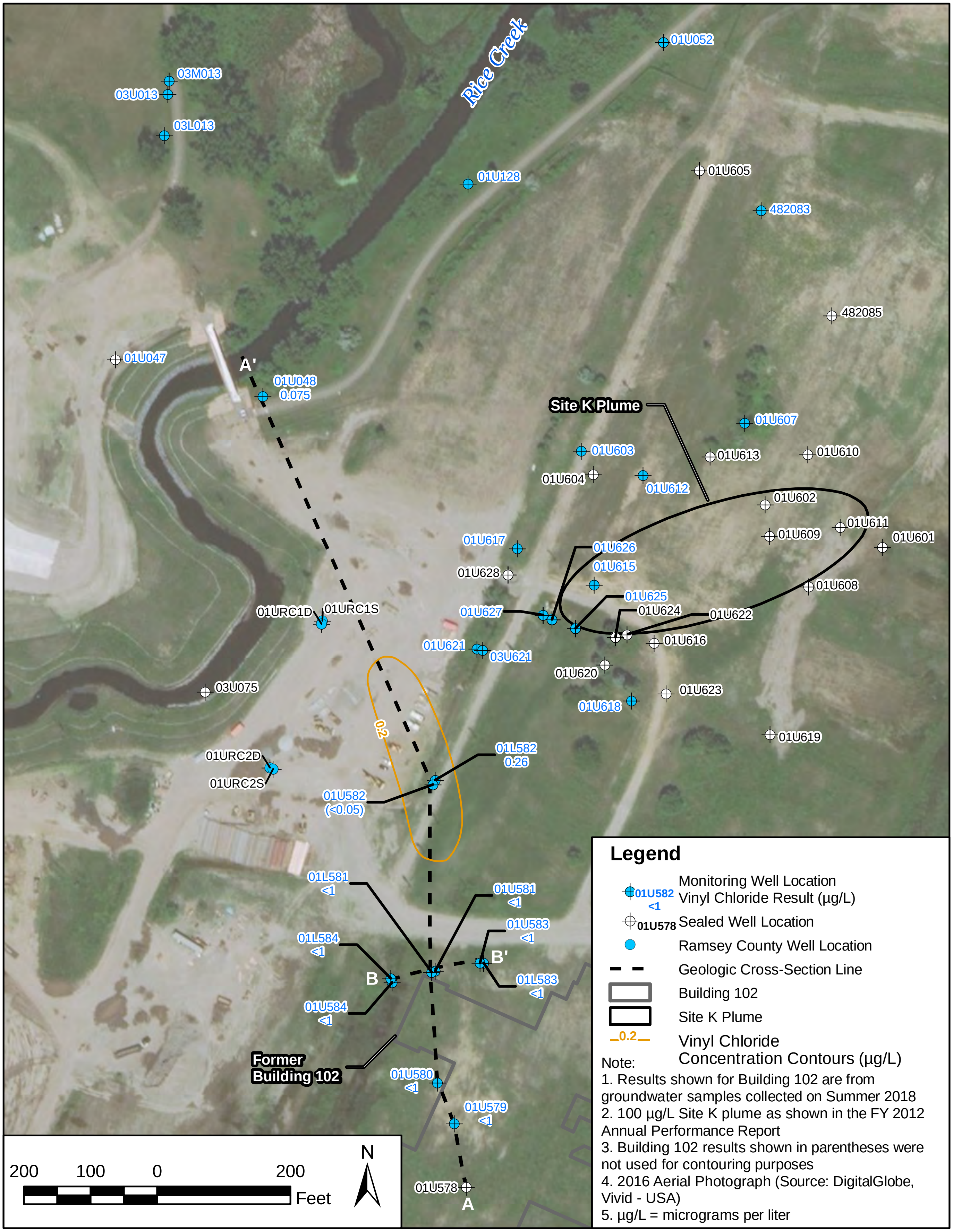
Building 102, Unit 1,
cis-1,2-Dichloroethene Results, Summer 2018

PIKA ARCADIS a joint venture

FY 2018

Figure 10-4

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2019-01\Figure_10-4_Bldg 102 Cis Results_FY2018.mxd
Date: 1/17/2019 Time: 5:10:27 AM User: kgpeters




## Legend

- 01U582 <1 — Monitoring Well Location, Vinyl Chloride Result (µg/L)
- 01U578 — Sealed Well Location
- Ramsey County Well Location
- Geologic Cross-Section Line
- Building 102
- Site K Plume
- 0.2 — Vinyl Chloride Concentration Contours (µg/L)

Note:
1. Results shown for Building 102 are from groundwater samples collected on Summer 2018
2. 100 µg/L Site K plume as shown in the FY 2012 Annual Performance Report
3. Building 102 results shown in parentheses were not used for contouring purposes
4. 2016 Aerial Photograph (Source: DigitalGlobe, Vivid - USA)
5. µg/L = micrograms per liter

ANNUAL PERFORMANCE REPORT

Building 102, Unit 1,
Vinyl Chloride Results, Summer 2018

PIKA ARCADIS a joint venture

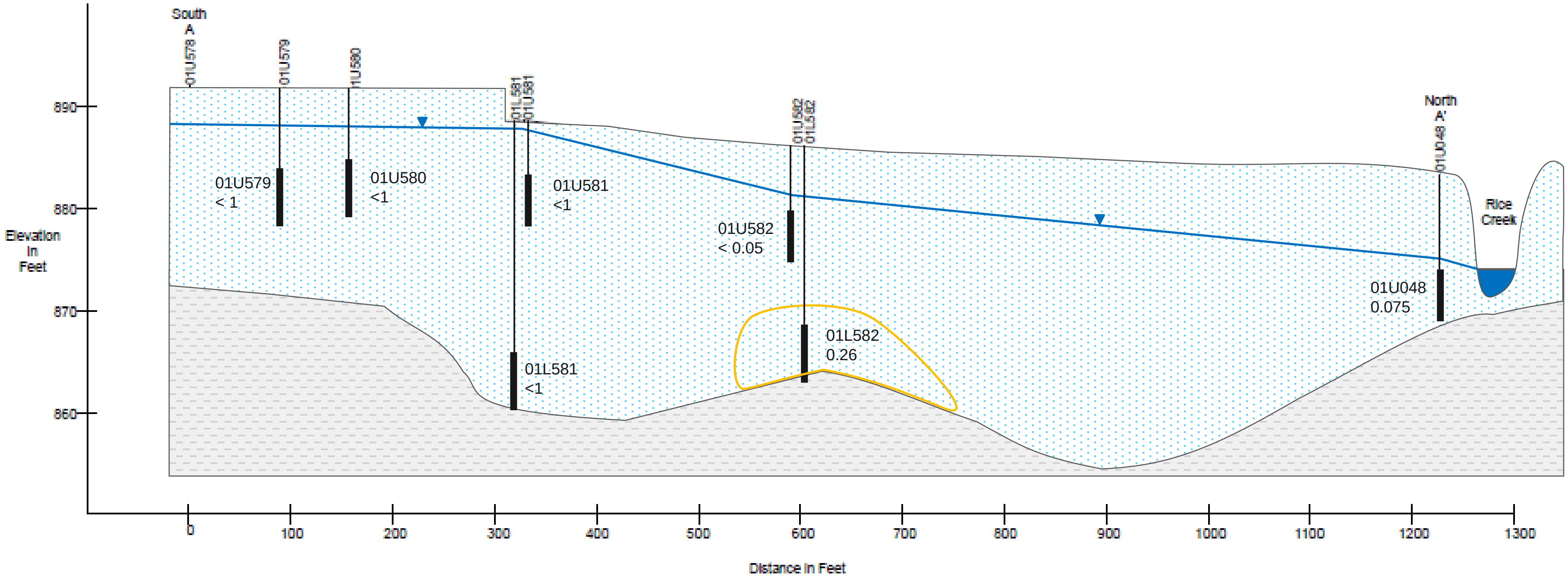
FY 2018

Figure 10-5

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2019-01\Figure_10-5_Bldg 102 Vinyl Results_FY2018.mxd
Date: 1/17/2019 Time: 4:59:47 AM User: kgpeters

## Figure 10-6
## Building 102, Vinyl Chloride Cross Section A-A'

U.S Army - TCAAP
Arden Hills, Minnesota



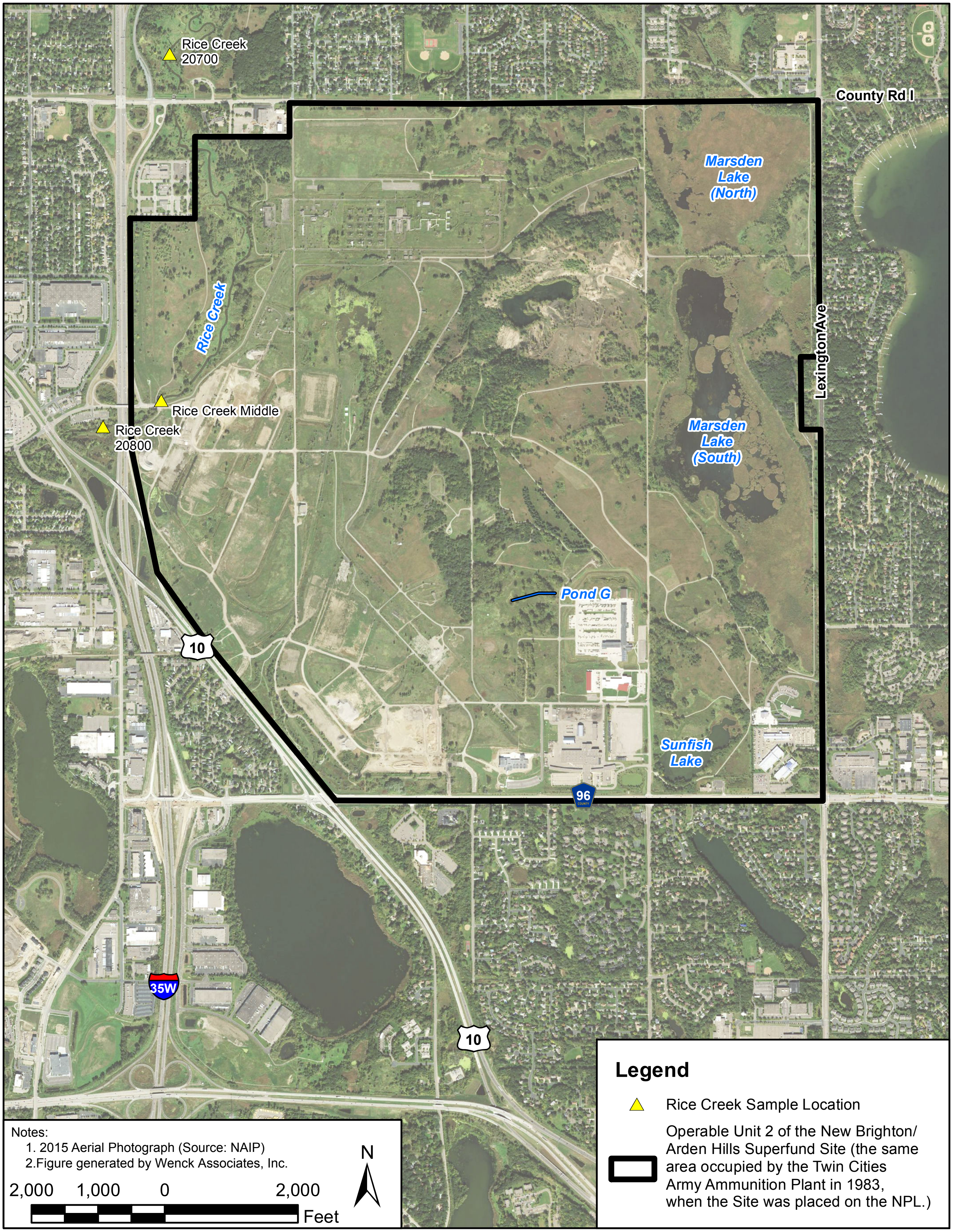

Legend
- Fridley Formation
- Twin Cities Formation

01U579 Monitoring Well ID

0.18 Vinyl Chloride Concentration (µg/L) (Summer 2018)

Vinyl Chloride Concentration Contour (0.2 µg/L)

Water Table



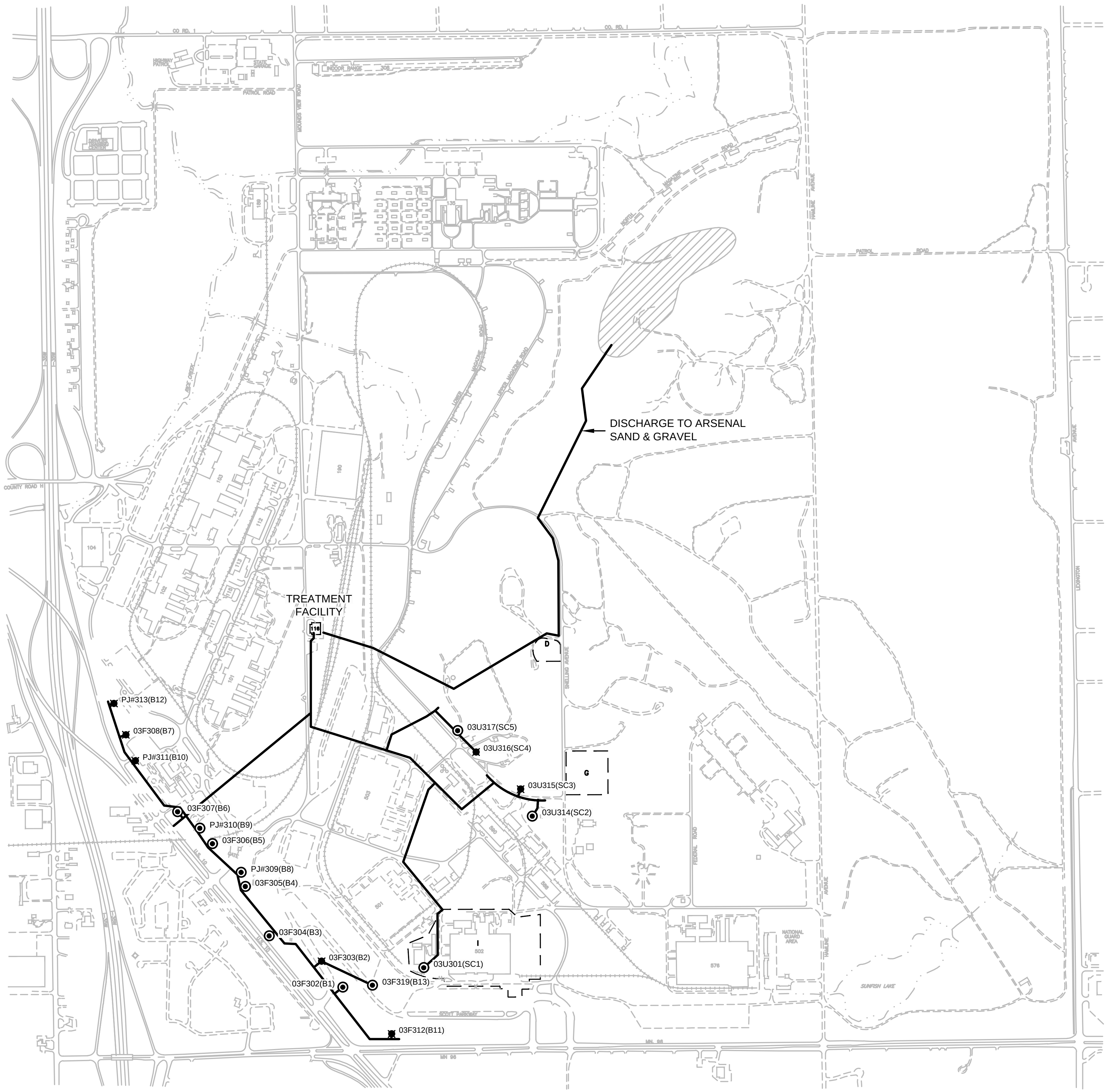

ANNUAL PERFORMANCE REPORT

OU2 Aquatic Sites and Sampling Locations

PIKA ARCADIS a joint venture

FY 2016

Figure 11-1




0 400 1200ft

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 12-1

TGRS LAYOUT
OPERABLE UNIT 2
*Arden Hills, Minnesota*

P:\drawings\11187000s\11187055\11187055-REPORT\11187055-43(001)\11187055-43(001)GN\11187055-43(001)GN-WA002.DWG Plot Date: JAN 08, 2019

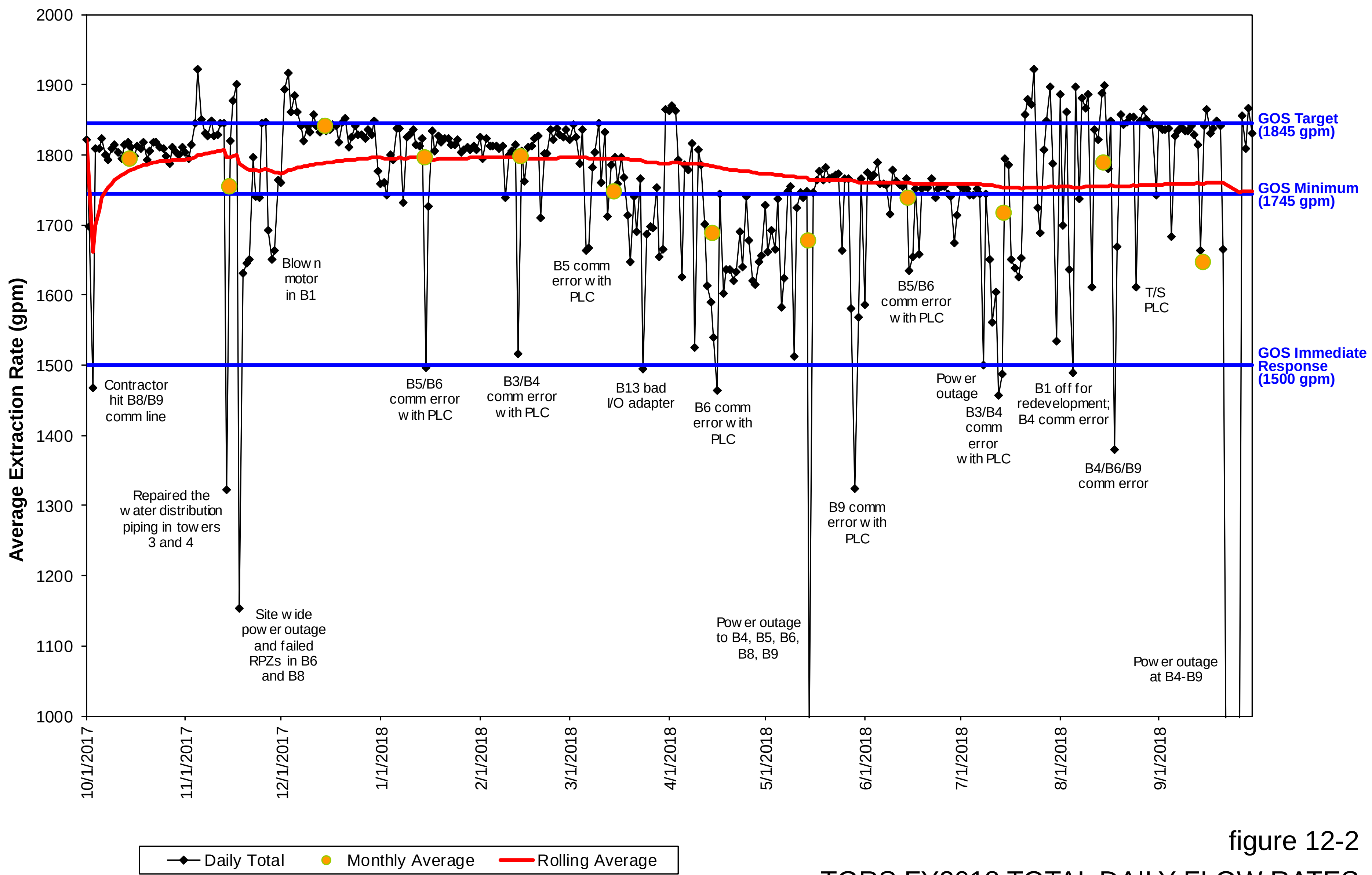
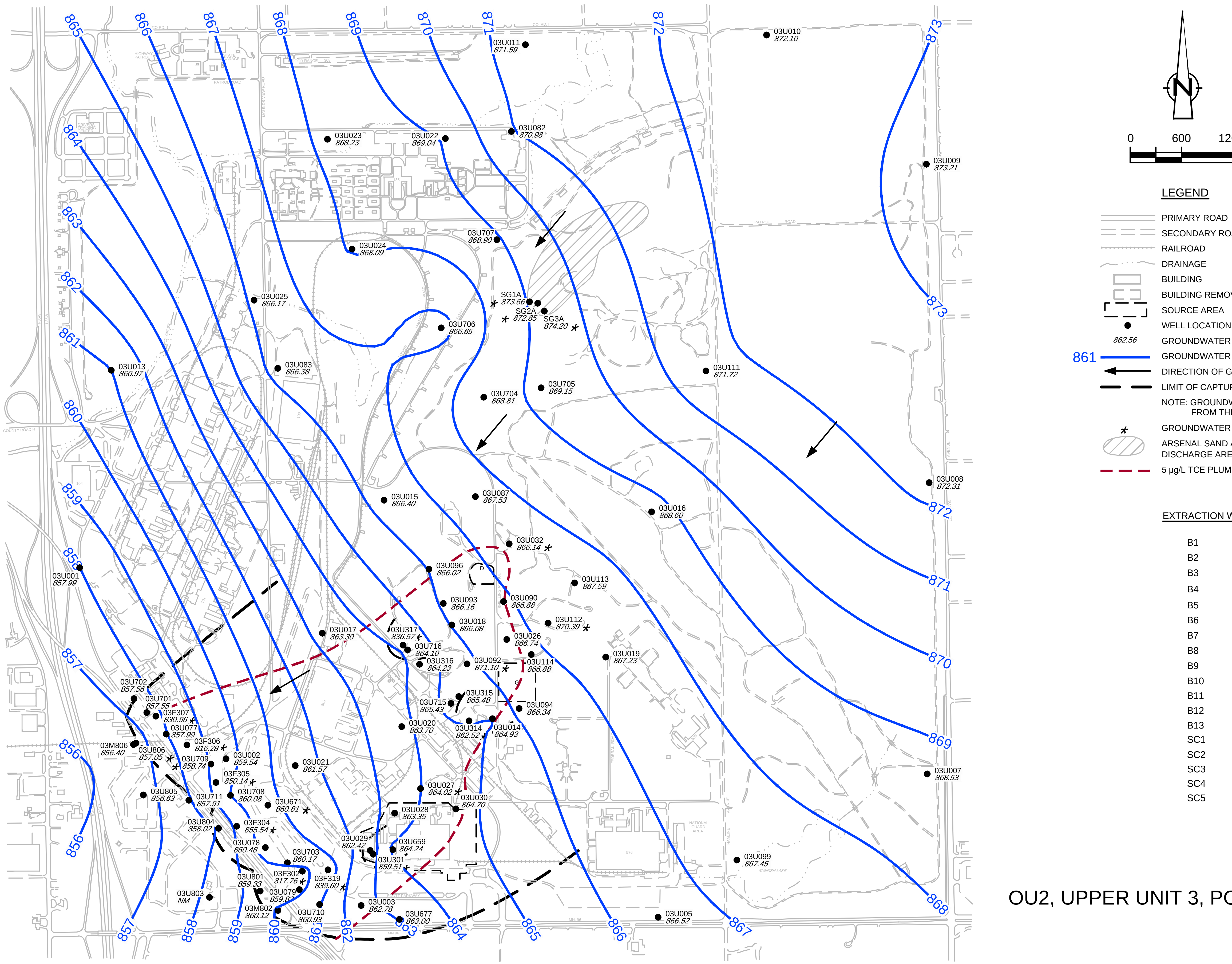



figure 12-2

TGRS FY2018 TOTAL DAILY FLOW RATES
OPERABLE UNIT 2
*Arden Hills, Minnesota*

11187055-43(001)GIS-SP007 JAN 11/2019




LEGEND

- PRIMARY ROAD
- SECONDARY ROAD
- RAILROAD
- DRAINAGE
- BUILDING
- BUILDING REMOVED
- SOURCE AREA
- WELL LOCATION
- 862.56 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

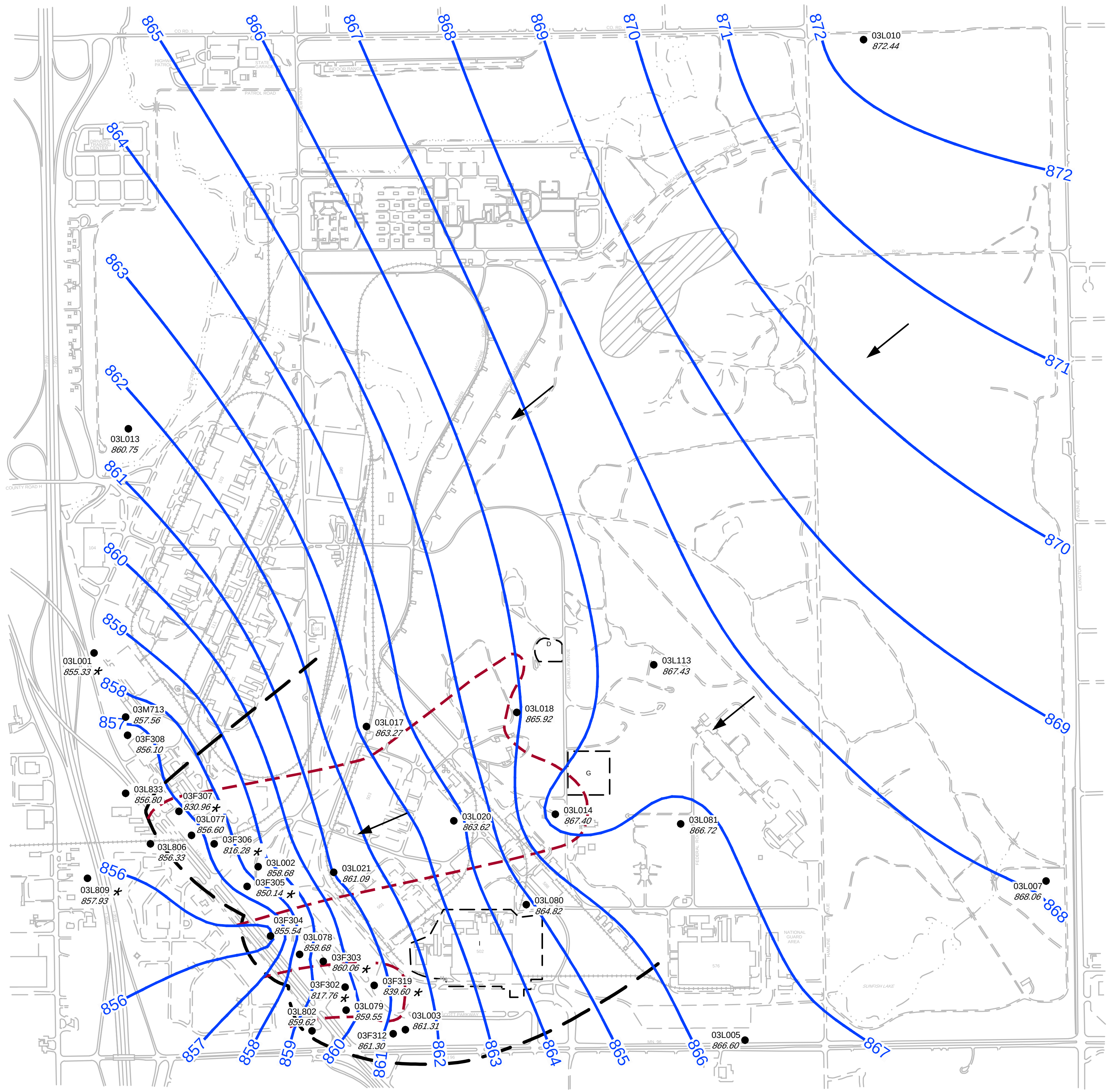
EXTRACTION WELL NAME CROSS REFERENCE

| | |
|---|---|
| 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 12-3

OU2, UPPER UNIT 3, POTENTIOMETRIC MAP
JUNE 2018
OPERABLE UNIT 2
*Arden Hills, Minnesota*

P:\drawings\11187000s\11187055\11187055-REPORT\11187055-43(001)\11187055-43(001)GN\11187055-43(001)GN-WA003.DWG Plot Date: JAN 11, 2019




N

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

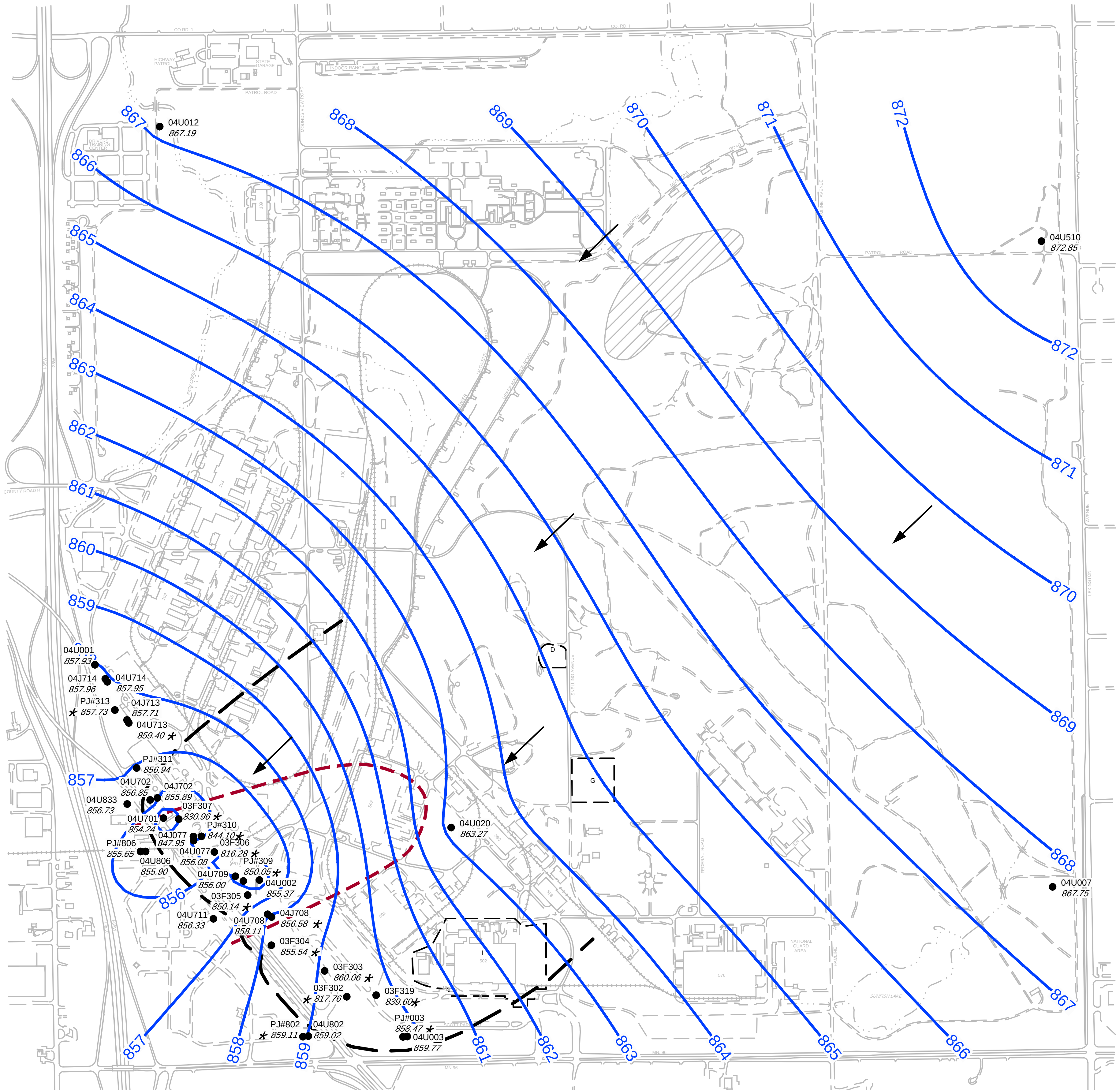
| | |
|---|---|
| B1 | 03F302 |
| B2 | 03F303 |
| B3 | 03F304 |
| B4 | 03F305 |
| B5 | 03F306 |
| B6 | 03F307 |
| B7 | 03F308 |
| B8 | PJ#309 |
| B9 | PJ#310 |
| B10 | PJ#311 |
| B11 | 03F312 |
| B12 | PJ#313 |
| B13 | 03F319 |
| SC1 | 03U301 |
| SC2 | 03U314 |
| SC3 | 03U315 |
| SC4 | 03U316 |
| SC5 | 03U317 |

figure 12-4

OU2, LOWER UNIT 3, POTENTIOMETRIC MAP
JUNE 2018
OPERABLE UNIT 2
*Arden Hills, Minnesota*

GHD

P:\drawings\11187000s\11187055\11187055-REPORT\11187055-43(001)\11187055-43(001)GN\11187055-43(001)GN-WA004.DWG Plot Date: JAN 11, 2019




0 600 1200 ft

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

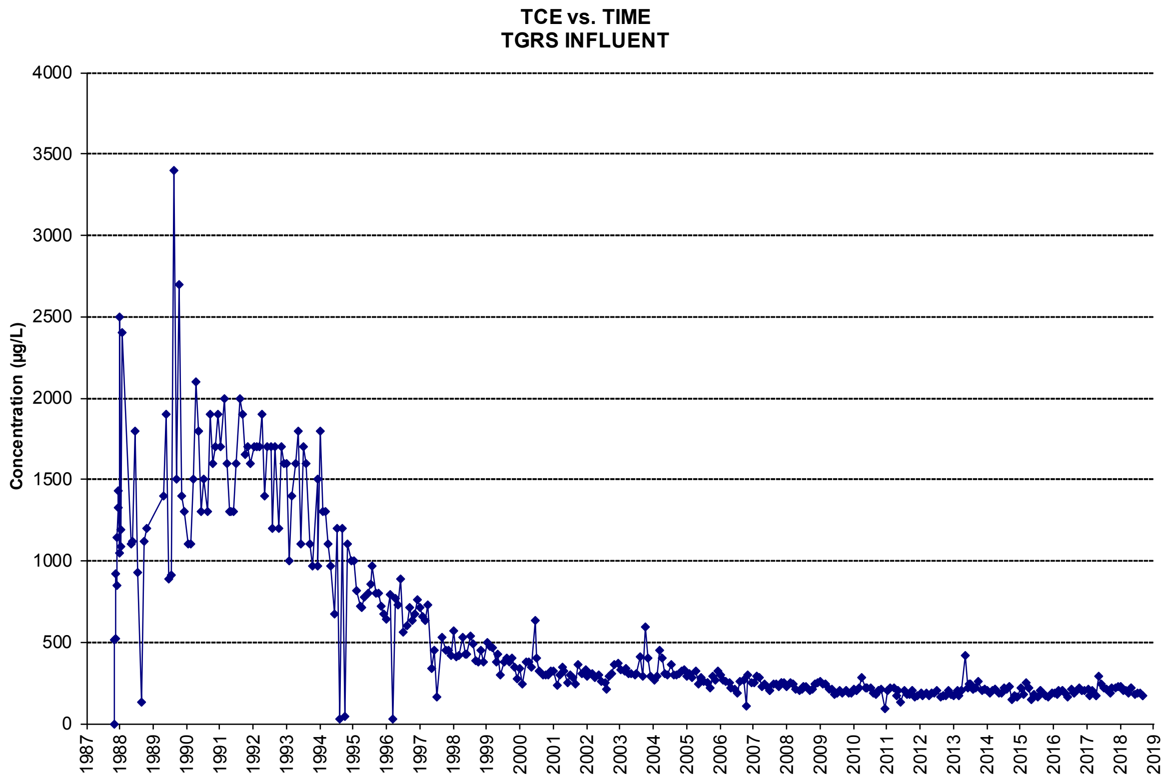
| | |
|---|---|
| B1 | 03F302 |
| B2 | 03F303 |
| B3 | 03F304 |
| B4 | 03F305 |
| B5 | 03F306 |
| B6 | 03F307 |
| B7 | 03F308 |
| B8 | PJ#309 |
| B9 | PJ#310 |
| B10 | PJ#311 |
| B11 | 03F312 |
| B12 | PJ#313 |
| B13 | 03F319 |
| SC1 | 03U301 |
| SC2 | 03U314 |
| SC3 | 03U315 |
| SC4 | 03U316 |
| SC5 | 03U317 |

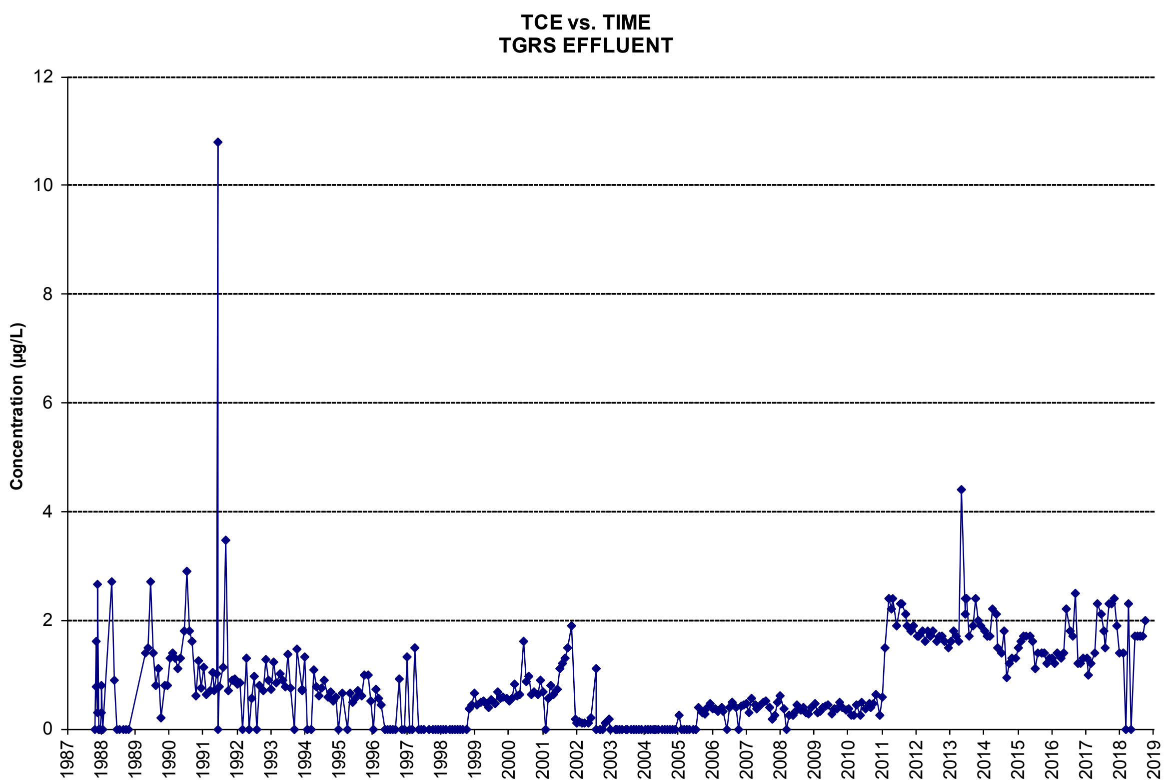
figure 12-5

OU2, UPPER UNIT 4, POTENTIOMETRIC MAP
JUNE 2018
OPERABLE UNIT 2
*Arden Hills, Minnesota*

GHD

P:\drawings\11187000s\11187055\11187055-REPORT\11187055-43(001)\11187055-43(001)GN\11187055-43(001)GN-WA005.DWG Plot Date: FEB 05, 2019



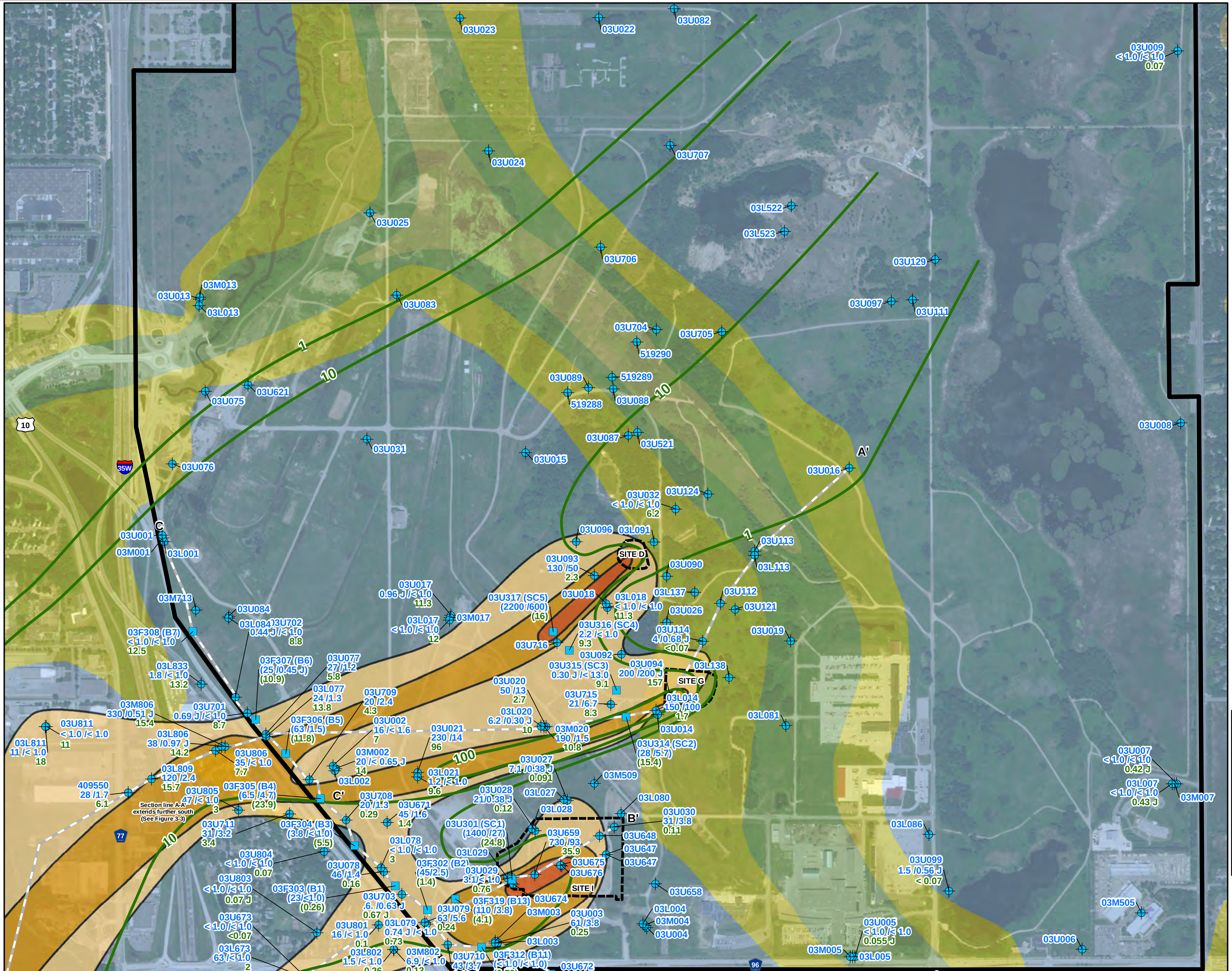

NOTE: SAMPLES REPORTING CONCENTRATIONS OF NON-DETECT WERE PLOTTED AS ZERO. WHEN DUPLICATE SAMPLES WERE COLLECTED, THE HIGHER CONCENTRATION WAS REPORTED.

figure 12-6

TGRS TREATMENT SYSTEM PERFORMANCE
OPERABLE UNIT 2
*Arden Hills, Minnesota*

GHD

11187055-43(001)GIS-SP008 JAN 11/2019




## 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
- 2018 1,4 Dioxane Concentration Contour (µg/L)

2018 Trichloroethene Concentrations (µg/L)

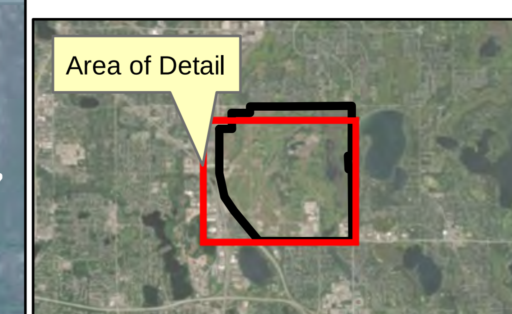
Upper and Lower Unit 3

- 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 Summer 2018.
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

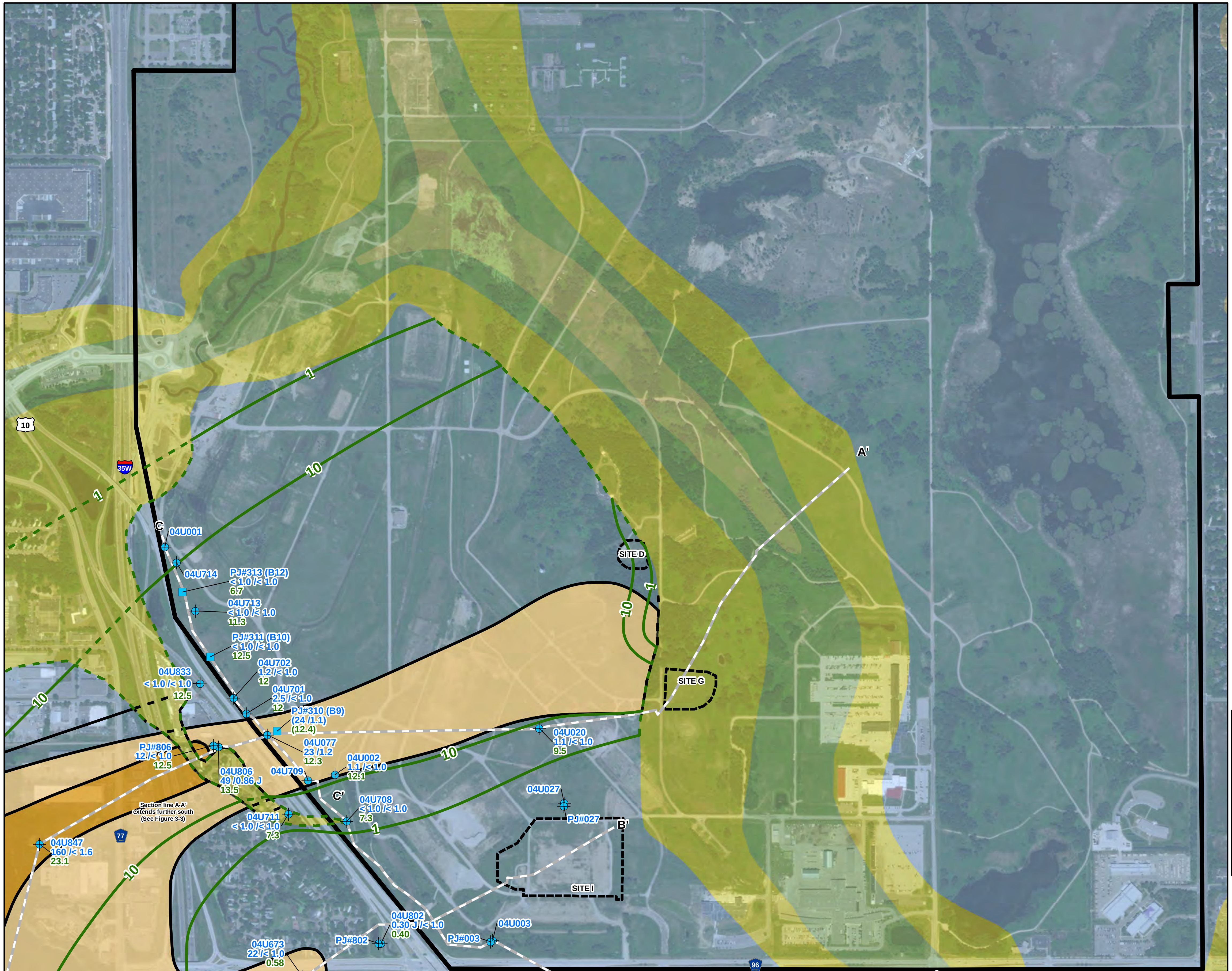



N

1,000 500 0 1,000 Feet

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2019-01\Figure_12-6_OU2_QA_TCE_DIOX_2018.mxd

| | | |
|---|---|---|
| ANNUAL PERFORMANCE REPORT | PIKA ARCADIS a joint venture | FY 2018 |
| OU2, Upper and Lower Unit 3 Combined, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2018 | | Figure 12-7 |




## Legend

- Monitoring Well
- 04U806 — Monitoring Well ID
- 52/0.88 JP — Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
- 13.2 — 1,4-Dioxane Concentration (µg/L)
- Extraction Well
- Private Well
- Cross-Section Line
- Site Boundary
- 2018 1,4 Dioxane Concentration Contour (µg/L) (Dashed Where Inferred)

2018 Trichloroethene Concentrations (µg/L)

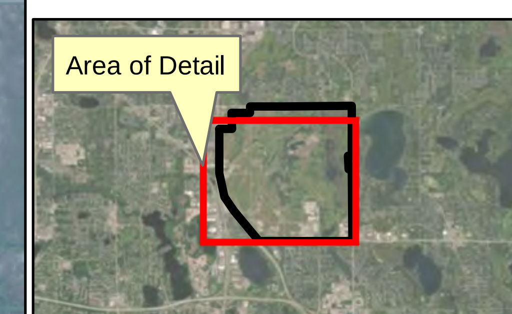
Upper Unit 4 (Dashed Where Inferred)

- 5-100
- 100-1,000
- Operable Unit 2

Bedrock Geology

- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Tunnel City Group

Notes:
1. All PJ# extraction wells are shown with data in parentheses, but were not used for contouring.
2. Results are from groundwater samples collected in Summer 2018.
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

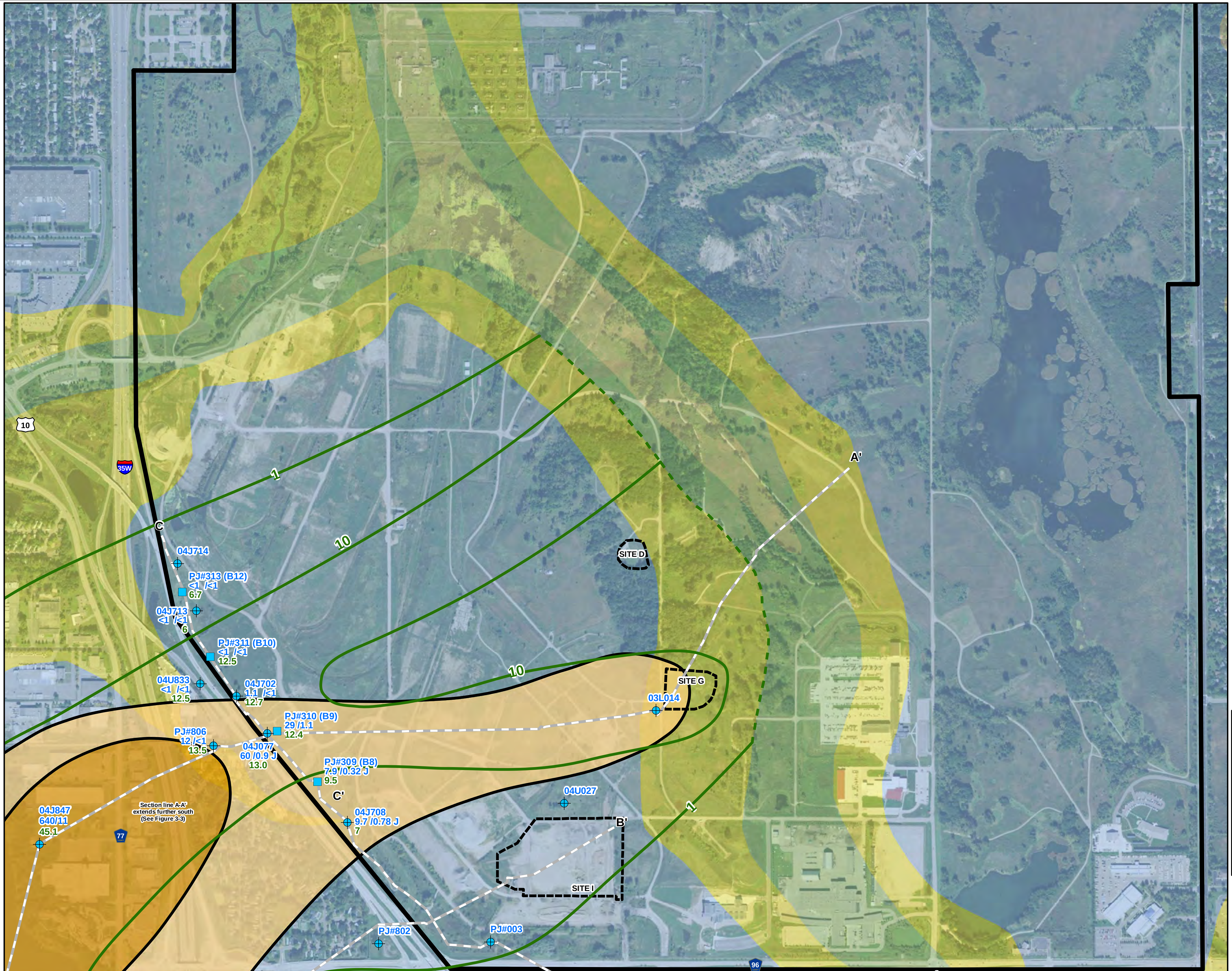



N

1,000 500 0 1,000 Feet

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2019-01\Figure_12-7_OU2_PDC_TCE_DIOX_2018.mxd

| ANNUAL PERFORMANCE REPORT | PIKA ARCADIS a joint venture | FY 2018 |
|---|---|---|
| OU2, Upper Unit 4, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2018 | | Figure 12-8 |




## Legend

Monitoring Well

04J077 Monitoring Well ID
51/0.91 JP Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
13.0 1,4-Dioxane Concentration (µg/L)

Extraction Well

Private Well

Cross-Section Line

Site Boundary

2018 1,4 Dioxane Concentration Contour (µg/L) (Dashed Where Inferred)

2018 Trichloroethene Concentrations (µg/L)

Lower Unit 4

5-100

100-1,000

Operable Unit 2

Bedrock Geology

St. Peter Sandstone

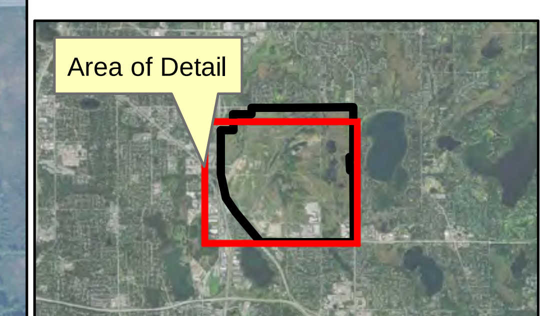
Prairie du Chien Group

Jordan Sandstone

St. Lawrence Formation

Tunnel City Group

Notes:
1. All PJ# extraction wells are shown with data in parentheses, but were not used for contouring.
2. Results are from groundwater samples collected in Summer 2018.
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\2019-01\Figure_12-8_OU2_Jordan_TCE_DIOX_2018.mxd

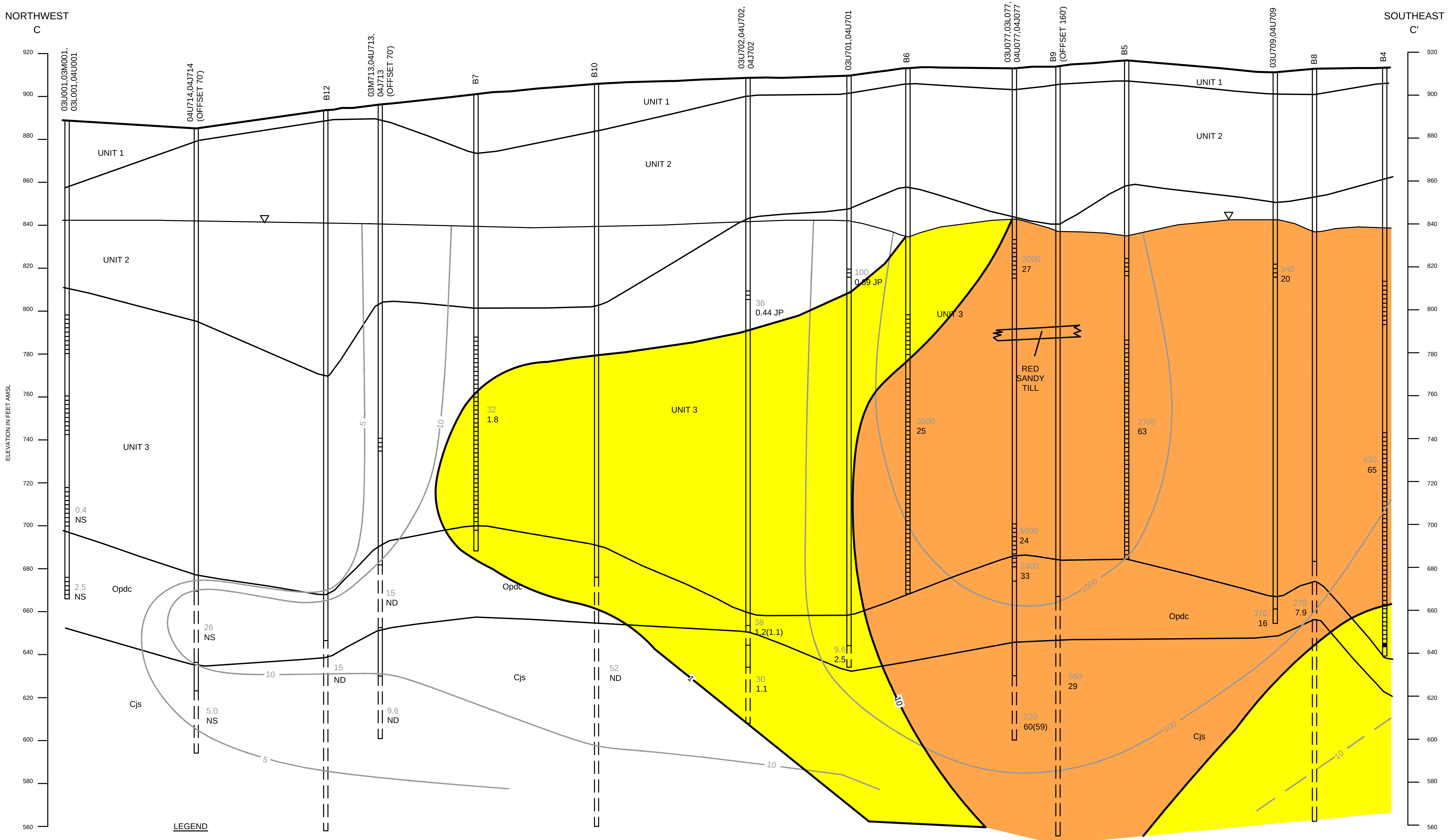
ANNUAL PERFORMANCE REPORT

OU2, Lower Unit 4, Trichloroethene and 1,4-Dioxane Isoconcentration Map, Summer 2018

PIKA ARCADIS a joint venture

FY 2018

Figure 12-9




LEGEND

100 TRCLE CONTOUR IN µg/L (10-89)

100 TRCLE CONTOUR IN µg/L (06-18)

OPEN HOLE INTERVAL

SCREENED INTERVAL

2018 TRCLE CONCENTRATION

( ) DUPLICATE SAMPLE

NS NOT SAMPLED

ND NON DETECT

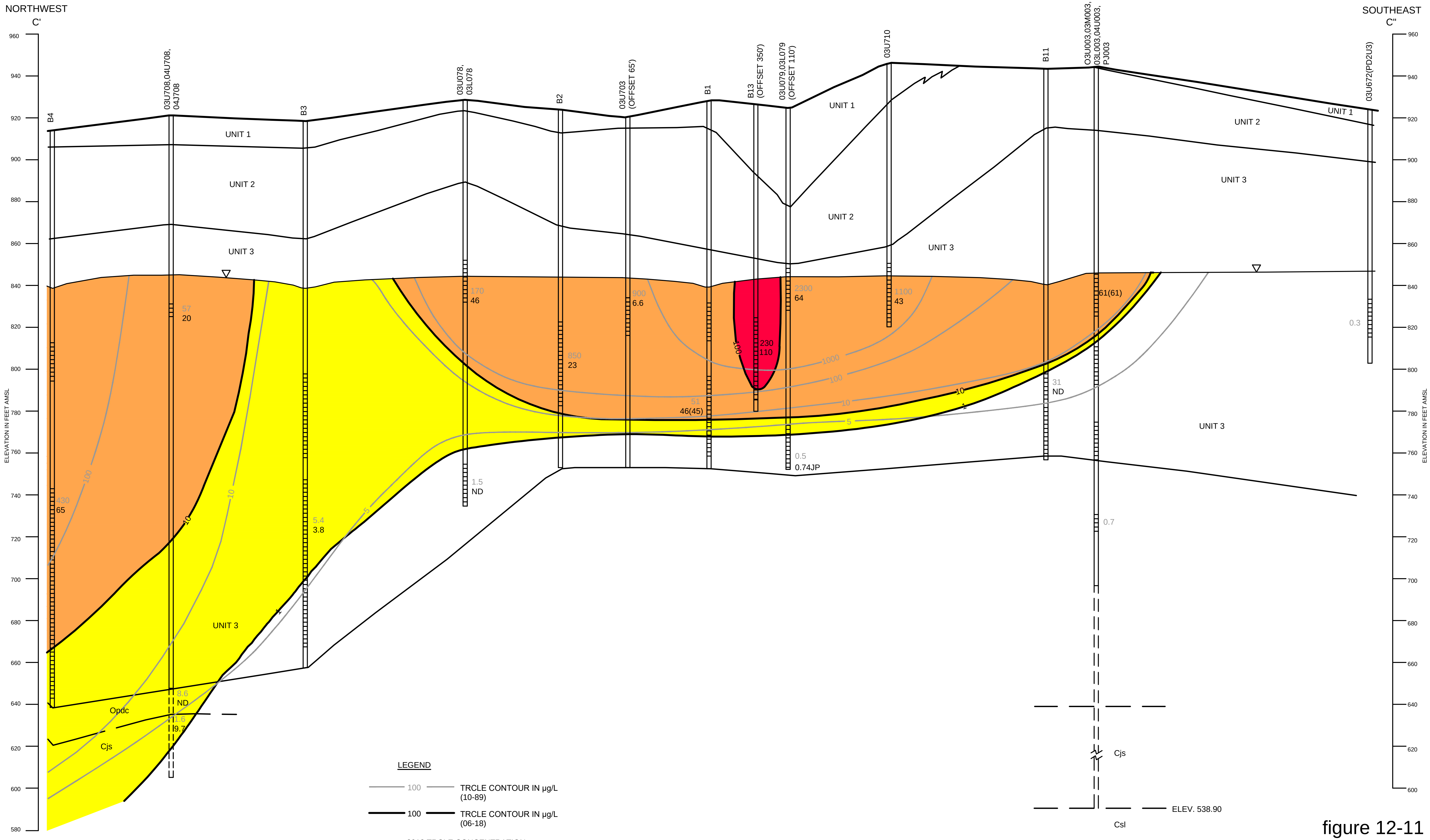
VERTICAL SCALE 0 20 SCALE IN FEET

HORIZONTAL SCALE 0 100 SCALE IN FEET

figure 12-10

JUNE 2018 GROUNDWATER TRCLE DATA
CROSS SECTION C-C'
OPERABLE UNIT 2
*Arden Hills, Minnesota*

P:\drawings\11187000s\11187055\11187055-REPORT\11187055-43(001)\11187055-43(001)GN\11187055-43(001)GN-WA006.DWG Plot Date: JAN 18, 2019




LEGEND

100 TRCLE CONTOUR IN µg/L (10-89)

100 TRCLE CONTOUR IN µg/L (06-18)

2018 TRCLE CONCENTRATION

( ) DUPLICATE SAMPLE

SCREENED INTERVAL

OPEN HOLE INTERVAL

VERTICAL SCALE 0 20 SCALE IN FEET

HORIZONTAL SCALE 0 100 SCALE IN FEET

GHD

figure 12-11

JUNE 2018 GROUNDWATER TRCLE DATA
CROSS SECTION C'-C"
OPERABLE UNIT 2
*Arden Hills, Minnesota*

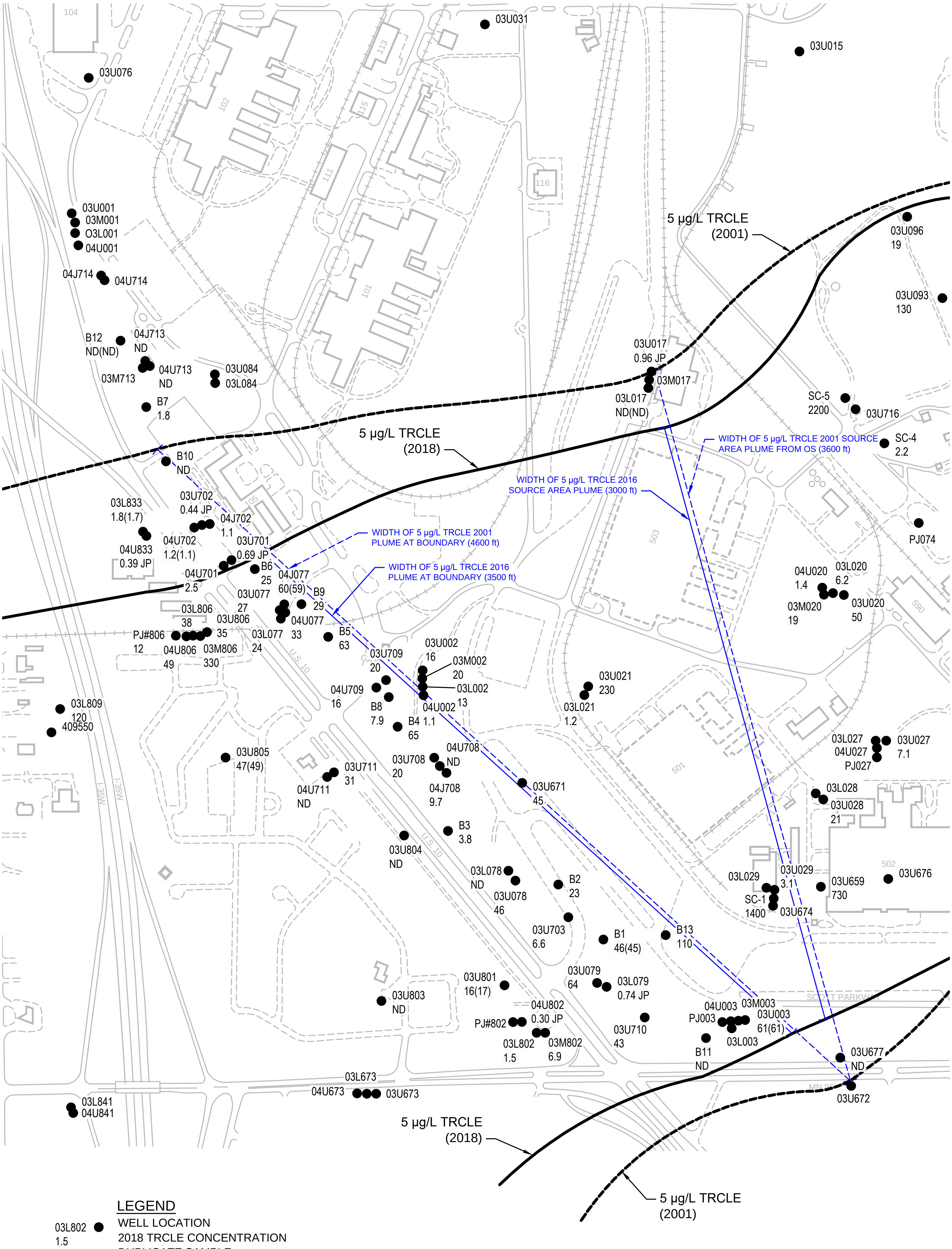
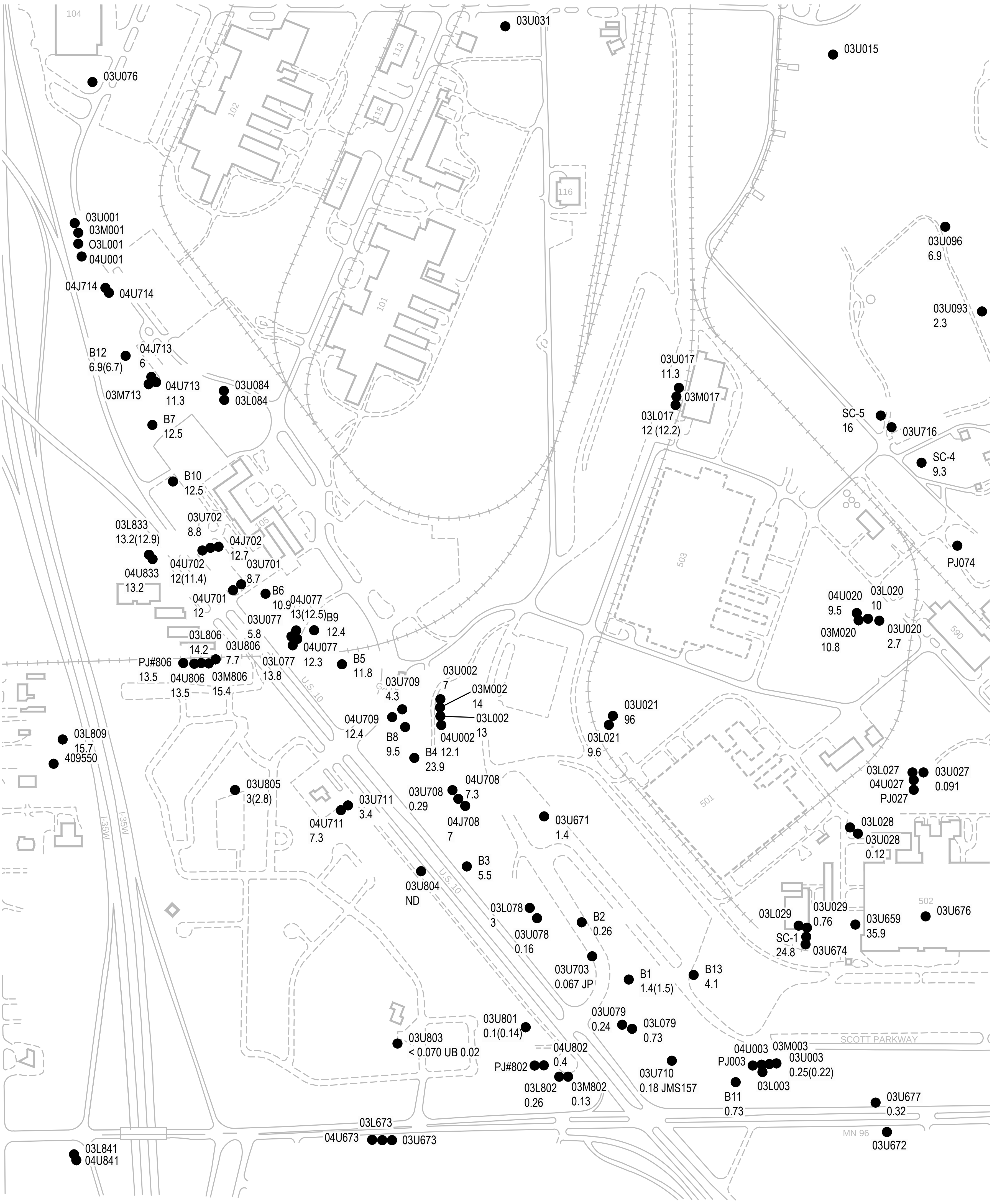



figure 12-12

TGRS ANNUAL MONITORING DATA - WEST PORTION
TRCLE CONCENTRATIONS (µg/L) JUNE 2018
OPERABLE UNIT 2
*Arden Hills, Minnesota*

GHD

P:\drawings\11187000s\11187055\11187055-REPORT\11187055-43(001)\11187055-43(001)GN\11187055-43(001)GN-WA008.DWG Plot Date: JAN 18, 2019




LEGEND

| | |
|---|---|
| 03L802 | WELL LOCATION |
| 1.5 | 2018 1,4-DIOXANE CONCENTRATION |
| ( ) | DUPLICATE SAMPLE |

N

0 200 500ft

GHD

figure 12-13

TGRS ANNUAL MONITORING DATA - WEST PORTION
1,4-DIOXANE CONCENTRATIONS (µg/L) JUNE 2018
OPERABLE UNIT 2
*Arden Hills, Minnesota*

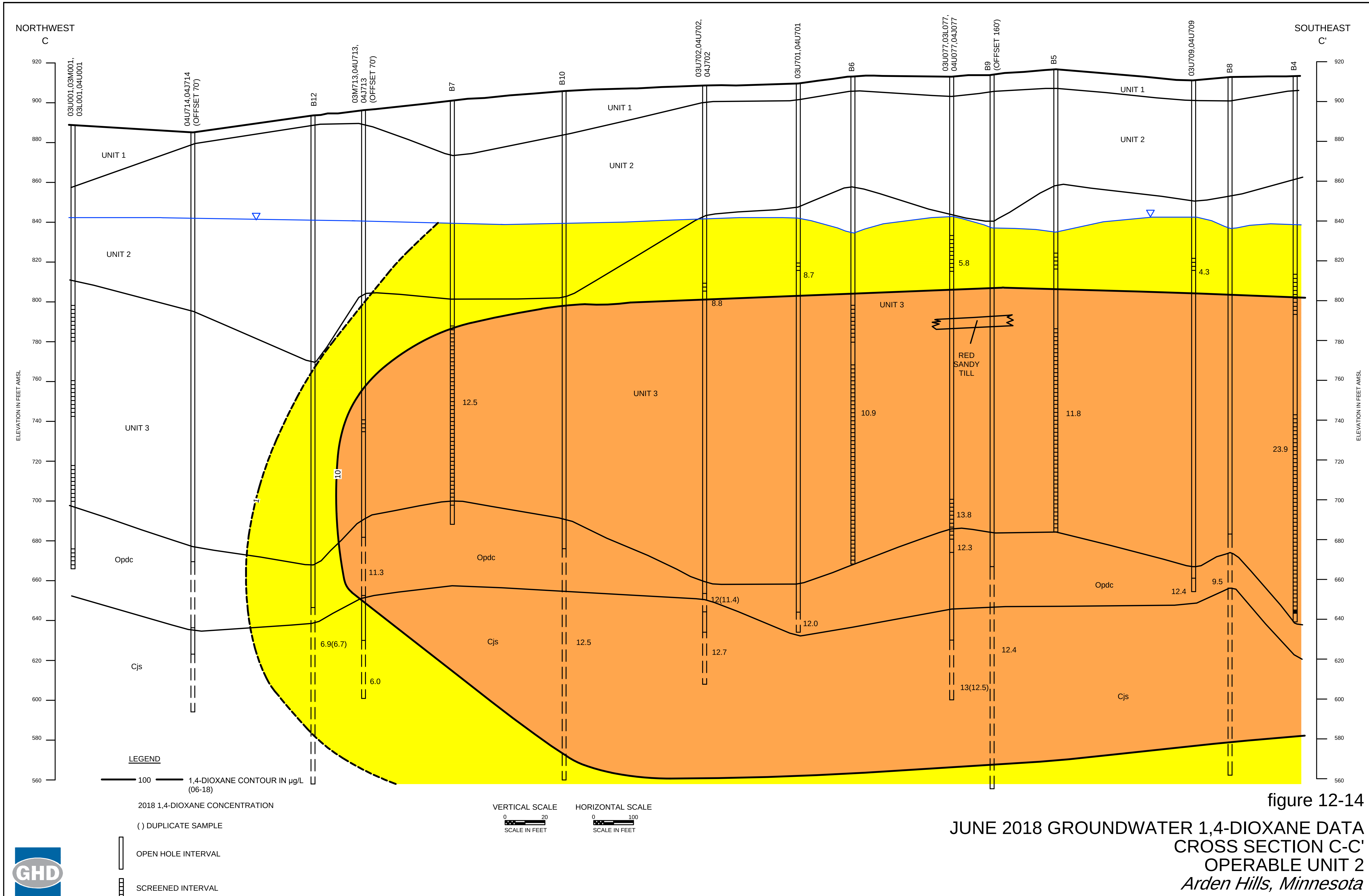



figure 12-14

JUNE 2018 GROUNDWATER 1,4-DIOXANE DATA
CROSS SECTION C-C'
OPERABLE UNIT 2
*Arden Hills, Minnesota*

P:\drawings\11187000s\11187055\11187055-REPORT\11187055-43(001)\11187055-43(001)GN\11187055-43(001)GN-WA010.DWG Plot Date: JAN 11, 2019

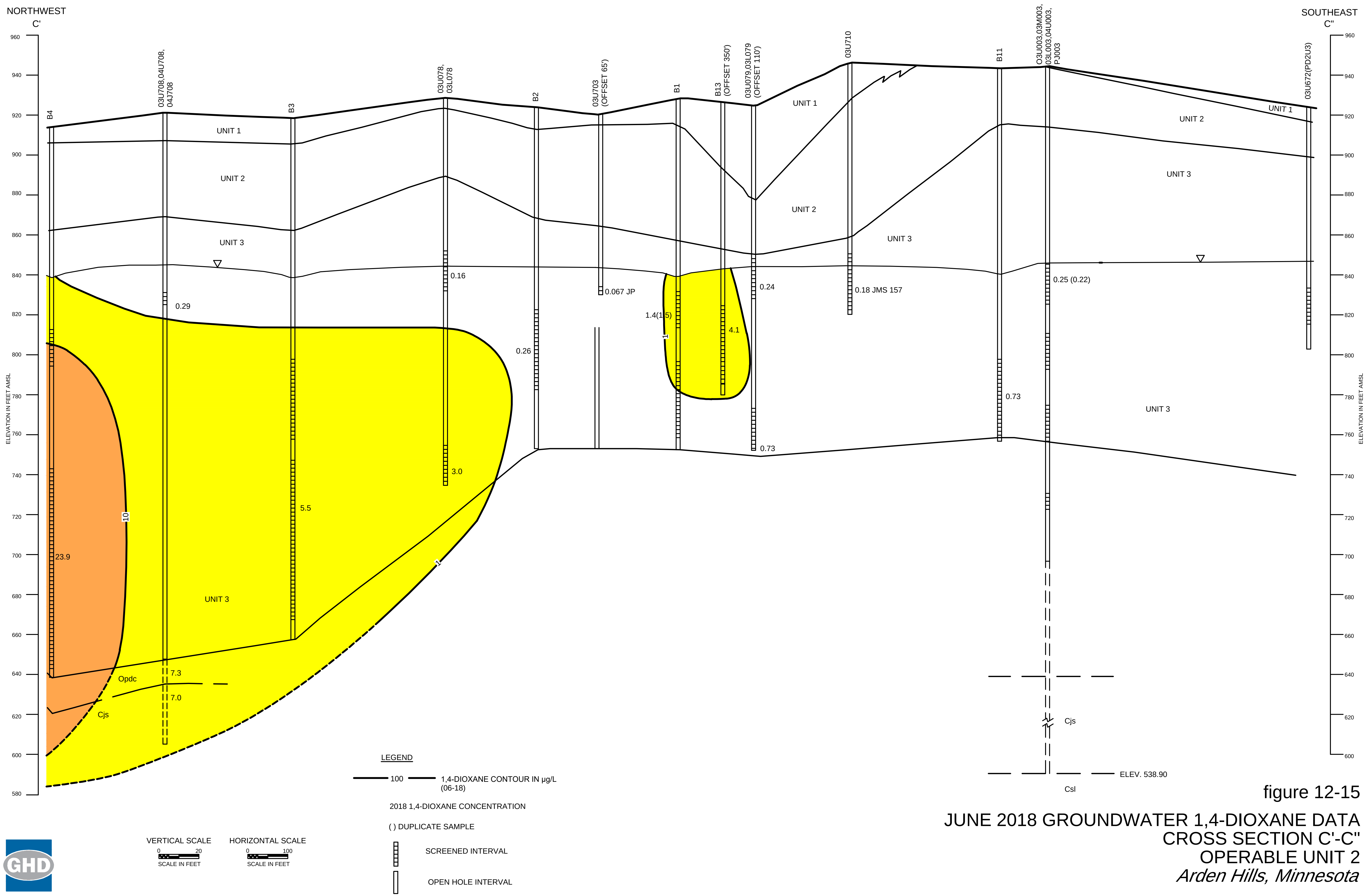



figure 12-15

JUNE 2018 GROUNDWATER 1,4-DIOXANE DATA
CROSS SECTION C'-C''
OPERABLE UNIT 2
*Arden Hills, Minnesota*

P:\drawings\11187000s\11187055\11187055-REPORT\11187055-43(001)\11187055-43(001)GN\11187055-43(001)GN-WA011.DWG Plot Date: JAN 18, 2019

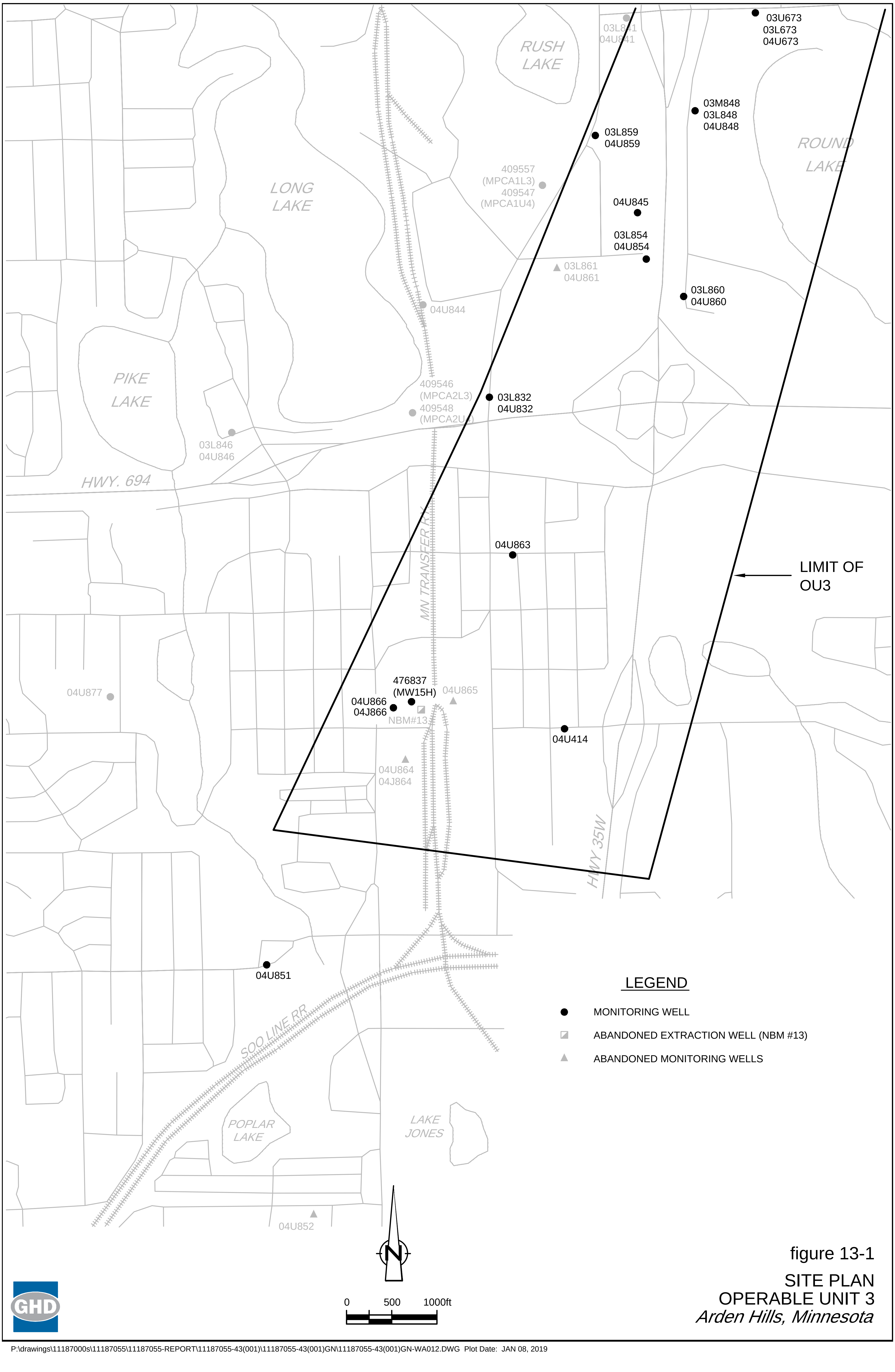



figure 13-1

SITE PLAN
OPERABLE UNIT 3
*Arden Hills, Minnesota*

P:\drawings\11187000s\11187055\11187055-REPORT\11187055-43(001)\11187055-43(001)GN\11187055-43(001)GN-WA012.DWG Plot Date: JAN 08, 2019

# APPENDIX A

## FY 2018 – FY 2022 Monitoring Plan

**Appendix A.1**
**FY 2018 - FY 2022 Monitoring Plan for Groundwater Monitoring Wells**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

PIKA ARCADIS a joint venture

**Unit Designations:**

| | | | |
|---|---|---|---|
| 01U - Upper Fridley Formation | 03M - Middle Hillside Formation | SL - St. Lawrence | J - Jordan |
| 01L - Lower Fridley Formation | 03L - Lower Hillside Formation | UNK - Unknown | |
| 03U - Upper Hillside Formation | SP - St. Peter | PC - Prairie du Chien | |

**Notes:**

(A) Indicates that the monitoring is the responsibility of Orbital ATK.
(B) Indicates that the monitoring is the responsibility of the Army.
(1) "L (A or B)" denotes a water level measurement by the appropriate party.
(2) "Q (A or B)" denotes a water quality sampling by the appropriate party. The required analyte list for each specific site is shown in Appendix A.4.
(3) The designations refer to the following purposes:

- ❖ Operable Unit 1 Water Quality
  - – 1.a = To contour the perimeter of the plume which defines the area of concern for alternate water supply/well abandonment
  - – OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- ❖ Operable Unit 1 Water Levels
  - – 3.b = To contour water levels for evaluation of containment
- ❖ Site A Water Quality
  - – OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- ❖ Site A Water Levels
  - – OR = Overall remedy. To evaluate groundwater flow direction relative to plume location
- ❖ Site C Water Quality
  - – OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- ❖ Site C Water Levels
  - – OR = Overall remedy. To evaluate groundwater flow direction relative to plume location
- ❖ Site I Water Quality
  - – 1.a = To track remedy progress
  - – OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- ❖ Site I Water Levels
  - – 1.a = To track remedy progress
- ❖ Site K Water Quality
  - – OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- ❖ Site K Water Levels
  - – 3.a = To contour water levels for evaluation of containment

- ❖ Building 102 Water Quality
  - – OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- ❖ Building 102 Water Levels
  - – OR = Overall remedy. To evaluate groundwater flow direction relative to plume location
- ❖ TGRS Water Quality
  - – OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- ❖ TGRS Water Levels
  - – 1.a = To contour water levels for evaluation of containment
- ❖ Operable Unit 3 Water Quality
  - – OR = Overall remedy. To evaluate attainment of the cleanup levels throughout the plume
- ❖ Operable Unit 3 Water Levels
  - – 2.a = To contour water levels for evaluation of MNA remedy

(4) Sampling performed by the City of Saint Anthony. Army collects sample only if in production and not being sampled by City of Saint Anthony; otherwise Army uses Saint Anthony data.

(5) Sample extraction well annually or biennially, as shown, since it is no longer being pumped.

(6) Wells 04U414 and 04U851 monitored every 5 years during event preceding 5-year review

(7) Sample OU1 private water supply well as late as September 30, if necessary due to temporary inaccessibility.

| Well Information | | | Notes | June 18 | June 19 | June 20 | June 21 | June 22 | Purpose For Monitoring(3) | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit | Well I.D. | Common Name | | | | | | | Water Quality | Water Level | |
| **Operable Unit 1** | | | | | | | | | | | |
| 03U | 03U811 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | 3.b | MPCA recommended annual sampling |
| 03U | 03U821 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| 03U | 03U822 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | 1.a, OR | None | |
| 03U | 03U831 | | | --- | --- | --- | --- | --- | --- | --- | abandoned 2006 |
| 03U | 409550 | PCA 6U3 | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | None | |
| 03U | 409596 | BS118U3 | | --- | --- | --- | --- | --- | --- | --- | abandoned 2007, may need replacement |
| 03M | 03M843 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | 1.a, OR | None | |
| 03L | 03L811 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| 03L | 03L822 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | None | |
| 03L | 03L832 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | None | |
| 03L | 03L841 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | 1.a, OR | None | |
| 03L | 03L846 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | 1.a, OR | None | |
| 03L | 03L853 | | | --- | --- | --- | --- | --- | --- | --- | |
| 03L | 409556 | PCA4L3 | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | 1.a, OR | None | |
| 03L | 409557 | PCA1L3 | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | 1.a, OR | None | |
| 03L | 409597 | BS118L3 | | --- | --- | --- | --- | --- | --- | --- | abandoned 2007, may need replacement |
| PC | 04U821 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| PC | 04U834 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | None | |
| PC | 04U836 | MW-1 | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| PC | 04U837 | MW-3 | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| PC | 04U838 | MW-5 | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| PC | 04U839 | MW-7 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | 3.b | MPCA recommended annual sampling |
| PC | 04U841 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| PC | 04U843 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | 1.a, OR | 3.b | |
| PC | 04U844 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| PC | 04U846 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| PC | 04U847 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| PC | 04U849 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| PC | 04U850 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| PC | 04U855 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | 1.a, OR | 3.b | MPCA recommended annual sampling |
| PC | 04U871 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | 3.b | |
| PC | 04U872 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | 3.b | |
| PC | 04U875 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | 1.a, OR | 3.b | |
| PC | 04U877 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | 3.b | |
| PC | 04U879 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | 1.a, OR | 3.b | MPCA recommended annual sampling |
| PC | 04U880 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | 1.a, OR | 3.b | |
| PC | 04U881 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | 1.a, OR | None | |
| PC | 04U882 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | None | |
| PC | 04U883 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | 1.a, OR | None | |
| PC | 191942 | BS118U4 | | --- | --- | --- | --- | --- | --- | --- | abandoned 2007, may need replacement |
| PC | 200154 | UM Golf Course | | Q(B) | --- | Q(B) | --- | Q(B) | 1.a, OR | --- | |
| PC | 200814 | American Linen | | --- | --- | --- | --- | --- | --- | --- | |
| PC | 206688 | Cloverpond | | Q(B) | --- | Q(B) | --- | Q(B) | 1.a, OR | --- | |
| PC | 234547 | Honeywell Ridgeway | | --- | --- | --- | --- | --- | --- | --- | |
| PC | 409547 | PCA1U4 | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| PC | 409548 | PCA2U4 | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| PC | 409549 | PCA3U4 | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| PC | 409555 | PCA5U4 | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | 1.a, OR | 3.b | |
| PC | 512761 | Gross Golf Course #2 | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| PC | 554216 | New Brighton #14 | | | | | | | | | See Appendix A.2 |
| PC | 582628 | New Brighton #15 | | | | | | | | | See Appendix A.2 |
| J | 04J822 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | 3.b | |
| J | 04J834 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | None | |
| J | 04J835 | | | --- | --- | --- | --- | --- | --- | --- | |

| Well Information | | | Notes | June 18 | June 19 | June 20 | June 21 | June 22 | Purpose For Monitoring[3] | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit | Well I.D. | Common Name | | | | | | | Water Quality | Water Level | |
| J | 04J836 | MW-2 | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| J | 04J837 | MW-4 | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| J | 04J838 | MW-6 | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| J | 04J839 | MW-8 | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | 3.b | |
| J | 04J847 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | 3.b | |
| J | 04J849 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | 3.b | |
| J | 04J882 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | None | |
| J | 200524 | St. Anthony #5 | | Q(B) | --- | Q(B) | --- | Q(B) | OR | --- | Army gets St. Anthony Data |
| J | 200803 | St. Anthony #4 | | Q(B) | --- | Q(B) | --- | Q(B) | OR | --- | Army gets St. Anthony Data |
| J | 206796 | New Brighton #5 | | | | | | | | | See Appendix A.2 |
| J | 206797 | New Brighton #6 | | | | | | | | | See Appendix A.2 |
| PC/J | 200804 | St. Anthony #3 | | Q(B) | --- | Q(B) | --- | Q(B) | OR | --- | Army gets St. Anthony Data |
| PC/J | 200812 | Gross Golf #1 | | --- | --- | --- | --- | --- | --- | --- | |
| PC/J | 206792 | New Brighton #4 | | | | | | | | | See Appendix A.2 |
| PC/J | 206793 | New Brighton #3 | | | | | | | | | See Appendix A.2 |
| PC/J | 233221 | R&D Systems, N. Well | | --- | --- | --- | --- | --- | --- | --- | |
| PC/J | 234549 | Reiner | | --- | --- | --- | --- | --- | 1.a, OR | --- | Well out of service |
| PC/J | PJ#318 | | | Q,L(B) | --- | Q,L(B) | --- | Q,L(B) | OR | None | |
| UNK | 234546 | Honeywell Ridgeway | | Q(B) | --- | Q(B) | --- | Q(B) | OR | --- | |
| **Operable Unit 2 - Site A Shallow Groundwater** | | | | | | | | | | | |
| 01U | 01U038 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U039 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U040 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U041 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U063 | | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U067 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U102 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U103 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | Including antimony |
| 01U | 01U104 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U105 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U106 | | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U107 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U108 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U110 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U115 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U116 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U117 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U118 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U119 | | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U120 | | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U125 | | | --- | --- | --- | --- | --- | --- | --- | |
| 01U | 01U126 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U127 | | | L(B) | L(B) | L(B) | L(B) | L(B) | OR | OR | |
| 01U | 01U133 | | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U135 | | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U136 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U137 | | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U138 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U139 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U140 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U141 | | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U145 | Piezometer | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U146 | Piezometer | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U147 | Piezometer | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U148 | Piezometer | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |

| Well Information | | | Notes | June 18 | June 19 | June 20 | June 21 | June 22 | Purpose For Monitoring(3) | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit | Well I.D. | Common Name | | | | | | | Water Quality | Water Level | |
| 01U | 01U149 | Piezometer | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U150 | Piezometer | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U151 | Piezometer | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U152 | Piezometer | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U153 | Piezometer | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U154 | Piezometer | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U155 | Piezometer | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U156 | Piezometer | | L(B) | L(B) | L(B) | L(B) | L(B) | --- | OR | |
| 01U | 01U157 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U158 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U350 | | | --- | --- | --- | --- | --- | OR | OR | |
| 01U | 01U351 | EW-1 | | --- | --- | --- | --- | --- | OR | OR | |
| 01U | 01U352 | EW-2 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U353 | EW-3 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U354 | EW-4 | | --- | --- | --- | --- | --- | OR | OR | |
| 01U | 01U355 | EW-5 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U356 | EW-6 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U357 | EW-7 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U358 | EW-8 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U901 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U902 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | Including antimony |
| 01U | 01U903 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U904 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | Including antimony |
| **Operable Unit 2 - Site C Shallow Groundwater** | | | | | | | | | | | |
| 01U | 01U045 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U046 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U085 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U551 | EW-1 | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U552 | EW-2 | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U553 | EW-3 | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U561 | MW-1 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U562 | MW-2 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U563 | MW-3 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U564 | MW-4 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U565 | MW-5 | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U566 | MW-6 | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U567 | MW-7 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U568 | MW-8 | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U569 | MW-9 | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U570 | MW-10 | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U571 | MW-11 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U572 | MW-12 | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U573 | MW-13 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U574 | MW-14 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U575 | MW-15 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U576 | MW-16 | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| **Operable Unit 2 - Site I Shallow Groundwater** | | | | | | | | | | | |
| 01U | 01U064 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U631 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY 14 |
| 01U | 01U632 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U636 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U639 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U640 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U666 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U667 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | OR | abandoned FY14, replacement pending |

| Well Information | | | Notes | June 18 | June 19 | June 20 | June 21 | June 22 | Purpose For Monitoring(3) | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit | Well I.D. | Common Name | | | | | | | Water Quality | Water Level | |
| 01U | 482086 | I01MW | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 482087 | I05MW | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 482088 | I02MW | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 482089 | I04MW | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 482090 | I03MW | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| *Note: All of the Site I shallow groundwater wells were sealed in FY14. Following soil remediation under Building 502, only 01U667 was re-installed (with annual sampling).* | | | | | | | | | | | |
| **Operable Unit 2 - Site K Shallow Groundwater** | | | | | | | | | | | |
| 01U | 01U047 | | | L(A) | L(A) | L(A) | L(A) | L(A) | --- | 3.a | |
| 01U | 01U048 | | | L(A) | L(A) | L(A) | L(A) | L(A) | --- | 3.a | |
| 01U | 01U052 | | | L(A) | L(A) | L(A) | L(A) | L(A) | --- | 3.a | |
| 01U | 01U065 | | | L(A) | L(A) | L(A) | L(A) | L(A) | --- | 3.a | |
| 01U | 01U128 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 3.a | |
| 01U | 01U601 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U602 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U603 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 3.a | |
| 01U | 01U604 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U605 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U607 | | | L(A) | L(A) | L(A) | L(A) | L(A) | --- | 3.a | |
| 01U | 01U608 | | | L(A) | L(A) | L(A) | L(A) | L(A) | --- | --- | abandoned FY14, replacement pending |
| 01U | 01U609 | | | L(A) | L(A) | L(A) | L(A) | L(A) | --- | --- | abandoned FY14, replacement pending |
| 01U | 01U611 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | --- | --- | abandoned FY14, replacement pending |
| 01U | 01U612 | | | L(A) | L(A) | L(A) | L(A) | L(A) | --- | 3.a | |
| 01U | 01U613 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U615 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 3.a | |
| 01U | 01U616 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U617 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 3.a | |
| 01U | 01U618 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 3.a | |
| 01U | 01U619 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U620 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U621 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 3.a | |
| 01U | 01U624 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U625 | | | L(A) | L(A) | L(A) | L(A) | L(A) | --- | 3.a | |
| 01U | 01U626 | | | L(A) | L(A) | L(A) | L(A) | L(A) | --- | 3.a | |
| 01U | 01U627 | | | L(A) | L(A) | L(A) | L(A) | L(A) | --- | 3.a | |
| 01U | 01U628 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 482083 | K04-MW | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 3.a | |
| 01U | 482084 | K02-MW | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 482085 | K01-MW | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 03U | 03U621 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 3.a | |
| **Operable Unit 2 - Building 102 Shallow Groundwater** | | | | | | | | | | | |
| 01U | 01U048 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U578 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 01U | 01U579 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U580 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U581 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U582 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U583 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01U | 01U584 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01L | 01L581 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01L | 01L582 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01L | 01L583 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| 01L | 01L584 | | | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | Q,L(B) | OR | OR | |
| **Operable Unit 2 - Deep Groundwater (TGRS)** | | | | | | | | | | | |
| 03F | 03F302 | B1 | | | | | | | | | See Appendix A.2 |
| 03F | 03F303 | B2 | (5) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |

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| Well Information | | | Notes | June 18 | June 19 | June 20 | June 21 | June 22 | Purpose For Monitoring[3] | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit | Well I.D. | Common Name | | | | | | | Water Quality | Water Level | |
| 03F | 03F304 | B3 | | | | | | | | | See Appendix A.2 |
| 03F | 03F305 | B4 | | | | | | | | | See Appendix A.2 |
| 03F | 03F306 | B5 | | | | | | | | | See Appendix A.2 |
| 03F | 03F307 | B6 | | | | | | | | | See Appendix A.2 |
| 03F | 03F308 | B7 | (5) | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03F | 03F312 | B11 | (5) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| 03F | 03F319 | B13 | | | | | | | | | See Appendix A.2 |
| 03U | 03U001 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U002 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U003 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U004 | | | --- | --- | --- | --- | --- | --- | --- | Abandoned FY13 |
| 03U | 03U005 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U007 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | Background | 1.a | |
| 03U | 03U008 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U009 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | Background | 1.a | |
| 03U | 03U010 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U011 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U012 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U013 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U014 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U015 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U016 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U017 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U018 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U019 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U020 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U021 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U022 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U023 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U024 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U025 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U026 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U027 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U028 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U029 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U030 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U031 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 03U | 03U032 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U075 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 03U | 03U076 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 03U | 03U077 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U078 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U079 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U082 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U083 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U084 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 03U | 03U087 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U088 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U089 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U090 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U092 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U093 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| 03U | 03U094 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U096 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U097 | | | --- | --- | --- | --- | --- | --- | --- | |

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| Well Information | | | Notes | June 18 | June 19 | June 20 | June 21 | June 22 | Purpose For Monitoring(3) | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit | Well I.D. | Common Name | | | | | | | Water Quality | Water Level | |
| 03U | 03U099 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| 03U | 03U111 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U112 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U113 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U114 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U121 | | | --- | --- | --- | --- | --- | --- | --- | |
| 03U | 03U129 | | | --- | --- | --- | --- | --- | --- | --- | |
| 03U | 03U301 | SC1 | | | | | | | | | See Appendix A.2 |
| 03U | 03U314 | SC2 | | | | | | | | | See Appendix A.2 |
| 03U | 03U315 | SC3 | (5) | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U316 | SC4 | (5) | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U317 | SC5 | | | | | | | | | See Appendix A.2 |
| 03U | 03U521 | | | --- | --- | --- | --- | --- | --- | --- | |
| 03U | 03U647 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 03U | 03U648 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 03U | 03U658 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY13 |
| 03U | 03U659 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U671 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U672 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14, replaced by 03U677 |
| 03U | 03U674 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 03U | 03U675 | | | --- | --- | --- | --- | --- | --- | --- | |
| 03U | 03U676 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 03U | 03U677 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | constructed FY14 |
| 03U | 03U701 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U702 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U703 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U704 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U705 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U706 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U707 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U708 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| 03U | 03U709 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U710 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U711 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U715 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U716 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03U | 03U801 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| 03U | 03U803 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U804 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U805 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03U | 03U806 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| 03U | 519288 | E101-MW | | --- | --- | --- | --- | --- | --- | --- | |
| 03U | 519289 | E102-MW | | --- | --- | --- | --- | --- | --- | --- | |
| 03U | 519290 | E103-MW | | --- | --- | --- | --- | --- | --- | --- | |
| 03M | 03M001 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03M | 03M002 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03M | 03M003 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03M | 03M004 | | | --- | --- | --- | --- | --- | --- | --- | Abandoned FY13 |
| 03M | 03M005 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03M | 03M007 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03M | 03M010 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03M | 03M012 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03M | 03M013 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03M | 03M017 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03M | 03M020 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |

| Well Information | | | Notes | June 18 | June 19 | June 20 | June 21 | June 22 | Purpose For Monitoring[3] | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit | Well I.D. | Common Name | | | | | | | Water Quality | Water Level | |
| 03M | 03M713 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03M | 03M802 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| 03M | 03M806 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| 03L | 03L001 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03L | 03L002 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03L | 03L003 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03L | 03L004 | | | --- | --- | --- | --- | --- | --- | --- | Abandoned FY13 |
| 03L | 03L005 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03L | 03L007 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | Background | 1.a | |
| 03L | 03L010 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03L | 03L012 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03L | 03L013 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03L | 03L014 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03L | 03L017 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03L | 03L018 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03L | 03L020 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03L | 03L021 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03L | 03L027 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 03L | 03L028 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 03L | 03L029 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 03L | 03L077 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03L | 03L078 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03L | 03L079 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03L | 03L080 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03L | 03L081 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03L | 03L084 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| 03L | 03L113 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| 03L | 03L802 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| 03L | 03L806 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| 03L | 03L809 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| 03L | 03L833 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| PC | 04U001 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| PC | 04U002 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| PC | 04U003 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| PC | 04U007 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | Background | 1.a | |
| PC | 04U012 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| PC | 04U020 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| PC | 04U027 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| PC | 04U077 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| PC | 04U510 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | Background | 1.a | |
| PC | 04U701 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| PC | 04U702 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| PC | 04U708 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| PC | 04U709 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| PC | 04U711 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| PC | 04U713 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| PC | 04U714 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| PC | 04U802 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| PC | 04U806 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| PC | 04U833 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| J | 04J077 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| J | 04J702 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| J | 04J708 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| J | 04J713 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| J | 04J714 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |

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| Well Information | | | Notes | June 18 | June 19 | June 20 | June 21 | June 22 | Purpose For Monitoring[3] | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit | Well I.D. | Common Name | | | | | | | Water Quality | Water Level | |
| PC/J | PJ#003 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| PC/J | PJ#027 | | | --- | --- | --- | --- | --- | --- | --- | abandoned FY14 |
| PC/J | PJ#309 | B8 | | | | | | | | | See Appendix A.2 |
| PC/J | PJ#310 | B9 | | | | | | | | | See Appendix A.2 |
| PC/J | PJ#311 | B10 | (5) | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| PC/J | PJ#313 | B12 | (5) | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 1.a | |
| PC/J | PJ#802 | | | L(A) | --- | L(A) | --- | L(A) | --- | 1.a | |
| PC/J | PJ#806 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 1.a | |
| --- | Staff Gauges | | | L(A) | --- | L(A) | --- | L(A) | --- | --- | |
| **Operable Unit 2 - Unit 1 Wells** | | | | | | | | | | | |
| 01U | 01U035 | | | --- | --- | --- | --- | --- | --- | --- | |
| 01U | 01U043 | | | --- | --- | --- | --- | --- | --- | --- | |
| 01U | 01U044 | | | --- | --- | --- | --- | --- | --- | --- | |
| 01U | 01U045 | | | --- | --- | --- | --- | --- | --- | --- | |
| 01U | 01U046 | | | --- | --- | --- | --- | --- | --- | --- | |
| 01U | 01U060 | | | --- | --- | --- | --- | --- | --- | --- | |
| 01U | 01U072 | | | --- | --- | --- | --- | --- | --- | --- | |
| 01U | 01U085 | | | --- | --- | --- | --- | --- | --- | --- | |
| **Operable Unit 3** | | | | | | | | | | | |
| 03U | 03U673 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | |
| 03M | 03M848 | | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 2.a | |
| 03L | 03L673 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | |
| 03L | 03L832 | | | L(A) | --- | L(A) | --- | L(A) | --- | 2.a | |
| 03L | 03L848 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | |
| 03L | 03L854 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | |
| 03L | 03L859 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | |
| 03L | 03L860 | | | L(A) | --- | L(A) | --- | L(A) | --- | 2.a | |
| 03L | 03L861 | | | --- | --- | --- | --- | --- | --- | --- | Abandoned FY06 |
| 03L | 476837 | MW15H | | --- | --- | --- | --- | --- | --- | --- | |
| PC | 04U414 | 414U4 | (6) | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | |
| PC | 04U673 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | |
| PC | 04U832 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | Contingency Action for FY08 |
| PC | 04U845 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | Contingency Action for FY08 |
| PC | 04U848 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | |
| PC | 04U851 | | (6) | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | |
| PC | 04U852 | | | --- | --- | --- | --- | --- | --- | --- | Abandoned FY09 |
| PC | 04U854 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | |
| PC | 04U859 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | |
| PC | 04U860 | | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | |
| PC | 04U861 | | | --- | --- | --- | --- | --- | --- | --- | Abandoned FY06 |
| PC | 04U863 | 323U4 | | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | Q,L(A) | OR | 2.a | |
| PC | 04U864 | 324U4 | | --- | --- | --- | --- | --- | --- | --- | Abandoned FY09 |
| PC | 04U865 | 325U4 | | --- | --- | --- | --- | --- | --- | --- | Abandoned FY09 |
| PC | 04U866 | 326U4 | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | |
| PC | 520931 | NBM #13 | | --- | --- | --- | --- | --- | --- | --- | Abandoned FY07 |
| J | 04J864 | 324 J | | --- | --- | --- | --- | --- | --- | --- | Abandoned FY09 |
| J | 04J866 | 326 J | | Q,L(A) | --- | Q,L(A) | --- | Q,L(A) | OR | 2.a | |
| **Well Inventory** | | | | | | | | | | | |
| *(Entries under "Notes" refer to the well inventory category)* | | | | | | | | | | | |
| --- | 200180 | Town & Country Golf Course | 1b | --- | --- | Q(B) | --- | --- | Well Inventory | --- | 2279 Marshal Ave |
| --- | 200522 | Windsor Green | 1b | --- | --- | Q(B) | --- | --- | Well Inventory | --- | Silver Lake Rd & Cty Rd E |
| --- | 200523 | Windsor Green | 1b | --- | --- | Q(B) | --- | --- | Well Inventory | --- | Silver Lake Rd & Cty Rd E |
| --- | 234338 | Bosell | 1b | --- | --- | Q(B) | --- | --- | Well Inventory | --- | 1575 14th Ave NW |
| --- | 234421 | BioClean (BioChem) | 1b | --- | --- | Q(B) | --- | --- | Well Inventory | --- | 2151 Mustang Dr |
| --- | 234544 | R&D Systems | 1b | --- | --- | Q(B) | --- | --- | Well Inventory | --- | 2201 Kennedy St NE |

| Well Information | | | Notes | June 18 | June 19 | June 20 | June 21 | June 22 | Purpose For Monitoring[3] | | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Unit | Well I.D. | Common Name | | | | | | | Water Quality | Water Level | |
| --- | 249632 | Montzka, Harold | 1b | --- | --- | Q(B) | --- | --- | Well Inventory | --- | 2301 N Upland Crest NE |
| --- | 433298 | Town & Country Golf Course | 1b | --- | --- | Q(B) | --- | --- | Well Inventory | --- | 2279 Marshall Ave |
| --- | 509052 | Shriners Hospital | 1b | --- | --- | Q(B) | --- | --- | Well Inventory | --- | 2025 E River Rd |
| --- | 537801 | Midway Industrial | 1b | --- | --- | Q(B) | --- | --- | Well Inventory | --- | 4759 Old Hwy 8 |
| --- | 756236 | Alcan | 1c | --- | --- | Q(B) | --- | --- | Well Inventory | --- | 150 26th Ave SE |
| --- | 200176 | Waldorf Paper Products | 2b | --- | --- | Q(B) | --- | --- | Well Inventory | --- | 2236 Myrtle Ave |
| --- | 249007 | Walton, Toni | 2b | --- | --- | Q(B) | --- | --- | Well Inventory | --- | 4453 Old Hwy 10 |
| --- | S00002 | Midland Hills Country Club | 2b | --- | --- | Q(B) | --- | --- | Well Inventory | --- | 2001 N Fulham St |
| --- | 200076 | Old Dutch Foods, Inc | 2c | --- | --- | Q(B) | --- | --- | Well Inventory | --- | 2375 Terminal Rd |
| --- | 236439 | Waldorf Paper Products | 2c | --- | --- | Q(B) | --- | --- | Well Inventory | --- | 2250 Wabash Ave |

**General Notes:**
The next major sampling event for Well Inventory will be in June 2020 (conducted every 4 years)
All of the Site I shallow groundwater wells were sealed in FY14.

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| Location | Sampling Frequency | Parameters |
|---|---|---|
| **OU1: Deep Groundwater** [1] | | |
| ● Extraction Wells NBM#4, #14, and #15 | - Monthly | - Pumping Volumes |
| (and also NBM#3, #5, and #6) | - Monthly | - Water Quality [2] |
| ● PGAC Effluent | - Monthly | - Water Quality [2] |
| | | |
| **OU2: Site K Remedial Action** | | |
| ● Extracted Groundwater | - Monthly | - Pumping Volume |
| ● Treatment System Effluent [Outfall 391 (010)] | - See Appendix A.3 | - See Appendix A.3 |
| | | |
| **OU2: TCAAP Groundwater Recovery System (TGRS)** | | |
| ● Extraction Wells | - Monthly | - Pumping Volumes |
| | - Semi-Annually | - Water Levels |
| | - Semi-Annually | - Water Quality [2] |
| ● Treatment System Influent | - Monthly | - Pumping Volumes |
| | - Monthly | - Water Quality [2] |
| ● Treatment System Effluent | - Monthly | - Water Quality [2] |

**Footnotes:**

1. Performed by the City of New Brighton using their Sampling and Analysis Plan (subject to the remedy time-out for the 1,4-dioxane issue).
2. The required analyte list for each specific site is presented in Appendix A.4.

| Analysis | Analytical Method | Units | Site K Effluent | Site C Surface Water Locations | | |
|---|---|---|---|---|---|---|
| | | | (Outfall 010) | (SW-5) | (SW-6) | (NE Wetland) |
| Flow Rate | --- | gal/day | Continuous | | | |
| Total Flow | --- | gal | M | | | |
| pH | (field) | (pH) | Q | | | |
| Hardness | (field) | (pH) | Q | | | |
| Cyanide | 9012A | mg/L | Q | | | |
| Copper | 6020 | mg/L | Q | | | |
| Lead | 6020 | mg/L | Q | A | A | A |
| Mercury | 7470A | mg/L | Q | | | |
| Phosphorus (Total) | 365.4 | mg/L | Q | | | |
| Silver | 6020 | mg/L | Q | | | |
| Zinc | 6020 | mg/L | Q | | | |
| Trichloroethene | 8260C | mg/L | Q | | | |
| 1,1-Dichloroethene | 8260C | mg/L | Q | | | |
| 1,1-Dichloroethane | 8260C | mg/L | Q | | | |
| Cis-1,2-Dichloroethene | 8260C | mg/L | Q | | | |
| Trans-1,2-Dichloroethene | 8260C | mg/L | Q | | | |
| Vinyl Chloride | 8260C | mg/L | Q | | | |
| 1,2-Dichloroethane | 8260C | mg/L | Q | | | |

**Acronyms and Abberviations:**
A = Annually in June
M = Measurement required once per month
mg/L = milligrams per liter
Q = Analysis required once per quarter

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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 2018,1,4-dioxane (Method 522) was also analyzed for at all summer VOC sampling locations with the exception of Site A. 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 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 6020

**Table D-1**
**Remedial Production Ranges for Normal Operation**
**(Effective January 2008)**

| NBCGRS Well | Estimated Physical Capacity Range | | | Remedial Production Range | | Flow Rate Equivalents (24-hr Production Basis) | |
|---|---|---|---|---|---|---|---|
| | Normal Individual Low (gpm) | Normal Individual High (gpm) (See Note 1) | Peak Combined High (gpm) (See Note 1) | Lower Limit (MGD) | Upper Limit (MGD) | Lower Limit (gpm) | Upper Limit (gpm) |
| 3 (See Note 2) | 300 | 600 | 400 | 0.000 | 0.576 | 0 | 400 |
| 4 (See Note 2) | 500 | 1,100 | 900 | 1.152 | 1.296 | 800 | 900 |
| 3 + 4 (See Note 2) | 800 | n/a | 1,300 | 1.152 | 1.872 | 800 | 1,300 |
| 5 | 400 | 850 | 750 | 0.864 | 1.080 | 600 | 750 |
| 6 | 400 | 850 | 750 | 0.000 | 1.080 | 0 | 750 |
| 5 + 6 (See Note 3) | 800 | 1,700 | 1,500 | 0.864 | 2.160 | 600 | 1,500 |
| 14 | 500 | 1,200 | 1,000 | 0.000 | 1.440 | 0 | 1,000 |
| 15 | 500 | 1,200 | 1,000 | 1.152 | 1.440 | 800 | 1,000 |
| TOTAL WELL CAPACITY | 2,600 | n/a | 4,800 | **3.168** | **6.912** | **2,200** | **4,800** |
| TREATMENT CAPACITY | | 3,200 | 5,000 | | | | |
| NBCGRS SYSTEM LIMIT | | 3,200 | 4,800 | | | | |

NOTES:

1. During peak production periods with all wells running, individual well capacities are limited by interference, high drawdown, and high system head losses
2. While shown individually to illustrate normal operational intent, enforceable target is for combined Well 3 plus Well 4 since the wells are located in close proximity and effectively operate as a single point source. Wells 3 and 4 can be used interchangeably to produce total daily target.
3. While shown individually to illustrate normal operational intent, enforceable target is for combined Well 5 plus Well 6 since the wells are located in close proximity and effectively operate as a single point source. Wells 5 and 6 can be used interchangeably to produce total daily target.

15 FEB 2008
Michael R. Fix
Twin Cities Army Ammunition Plant

2/15/08
Grant M. Wyffels
City of New Brighton

Table D-2
Alternate Remedial Production Ranges for Contingent Events
(Effective January 2008)

| Event | Normal Operation | | | Well 3 and/or 4 Down | | | Well 5 and/or 6 Down | | | Well 14 Down | | | Well 15 Down | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Well / Pair | Priority | Lower Limit (MGD) | Upper Limit (MGD) | Priority | Lower Limit (MGD) | Upper Limit (MGD) | Priority | Lower Limit (MGD) | Upper Limit (MGD) | Priority | Lower Limit (MGD) | Upper Limit (MGD) | Priority | Lower Limit (MGD) | Upper Limit (MGD) |
| 3 + 4 | 2 | 1.152 | 1.872 | NA | **0.000** | **0.000** | 2 | 1.440 | 1.872 | 2 | 1.152 | 1.872 | 1 | 1.440 | 1.872 |
| 5 + 6 | 3 | 0.864 | 2.160 | 2 | 1.728 | 2.160 | NA | **0.000** | **0.000** | 3 | 0.864 | 2.160 | 2 | 1.728 | 2.160 |
| 14 | 4 | 0.000 | 1.440 | 3 | 1.152 | 1.440 | 3 | 1.152 | 1.440 | NA | **0.000** | **0.000** | 3 | 0.720 | 1.152 |
| 15 | 1 | 1.152 | 1.440 | 1 | 1.152 | 1.440 | 1 | 1.152 | 1.440 | 1 | 1.152 | 1.440 | NA | **0.000** | **0.000** |
| Total | | 3.168 | 6.912 | | 4.032 | 5.040 | | 3.744 | 4.752 | | 3.168 | 5.472 | | 3.888 | 5.184 |

# APPENDIX B

## FY 2018 Well Index

## Purpose

The purpose of the well index is to identify all wells, both past and present, that:

- Have been used to collect water quality data or groundwater elevations in regard to work at the New Brighton/Arden Hills Superfund Site (including private wells and offsite monitoring wells sampled by the Army); or
- Are owned by the Army; or
- Are located within the boundaries of OU2 (the former TCAAP property)

In addition, the well index aims to identify the current status (in use, sealed, abandoned, etc.) of these wells.

The well index does not include wells identified in the Well Inventory Update (Appendix E) that have not been sampled by the Army at any point in history.

The list contained in the well index is by no means a compilation of all available data. Other data may exist regarding an individual well that was not discovered or searched out during the course of this effort. The list is intended to be a reasonable effort to gather the data concerning the wells that is readily available. Therefore, if additional data is desired concerning a certain well, it may be possible to search out and obtain that data from records not searched during the course of the investigation.

## Background

OU2 and OU1/OU3 wells have been installed in four hydrogeologic units beneath the site. These hydrogeologic units, as referred to in this report, are conceptually illustrated on Figure B-1 and are described below:

Unit 1: This unit, referred to as the Fridley Formation, consists of alluvium and lacustrine deposits above the Twin Cities Formation (Unit 2). The formation is made up of fine- to medium-grained sand and clayey silt, which acts as an unconfined aquifer with an estimated hydraulic conductivity of 8.3 x $10^{-3}$ cm/sec (International Technology Corp. 1992). The Unit 1 deposits are discontinuous at the New Brighton/Arden Hills Superfund Site (NB/AH Site) and range in thickness from zero to 50 feet. They are predominantly limited to the north, east, and southwest portions of the site. Groundwater in Unit 1 is also discontinuous.

Unit 2: Known as the Twin Cities Formation, Unit 2 consists of Quaternary aged glacial till and, similar to Unit 1, is discontinuous at the NB/AH Site. Unit 2 is generally regarded as an aquitard to vertical migration of groundwater; however, sand and gravel lenses may contain water.

Unit 3: This unit consists primarily of the Quaternary aged Hillside Sand Formation, which is continuous beneath OU2. Near the center of OU2, the Hillside Sand Formation is overlain by the Arsenal Sand, which forms a kame. There is no distinct lithologic contact between the Hillside Sand and the Arsenal Sand, and both are considered included in Unit 3. Unit 3 ranges in thickness from 25 to 450 feet. For monitoring purposes, the Unit 3 aquifer thickness has been arbitrarily subdivided into thirds designated as upper, middle, and lower.

Unit 4: This unit consists collectively of bedrock from the Prairie du Chien Group and Jordan Formation (Ordovician and Cambrian periods, respectively). For monitoring purposes, the Prairie du Chien Group is referred to as Upper Unit 4, while the Jordan Formation is Lower Unit 4. The Jordan Formation varies from fine- to coarse-grained quartz sandstone. The Prairie du Chien Group in the NB/AH Site area consists of a finely crystalline dolomite of the Oneota Formation, as well as quartz sandstone and dolomite members of the Shakopee Formation. A more detailed description of the bedrock geology can be found in the Remedial Investigation Report (Argonne National Laboratory, 1991).

In order to identify the hydrogeologic unit in which each well is completed, the United States Army Environmental Center (USAEC), formerly the United States Army Toxic and Hazardous Materials Agency (USATHAMA), developed a standardized identification system for wells at the NB/AH Site (referred to as the Army Designation or IRDMIS number). Well designations consist of six characters, such as 03U093. The first two characters represent the hydrogeologic unit in which the well is completed, as follows:

| | | |
|---|---|---|
| 01 | - | Unit 1 |
| 03 | - | Unit 3 |
| 04 | - | Unit 4: Prairie du Chien Group <u>or</u> Jordan Formation |
| PJ | - | Unit 4: Prairie du Chien Group <u>and</u> Jordan Formation |

The third character represents the relative position of the well screen or open hole within the specified hydrogeologic unit, as follows:

| | | |
|---|---|---|
| U | - | upper portion |
| M | - | middle portion |
| L | - | lower portion |
| J | - | Jordan Sandstone |
| F | - | fully penetrating Unit 3 |
| # | - | open hole (total or partial thickness) |

The remaining three characters represent the well number, as follows:

| | |
|---|---|
| 001 thru 500 | USAEC wells and additional wells installed by others adjacent to an existing well with the 001-500 designation. |
| 501 thru 600 | NB/AH Site wells. |
| 601 thru 800 | OU2 Alliant Techsystems wells. |
| 801 thru 999 | OU1/OU3 Alliant Techsystems wells. |

OU1/OU3 wells installed by parties other than USAEC, the Army, or Alliant Techsystems are designated by their Minnesota unique number. Table B-1 is sorted by unique number, but includes the IRDMIS number and any other name(s) the wells may have. The well type in this table is abbreviated as follows:

| | | |
|---|---|---|
| UN | - | Unknown |
| MUNI | - | Municipal |
| MON | - | Monitoring |
| DOM | - | Domestic |
| IND | - | Industrial |
| P.S. | - | Public Supply |
| COM | - | Commercial |
| IRR | - | Irrigation |
| ABAND | - | Abandoned |
| PIEZ. | - | Piezometer |
| REM | - | Remedial |

In recent years, as property transfer of the remaining land that is still identified as TCAAP has progressed (and is now nearing completion), it became apparent that an updated well index with more information concerning each well would be of importance to pass on to future land owners. In addition, as groundwater quality continues to improve and contaminant plumes continue to shrink in vertical and horizontal extent, the index will function as a check to make sure that all Army owned wells are sealed and that all traces of the wells are removed from the area.

The FY 2017 Appendix B Table B-1 shows the most current well index. The well index continues to be a work in progress. Additional records regarding individual wells continue to become available as new wells are drilled and older unneeded wells are sealed and removed.

Figures B-2 and B-3 show the location of wells identified in Table B-1. With a known well name, the location of that well can be identified using the "Edit, Find" or "Edit, Search" function and then typing in the desired well name, which will highlight this well name on the figure.

The Appendix B Attachment contains available documentation for each well, including boring logs (if available). The attachment is sorted by Minnesota unique number. To view the information concerning a well, click on the desired well number in the bookmarks.

## FY 2018 Update

No new wells were added to the database.

## Ongoing Efforts to Update Appendix B

- The well index, Table B-1, has been compared with the wells identified in Appendix D, which contains historical water quality and groundwater elevation data. A number of wells were identified in Appendix D that do not exist in the well index. Ongoing efforts will be made to add information, as possible, concerning the location and status of these wells to the well index in Appendix B.

- The repository at the TCAAP office will continue to be utilized to obtain additional well information, where possible.

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Appendix B Table B-1 contains a summary of all information available concerning a certain well, and is sorted by Minnesota unique well number.

To search for detailed records regarding a well, open the appropriate file below and select the bookmark corresponding to the Minnesota unique well number of the well being searched. If the unique number is unknown for a well, it is included and sorted in the Appendix B Attachment by IRDMIS name or OTHER. Records included in the Appendix B Attachment that may or may not be available for each well include:

- The County Well Index well log,
- Access agreement(s),
- Correspondence related to the well,
- Field notes and boring logs,
- Well construction diagrams,
- Documentation of well modifications, and
- Sealing records.

## Appendix B Attachment

1. Wells Numbered 104772 through 194772
2. Wells Numbered 200070 through 225906
3. Wells Numbered 231741 through 235753
4. Wells Numbered 236066 through 257443
5. Wells Numbered 265735 through 482709
6. Wells Numbered 500248 through IRDMIS and OTHER

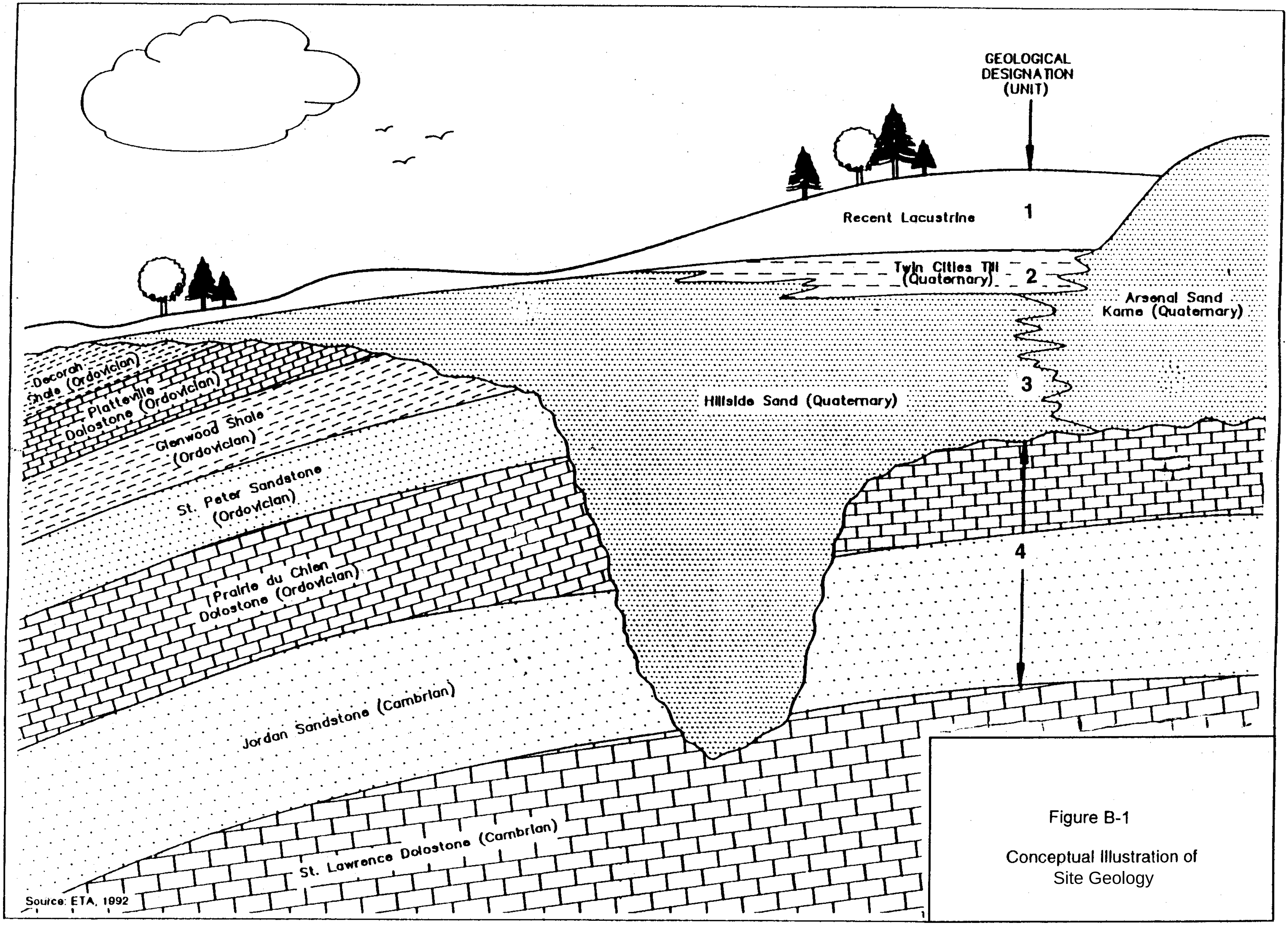


Figure B-1

Conceptual Illustration of Site Geology


ANNUAL PERFORMANCE REPORT

OU1 & OU3 Well Location

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Figure B-2


ANNUAL PERFORMANCE REPORT

OU2 Well Location

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Figure B-3

# APPENDIX C

## FY 2018 Data Collection and Management

## 1.0 INTRODUCTION

A groundwater monitoring program was initiated in January 1984 to obtain water level and water quality data at OU1, OU2 and OU3. Each year has been divided into quarters with each quarter assigned a number. Accordingly, FY 2018 was comprised of Quarter 137 (October through December), Quarter 138 (January through March), Quarter 139 (April through June), and Quarter 140 (July through September). Water sampling, water level measurements, and laboratory analyses were conducted in accordance with the “Quality Assurance Project Plan (QAPP) for Performance Monitoring” (Wenck, Revision 15, February 15, 2016), which covers all sites.

Prior to November 1, 2001, data collected from OU1, OU2 and OU3 was stored in the U.S. Army Environmental Command (USAEC) Installation Restoration Data Management Information System (IRDMIS). USAEC replaced the IRDMIS System on November 1, 2001, with a new system, the Environmental Restoration Information System (ERIS), which incorporated all the data that had previously been entered into IRDMIS. The Army has continued to enter data into ERIS; however, ERIS is not being used as the primary database for the OU1, OU2 and OU3 data. The historical databases in Appendix D.1 are the primary databases.

## 2.0 GROUNDWATER LEVELS AND GROUNDWATER QUALITY

### 2.1 Data Collection and Management

Groundwater level and groundwater quality data were collected in accordance with the FY 2018 Annual Monitoring Plan (Appendix A), which established the monitoring responsibilities for both the Army and Orbital ATK (formerly Alliant Techsystems). In response to the discovery of 1,4-dioxane in the area, a "major" sampling event was conducted in June of FY 2016 as indicated in the FY 2016 Annual Monitoring Plan. The sampling event for FY 2016 would otherwise have been a "minor" event. Additionally, the Army conducted a "major" well inventory sampling event in FY 2016. Due to these changes, the monitoring plan for future years was modified accordingly to include a "major" well inventory sampling event once every four years and maintain a biennial trend of "major" sampling events at all other sites. The FY 2018 was therefore a major sampling event. All FY 2018 sampling included 1,4-dioxane analyses at all VOC sampling locations, except as stated in Appendix A.4.

Water level monitoring and water sampling were conducted by JV for the Army and by GHD (formerly CRA) for Orbital ATK. Laboratory analysis of VOC samples from all sites was performed by ALS Laboratory Group, Salt Lake City, Utah. Laboratory analysis of 1,4-dioxane samples from all sites was performed by ALS Laboratory Group, Middletown, Pennsylvania. Appendix A.4 contains lists of required analytes, as referenced by the monitoring plans in Appendix A. The lists are site-specific, based on the chemicals of concern. At sites other than Site C, halogenated volatile organic compounds are the parameters of primary interest, though some of the sites (or specific wells at a site) are sampled for aromatic volatile organic compounds and/or metals. At Site C, dissolved lead is the only chemical of concern. Appendix C.2 presents deviations from the FY 2018 Annual Monitoring Plan.

Data verification and validation was conducted in accordance with procedures and requirements outlined in the QAPP and Addendum #1. Data qualifiers assigned to data through data verification and/or data validation appear in the data tables included within the individual sections of this report, with qualifier definitions given in footnotes to the tables. Data qualifiers are also included in the historical databases (Appendix D.1), which include a database of organic water quality, a database of inorganic water quality (excluding Site C), and a database for Site C water quality (for both groundwater and surface water). Data verification was performed by JV for the JV-collected data and by GHD for the GHD-collected data. Data validation was performed by Diane Short & Associates for the JV-collected data and by GHD for the GHD-collected data. Data verification and validation information from the two sampling firms was compiled into quarterly Data Usability Reports (DURs) that were submitted to the Minnesota Pollution Control Agency (MCPA) and United States Environmental Protection Agency (USEPA) for review. If any MPCA/USEPA-requested revisions were necessary, a final DUR was resubmitted. The final MPCA/USEPA approval letter has not yet been received for the FY 2018 DURs, but will be included in Appendix C.3.

For water level measurements, the depth to water from the surveyed top of the well casing elevation was measured. Groundwater elevations were calculated by subtracting the depths to water from the surveyed top of the well casing elevations and are included in the historical water elevation database (Appendix D.1).

## 2.2 Groundwater Elevation Contour Maps

The most extensive water level monitoring event performed during FY 2018 was in June and July (Quarter 139 and 140). This data was used to prepare groundwater elevation contour maps for deep groundwater at OU1/OU3 and OU2 (OU3 is shown on the same figure as OU1 in the OU1 section of this report), and for shallow groundwater at Sites A, C, K and Building 102. Groundwater elevation contour maps are included within the individual sections of this report. There is not a comprehensive water level event for shallow groundwater at Site I, given the well sealing that has been done.

## 2.3 Groundwater Quality Contour Maps and Cross-Sections

The most extensive sampling event performed during FY 2018 was in June and July (Quarter 139 and 140). This data were used to prepare updated groundwater quality isoconcentration contour maps and/or cross-sections for deep groundwater at OU1/OU3 and OU2 (OU3 is shown with OU1 on Section 3 Figures) and shallow groundwater at Site A, Site C, Site K and Building 102. Site I is excluded, given the well sealing that has been done. Contour maps were generated by hand, based on the observed contaminant concentrations and the extent of past site contamination. These maps are included in the Figures Section of this report.

For deep groundwater at OU1/OU3 and OU2, isoconcentration maps and cross-sections are provided for trichloroethene and 1,4-dioxane, since these are the primary chemicals of concern on a concentration basis. These isoconcentration maps include individual maps for Upper and Lower Unit 3 Combined, Upper Unit 4, and Lower Unit 4. To complement the isoconcentration maps, cross-sections were prepared to illustrate the vertical distribution of trichloroethene and 1,4-dioxane. One section line passes through the source area at Site G in OU2 and follows the north plume (OU1) through well 582628 (NBM#15) of the New Brighton Contaminated Groundwater Recovery System (NBCGRS). A second section line follows the OU2/OU1 boundary. A third section lines passes through the source area at Site I and follows the north plume (OU1) south to well 04U852, drawn further east but running roughly parallel with the first section line.

Contaminant concentrations for Middle Unit 3 wells and wells that fully penetrate Unit 3 (03F) (including any recovery wells that fully penetrate Unit 3 and that are being sampled as a monitoring well) are shown in parentheses on the Lower Unit 3 isoconcentration maps, but were not used for contouring purposes except when no Lower Unit 3 wells are located in the vicinity.

For Site A shallow groundwater, an isoconcentration map is provided for cis-1,2-dichloroethene, since this is the chemical of concern with the largest aerial extent at Site A, and for tetrachloroethene, which illustrates the source area and contaminant degradation. Cross-sections were also prepared for Site A to illustrate the vertical distribution of cis-1,2-dichloroethene. The isoconcentration maps for Site A were prepared only for Unit 1, since this is the only contaminated aquifer.

For Site C shallow groundwater, an isoconcentration map is provided for dissolved lead, since this is the only chemical of concern at Site C. Results for surface water monitoring are also shown on the same map to show impacts to surface water are not occurring as a result of the shallow groundwater contamination. Cross-sections were also prepared for Site C to illustrate the vertical distribution of dissolved lead. The isoconcentration map for Site C was prepared only for Unit 1, since this is the only contaminated aquifer.

For Site K shallow groundwater, an isoconcentration map is provided for trichloroethene, since this is the primary chemical of concern on a concentration basis. The isoconcentration map for Site K was prepared only for Unit 1, since this is the only contaminated aquifer.

For Building 102 shallow groundwater, a concentration map is provided for vinyl chloride, since this is the chemical of concern that has historically had the largest aerial extent at Building 102, and for trichloroethene and cis-1,2-dichloroethene, to illustrate the source area and contaminant degradation. A cross-section was also prepared for Building 102 to illustrate the vertical distribution of vinyl chloride. The isoconcentration maps for Building 102 were prepared only for Unit 1, since this is the only contaminated aquifer.

Contaminant concentrations for recovery wells that are actively pumping are shown in parentheses on the isoconcentration maps. These values were considered, but were generally not used alone to prepare the isoconcentration contours. Concentrations of recovery wells generally represent an average contaminant value for all groundwater being drawn to the well; hence, the concentrations do not necessarily represent a discrete location or depth. Contaminant concentrations for recovery wells that are not actively pumping are fully utilized for purposes of contouring.

## All Shallow and Deep Groundwater VOC Sites

*June 2018:* At all well locations where volatile organic compound (VOC) samples were scheduled to be collected (with the exception of Site A), samples for 1,4-dioxane were also collected at the same time, as requested by the USEPA and MPCA, in accordance with Quality Assurance Project Plan (QAPP) Addendum #1 (Wenck, May 21, 2015).

*July & August 2018:* The June 2018 sampling event carried over from to July and August 2018 due to scheduling conflicts.

## OU1: Deep Groundwater

*July 2018:*

Cloverpond: The well was not operational and could not be sampled.

Honeywell: The well was not operational and could not be sampled. An alternate well was documented on location but was not sampled during the 2018 sampling event due to access issues.

## OU2: Site A Shallow Groundwater

*July 2018:*

01U108: An obstruction prevented the sampling pump from being deployed in the well; therefore, the well could not be sampled.

01U350: Sampled as an alternative to well 01U108.

## OU2: Site K Shallow Groundwater

*June 2018:*

01U608: The well was intended to be reinstalled in 2017, but reinstallation was pushed back due to delays associated with redevelopments of the Site; therefore, the well could not be sampled.

01U609: The well was intended to be reinstalled in 2017, but reinstallation was pushed back due to delays associated with redevelopments of the Site; therefore, the well could not be sampled.

01U611: The well was intended to be reinstalled in 2017, but reinstallation was pushed back due to delays associated with redevelopments of the Site; therefore, the well could not be sampled.

01U667: The well was intended to be reinstalled in 2017, but reinstallation was pushed back due to delays associated with redevelopments of the Site; therefore, the well could not be sampled.

# APPENDIX D

## Comprehensive Groundwater Quality and Groundwater Level Databases

**Appendix D.1**
**Comprehensive Groundwater Quality and Groundwater Level Databases FY 2018**
**FY 2017 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

The historical groundwater databases are located on this CD in a folder named Appendix D.1. This folder contains four Microsoft Excel files:

| File | Contents |
|---|---|
| Compelev_FY18 | Groundwater elevations |
| Comporwq_FY18 | Groundwater quality: organic data |
| Compinwq_FY18 | Groundwater quality: inorganic data (excluding Site C) |
| Site C wq_FY18 | Groundwater quality: inorganic data (Site C only) |

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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<br>abandoned | 04U673 | 04U843 | 04U877 |
| 03L848 | 04U832 | 04U833 | 206688<br>out of service |
| 03L673 | 04U845 | 04U846 | 04U849 |
| 03L833 | 04U854 | 04U861<br>abandoned | 04U821 |
| 03L859 | 04U859 | 409549 | 191942<br>abandoned |

## Group 3 ** – Downgradient Sentinel

| | | | |
|---|---|---|---|
| 04U871 | 04U875 | 04U851 | |

## Group 4 – Lateral Sentinel

| | | | |
|---|---|---|---|
| 03U831<br>abandoned | 03L846 | 409556 | 409548 |
| 03U811 | 03L832 | 04U855 | 04U839 |
| 03U804 | 03L861<br>abandoned | 04U879 | 04U838 |
| 03U673 | 03L854 | 04U860 | 04U848 |
| 03U672<br>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 abandoned | 409597 abandoned | 03U831 abandoned |

### 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.

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| Mann-Kendall S | Mann-Kendall P | Trend Conclusion |
|---|---|---|
| S > 0 | P < / = 0.05 | Increasing |
| S > 0 | P < / = 0.10 | Probably Increasing |
| S = 0 | P < / = 0.05 | Stable |
| S < 0 | P < / = 0.10 | Probably Decreasing |
| S < 0 | P < / = 0.05 | Decreasing |
| Any 'S' | P > 0.05 | No Significant Trend |

**Appendix D.2.1.3**
**Response Thresholds by Group**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

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| 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

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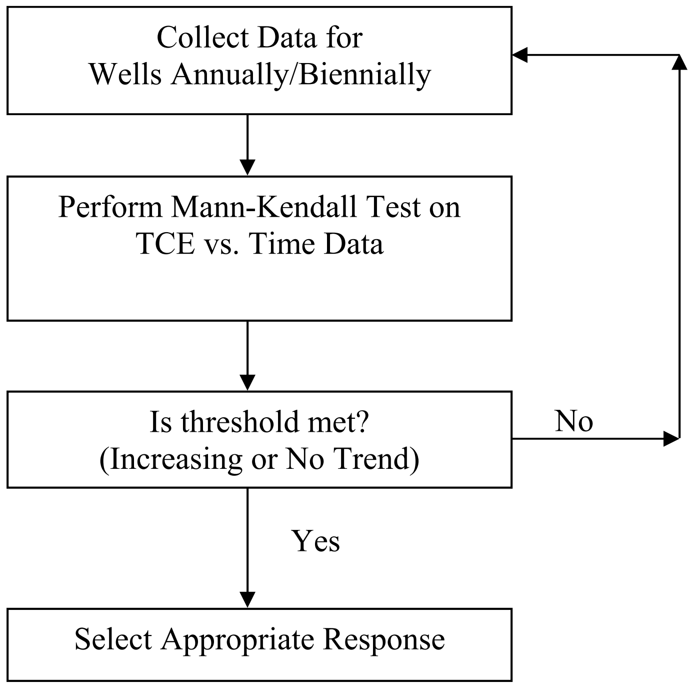

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## FACTORS TO CONSIDER

- Contaminant concentrations
- Location (vertical and horizontal)
- Surrounding data
- Risks to human health or the environment
- Need for urgency in response

## POSSIBLE EVALUATION RESPONSES

- Perform additional or confirmation sampling
- Write up in the Annual Performance Report
- Perform separate evaluation and write-up (Tech Memo)

## POSSIBLE LONG-TERM RESPONSES

- Increase sampling frequency
- Modify operation of remedial system(s)
- Perform new remedy evaluation
- Install additional monitoring well(s)
- Modify the Special Well Construction Area
- Control risk at the receptors

**Note:** Threshold responses to be described and evaluated in the Annual Performance Reports.

**Table 3-3**
**Group 1, 2, 3, 5, and 6 Mann-Kendall Summary for OU1**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**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:** | | | | | | | |
| 03L673 | -24 | <0.001 | 0.860 | 8 / 8 | Decreasing | No | |
| 03L833 | -17 | 0.0240 | 0.478 | 8 / 8 | Decreasing | No | |
| 03L848 | -23 | 0.00184 | 0.843 | 8 / 8 | Decreasing | No | |
| 03L859 | -23 | 0.00184 | 0.893 | 8 / 8 | Decreasing | No | |
| 03U677 | NA | NA | NA | 0 / 10 | NA | No | All ND |
| 03U805 | 20 | 0.00710 | 0.705 | 8 / 8 | Increasing | Yes | Southern edge of north plume, plume shifted slightly |
| 04U673 | -16 | 0.0310 | 0.0942 | 8 / 8 | Decreasing | No | Near south plume center, plume shifted slightly |
| 04U821 | -18 | 0.0160 | 0.603 | 8 / 8 | Decreasing | No | |
| 04U832 | 5 | 0.317 | 0.105 | 8 / 8 | No Significant Trend | Yes | Relatively stable, between 41 and 59 µg/L since 2005 |
| 04U833 | -30 | <0.001 | 0.623 | 9 / 9 | Decreasing | No | |
| 04U841 | -21 | 0.00500 | 0.690 | 8 / 8 | Decreasing | No | |
| 04U843 | 27 | <0.001 | 0.976 | 8 / 8 | Increasing | Yes | Near plume center |
| 04U845 | -15 | 0.0430 | 0.383 | 8 / 8 | Decreasing | No | |
| 04U846 | 19 | 0.0116 | 0.676 | 8 / 8 | Increasing | Yes | Near plume center, historically erratic |
| 04U854 | -21 | 0.00500 | 0.769 | 8 / 8 | Decreasing | No | |
| 04U859 | -27 | <0.001 | 0.923 | 8 / 8 | Decreasing | No | |
| 04U861 (abandoned) | 11 | 0.0280 | 0.752 | 6 / 6 | NA | NA | Abandoned after 2006 sample, in New Brighton Development |
| 04U875 | -20 | 0.0220 | 0.325 | 4 / 9 | Decreasing | No | |
| 04U877 | 7 | 0.272 | 0.0814 | 9 / 9 | No Significant Trend | Yes | |
| 206688 | -4 | 0.298 | 0.00700 | 6 / 6 | No Significant Trend | Yes | |
| 409549 | 14 | 0.0540 | 0.296 | 8 / 8 | Probably Increasing | Yes | Near plume center, plume shifted slightly |
| 409557 | 12 | 0.0890 | 0.117 | 8 / 8 | Probably Increasing | Yes | Between north & south plume, lateral dispersion |
| **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:** | | | | | | | |
| 03L809 | -11 | 0.114 | 0.470 | 8 / 8 | No Significant Trend | Yes | Raw trend is decreasing |
| 03L822 | -21 | 0.00500 | 0.761 | 8 / 8 | Decreasing | No | |
| 03U821 | -26 | <0.001 | 0.786 | 8 / 8 | Decreasing | No | |
| 03U822 | -5 | 0.317 | 0.230 | 8 / 8 | No Significant Trend | Yes | Between 42 and 160 µg/L since 2005 |
| 03U831 (abandoned) | 9 | 0.0680 | 0.405 | 2 / 6 | NA | NA | Abandoned due to construction after 2007 sampling |
| 409550 | -13 | 0.0720 | 0.489 | 8 / 8 | Probably Decreasing | No | Raw trend is decreasing |
| 409596 (abandoned) | -8 | 0.102 | 0.633 | 6 / 6 | NA | NA | Abandoned due to construction after 2007 sampling |
| 409597 (abandoned) | -11 | 0.0280 | 0.809 | 6 / 6 | NA | NA | Abandoned due to construction after 2007 sampling |

Notes and Abbreviations on Page 2.

Table 3-3
Group 1, 2, 3, 5, and 6 Mann-Kendall Summary for OU1
FY 2018 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

DRAFT

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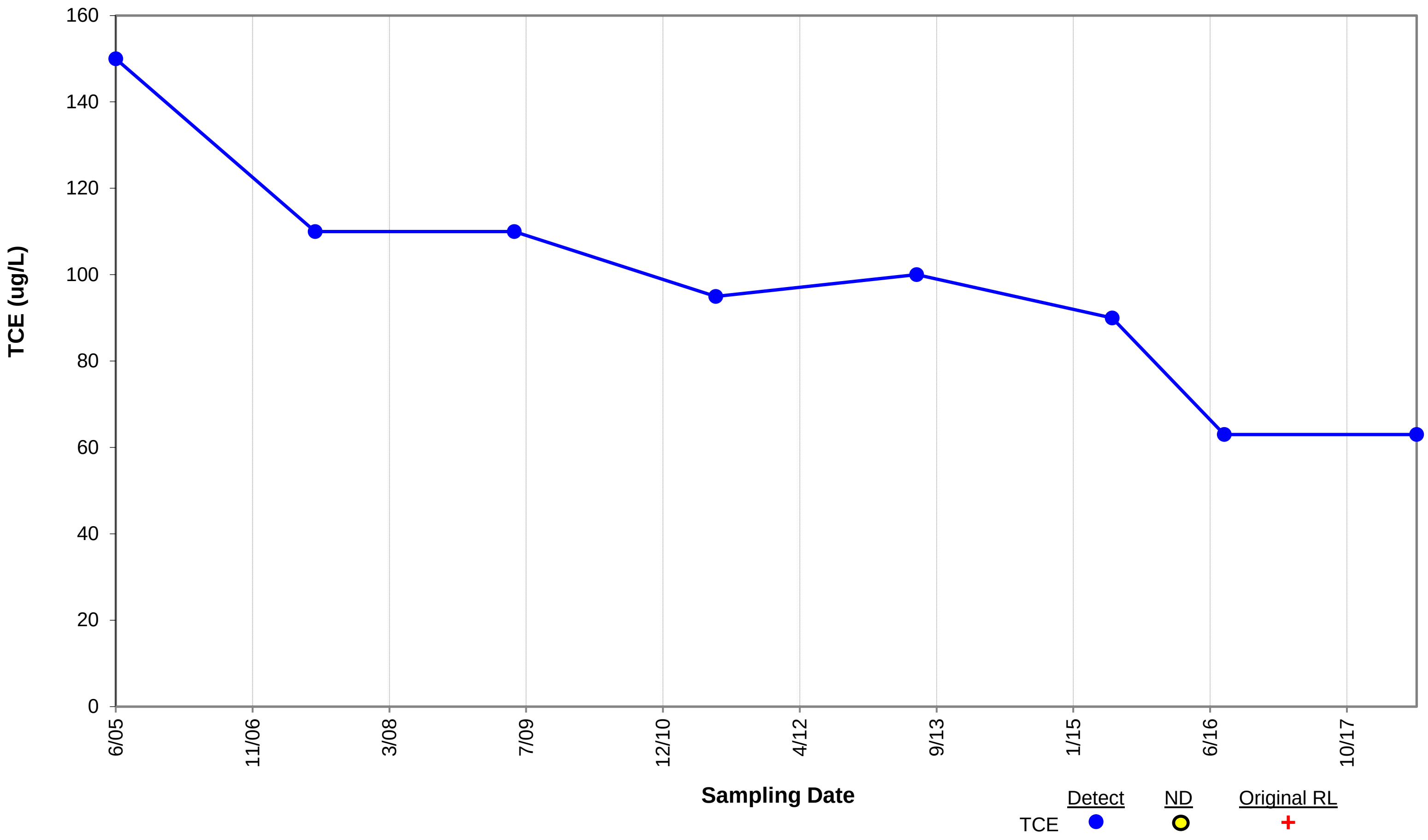
| Group | S Value | P Value | $R^2$ Value | Fraction of Detections | Results Trend | Threshold Triggered? | Comments |
|---|---|---|---|---|---|---|---|
| **Group 6 OU1 Jordan Wells:** | | | | | | | |
| 04J077 | -24 | 0.00630 | 0.638 | 9 / 9 | Decreasing | No | |
| 04J702 | -24 | <0.001 | 0.570 | 8 / 8 | Decreasing | No | |
| 04J708 | 20 | 0.00710 | 0.678 | 8 / 8 | Increasing | Yes | Southern edge of north plume, plume shifted slightly |
| 04J713 | NA | NA | NA | 0 / 8 | NA | No | All ND |
| 04J822 | -20 | 0.0220 | 0.610 | 9 / 9 | Decreasing | No | |
| 04J834 | -20 | 0.00710 | 0.685 | 4 / 8 | Decreasing | No | |
| 04J836 | 22 | 0.0120 | 0.668 | 9 / 9 | Increasing | Yes | Close proximity to NBCGRS wells, likely influenced by shutdown |
| 04J837 | -15 | 0.0750 | 0.345 | 9 / 9 | Probably Decreasing | No | Close proximity to NBCGRS wells, likely influenced by shutdown |
| 04J838 | 6 | 0.274 | 0.0741 | 8 / 8 | No Significant Trend | Yes | Close proximity to NBCGRS wells, likely influenced by shutdown |
| 04J839 | 8 | 0.238 | 0.134 | 9 / 9 | No Significant Trend | Yes | Historically Below 5 µg/L |
| 04J847 | 12 | 0.250 | 0.00741 | 13 / 13 | No Significant Trend | Yes | Near plume center |
| 04J849 | 24 | 0.00630 | 0.176 | 4 / 9 | Increasing | Yes | Historically Below 1 µg/L. |
| 04J882 | NA | NA | NA | 0 / 8 | NA | No | All ND |
| **Group 6 Nested Unit 4 Wells:** | | | | | | | |
| 04U077 | -26 | <0.001 | 0.858 | 8 / 8 | Decreasing | No | |
| 04U702 | -8 | 0.199 | 0.0451 | 8 / 8 | No Significant Trend | Yes | Below 3 µg/L |
| 04U708 | -20 | 0.00710 | 0.682 | 4 / 8 | Decreasing | No | |
| 04U713 | -16 | 0.0310 | 0.414 | 5 / 8 | Decreasing | No | |
| 04U834 | -13 | 0.0720 | 0.0000615 | 6 / 8 | Probably Decreasing | No | |
| 04U836 | -7 | 0.272 | 0.0246 | 9 / 9 | No Significant Trend | Yes | Close proximity to NBCGRS wells, likely influenced by shutdown |
| 04U837 | -9 | 0.209 | 0.354 | 9 / 9 | No Significant Trend | Yes | Raw trend is decreasing |
| 04U838 | 5 | 0.317 | 0.00262 | 8 / 8 | No Significant Trend | Yes | Historically below 3 µg/L |
| 04U839 | 26 | 0.00290 | 0.642 | 9 / 9 | Increasing | Yes | Close proximity to NBCGRS wells, likely influenced by shutdown |
| 04U847 | -12 | 0.0890 | 0.354 | 8 / 8 | Probably Decreasing | No | Raw trend is decreasing |
| 04U849 | 10 | 0.138 | 0.357 | 8 / 8 | No Significant Trend | Yes | Near plume center, appears relatively stable since 2011 |
| 04U882 | -15 | 0.0430 | 0.491 | 7 / 8 | 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
NBCGRS = New Brighton Contaminated Groundwater Recovery System
ND = non-detect
NP = North Plume
OU = Operable Unit
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
SP = South Plume
µg/L = micrograms per liter




| | | |
|---|---|---|
| **Mann-Kendall Test Result:** | **DECREASING TREND** p-value = <0.001 | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| **Theil-Sen Trend Line Result:** | **DECREASING TREND** Median Slope Estimate = -1.5E-02 ug/L per day<br>95% Confidence Interval = -2.4E-02 to -7.3E-03 ug/L per day | |

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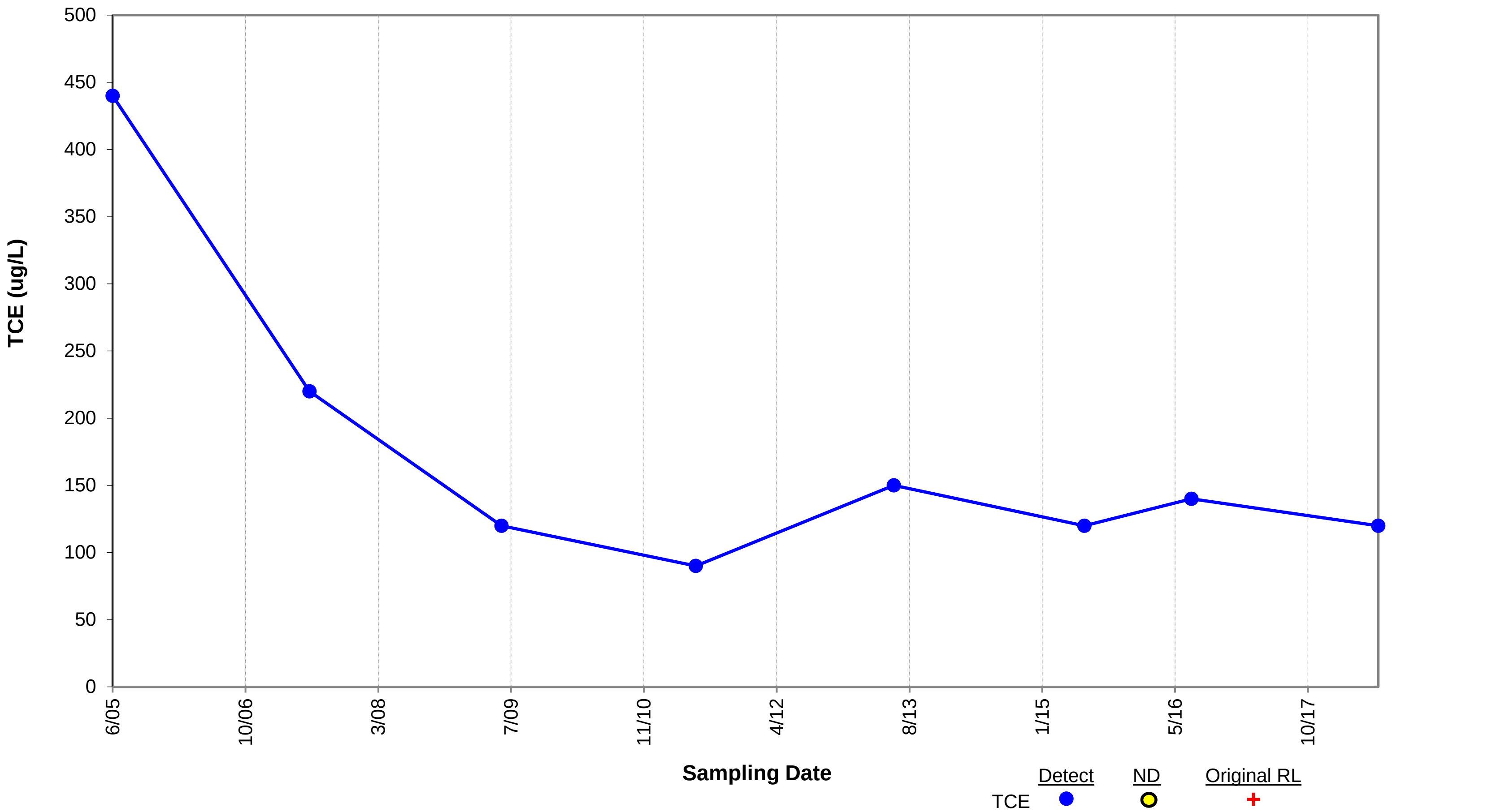
**Concentration vs. Time Plot – TCE in Well 03L673**
TCAAP

**Figure D.2.2-1**




**Mann-Kendall Test Result:** **No Significant Trend**
p-value = 0.114

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** **No Significant Trend**
Median Slope Estimate = -2.7E-02 ug/L per day
95% Confidence Interval = -8.9E-02 to 5.4E-03 ug/L per day

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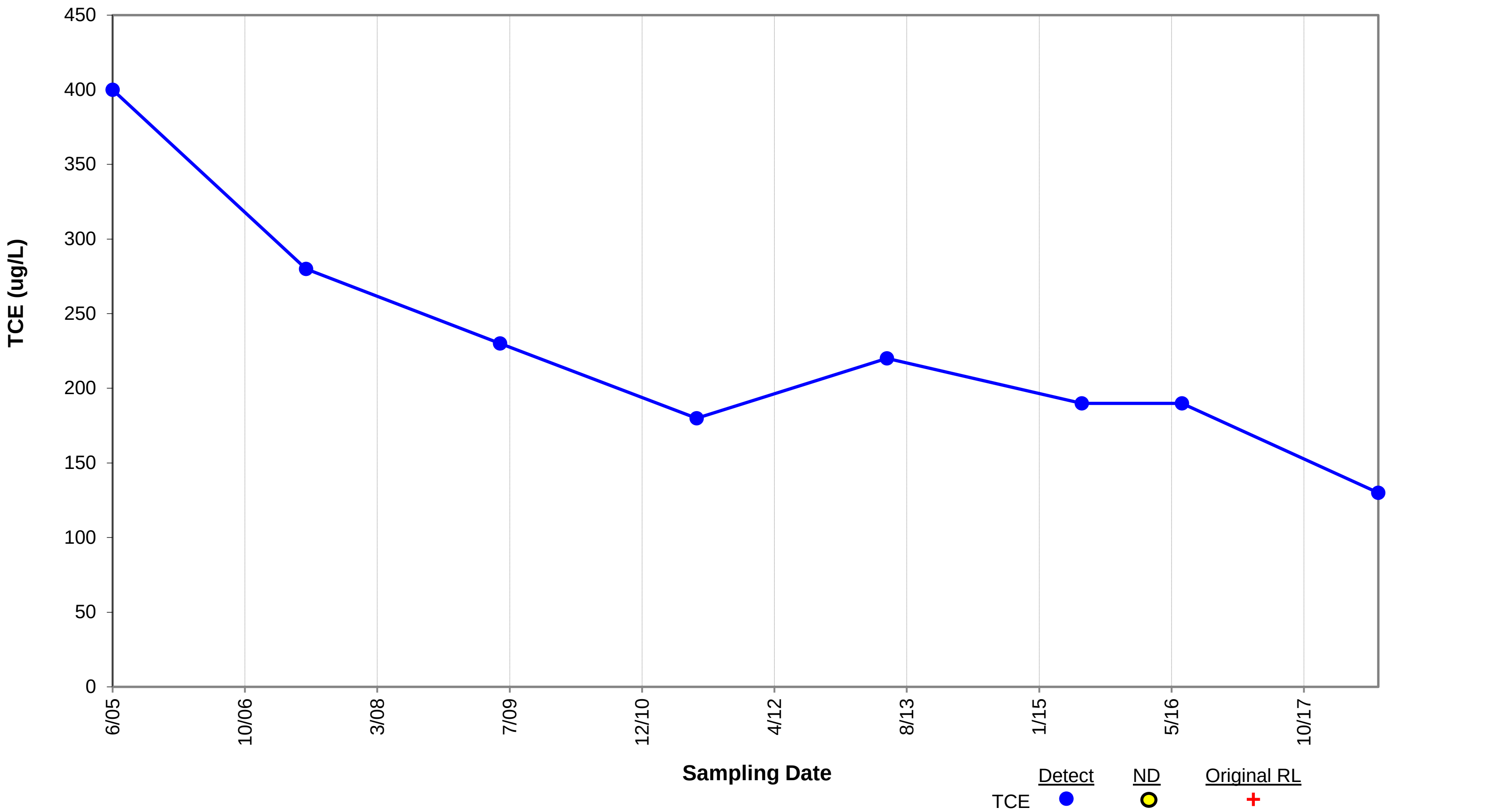
**Concentration vs. Time Plot – TCE in Well 03L809**
TCAAP

**Figure D.2.2-2**




**Mann-Kendall Test Result:** DECREASING TREND
p-value = 0.005

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** DECREASING TREND
Median Slope Estimate = -3.9E-02 ug/L per day
95% Confidence Interval = -6.8E-02 to -1.8E-02 ug/L per day

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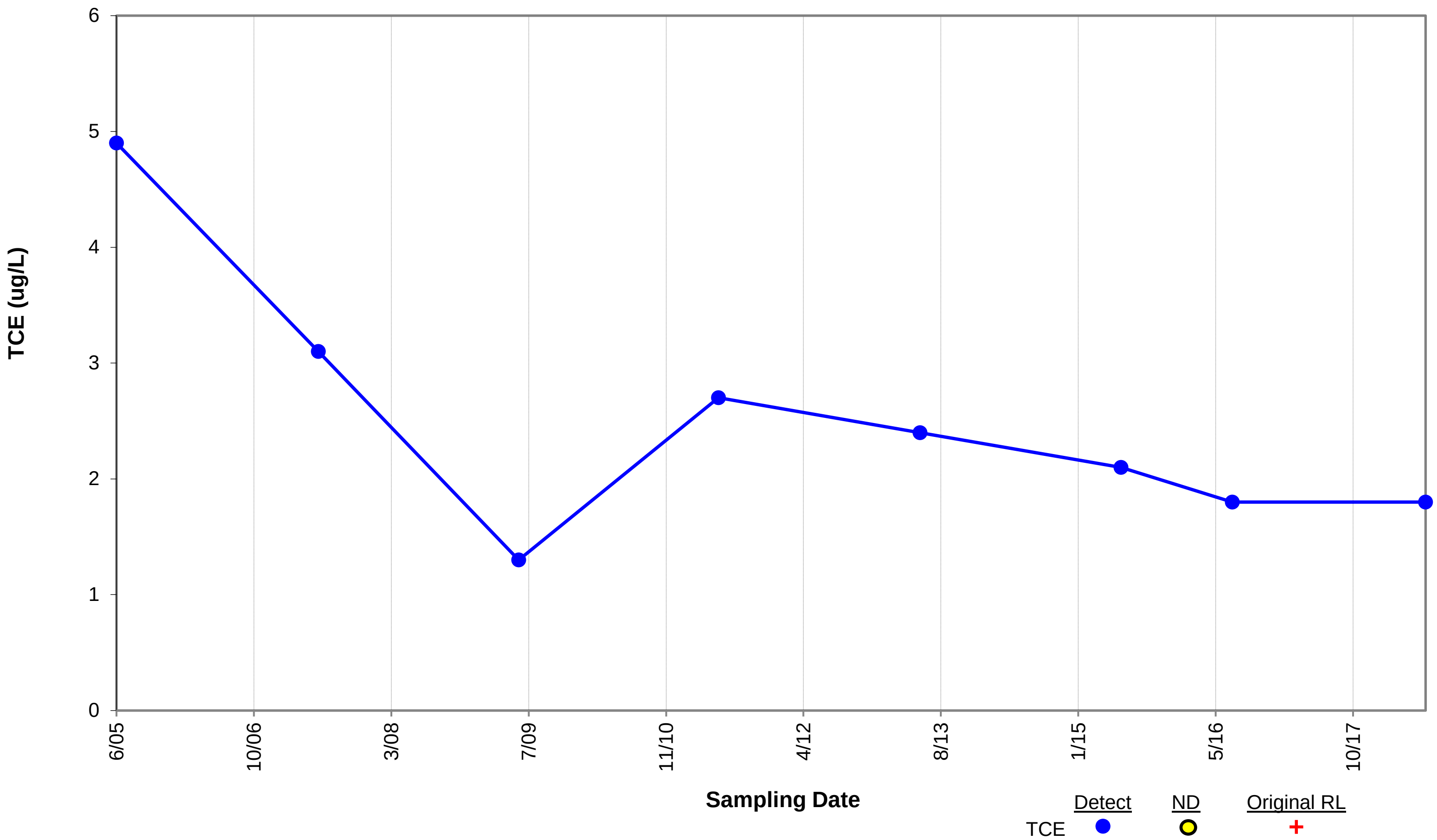
**Concentration vs. Time Plot – TCE in Well 03L822**
TCAAP

**Figure D.2.2-3**




**Mann-Kendall Test Result:** DECREASING TREND

p-value = 0.024

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** DECREASING TREND

Median Slope Estimate = -4.0E-04 ug/L per day

95% Confidence Interval = -7.7E-04 to -2.7E-04 ug/L per day

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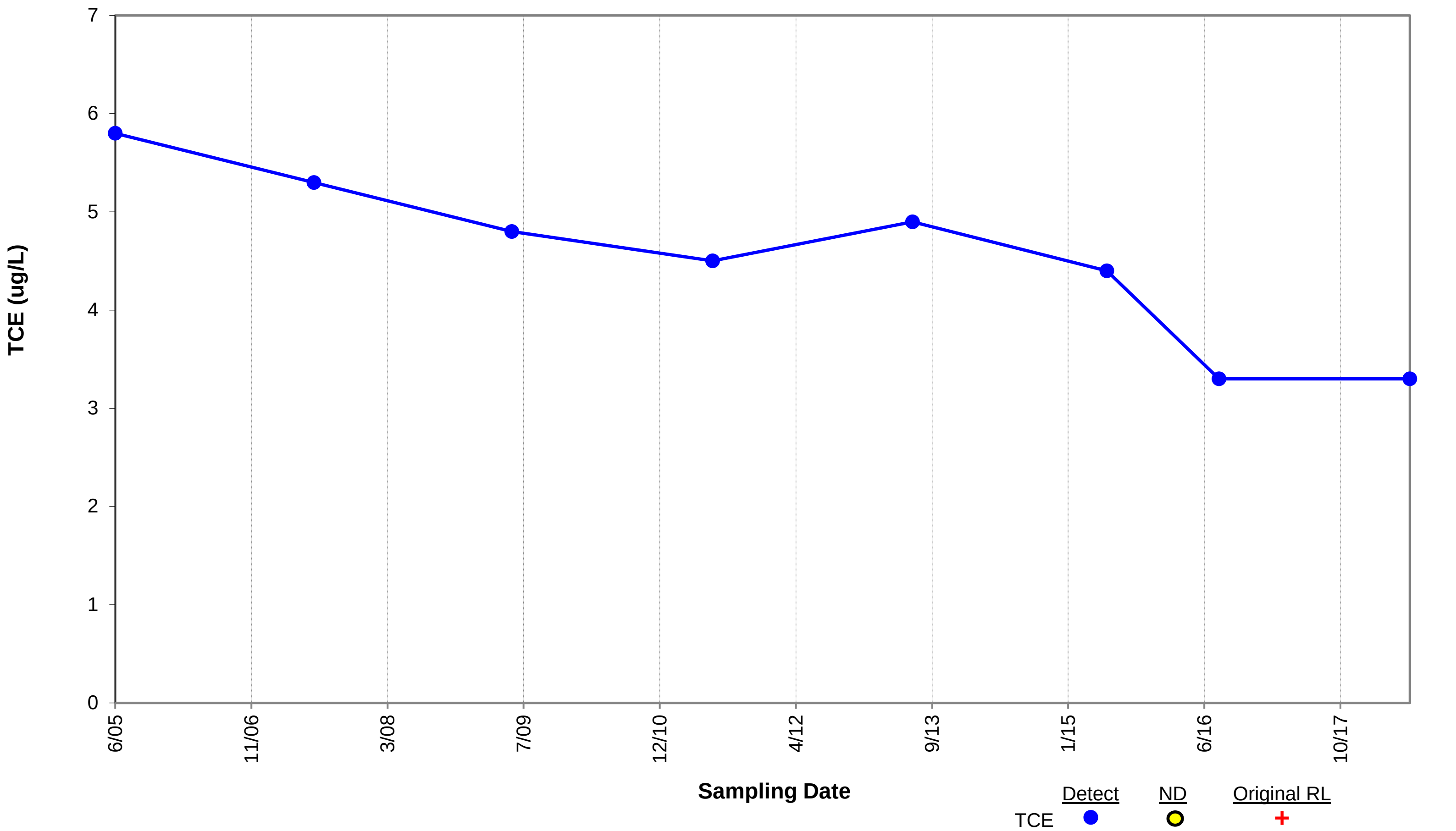
**Concentration vs. Time Plot – TCE in Well 03L833**

TCAAP

**Figure D.2.2-4**




**Mann-Kendall Test Result:** **DECREASING TREND**
p-value = 0.002

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** **DECREASING TREND**
Median Slope Estimate = -5.4E-04 ug/L per day
95% Confidence Interval = -6.9E-04 to -3.1E-04 ug/L per day

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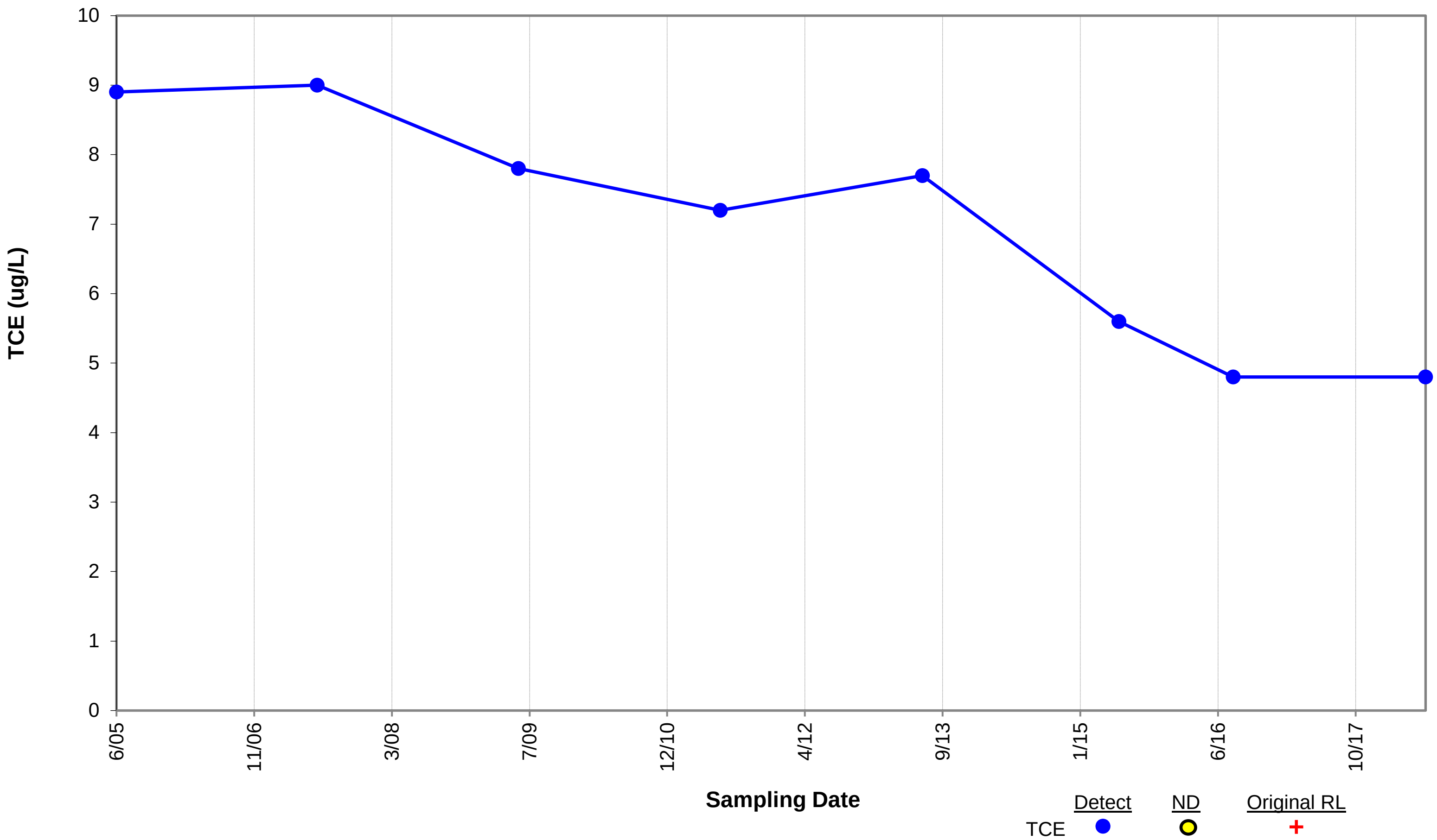
**Concentration vs. Time Plot – TCE in Well 03L848**
TCAAP

**Figure D.2.2-5**




**Mann-Kendall Test Result:** DECREASING TREND
p-value = 0.002

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** DECREASING TREND
Median Slope Estimate = -9.7E-04 ug/L per day
95% Confidence Interval = -1.3E-03 to -7.2E-04 ug/L per day

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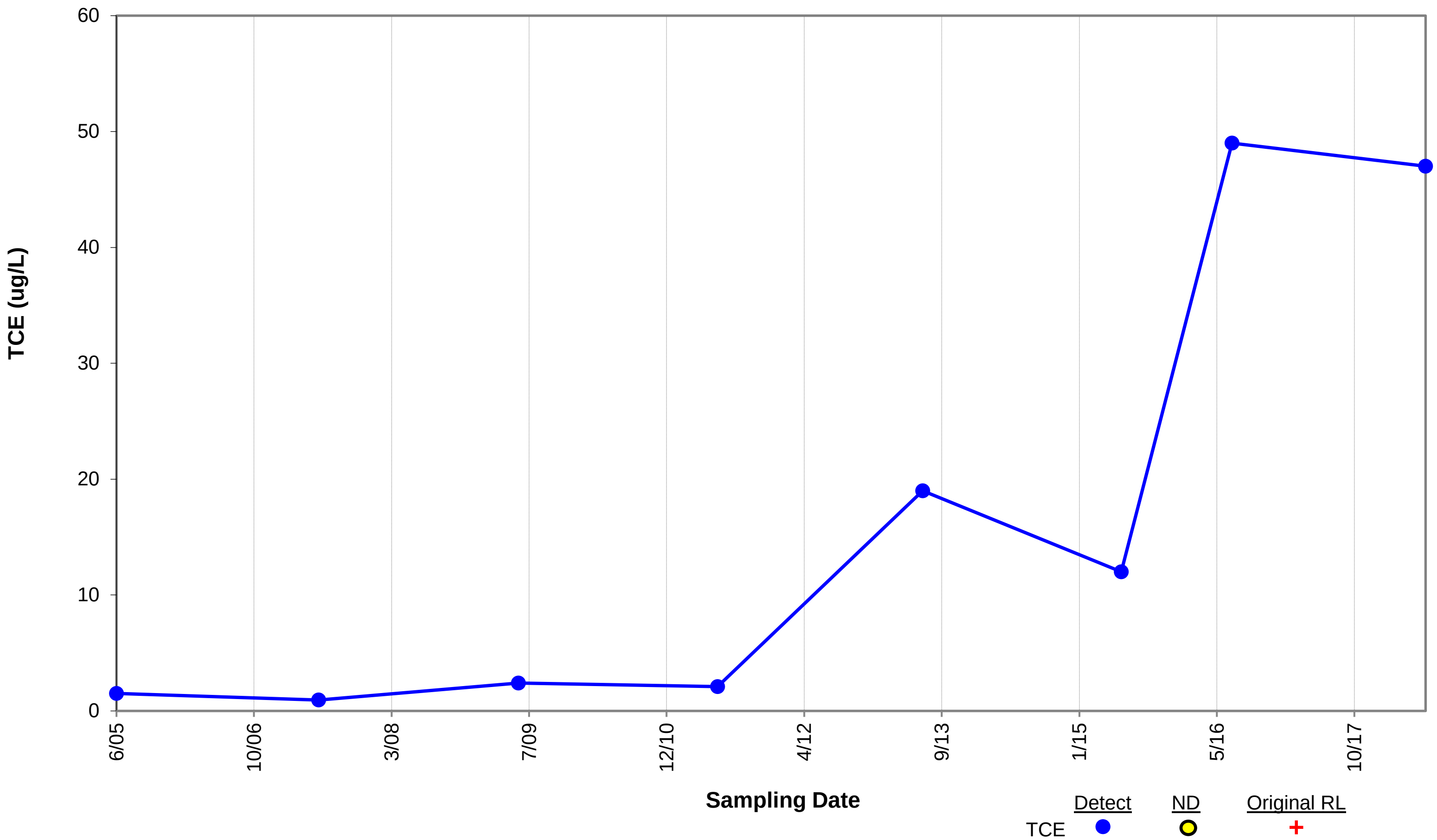
**Concentration vs. Time Plot – TCE in Well 03L859**
TCAAP

**Figure D.2.2-6**




**Mann-Kendall Test Result:** INCREASING TREND

p-value = 0.007

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** INCREASING TREND

Median Slope Estimate = 8.9E-03 ug/L per day

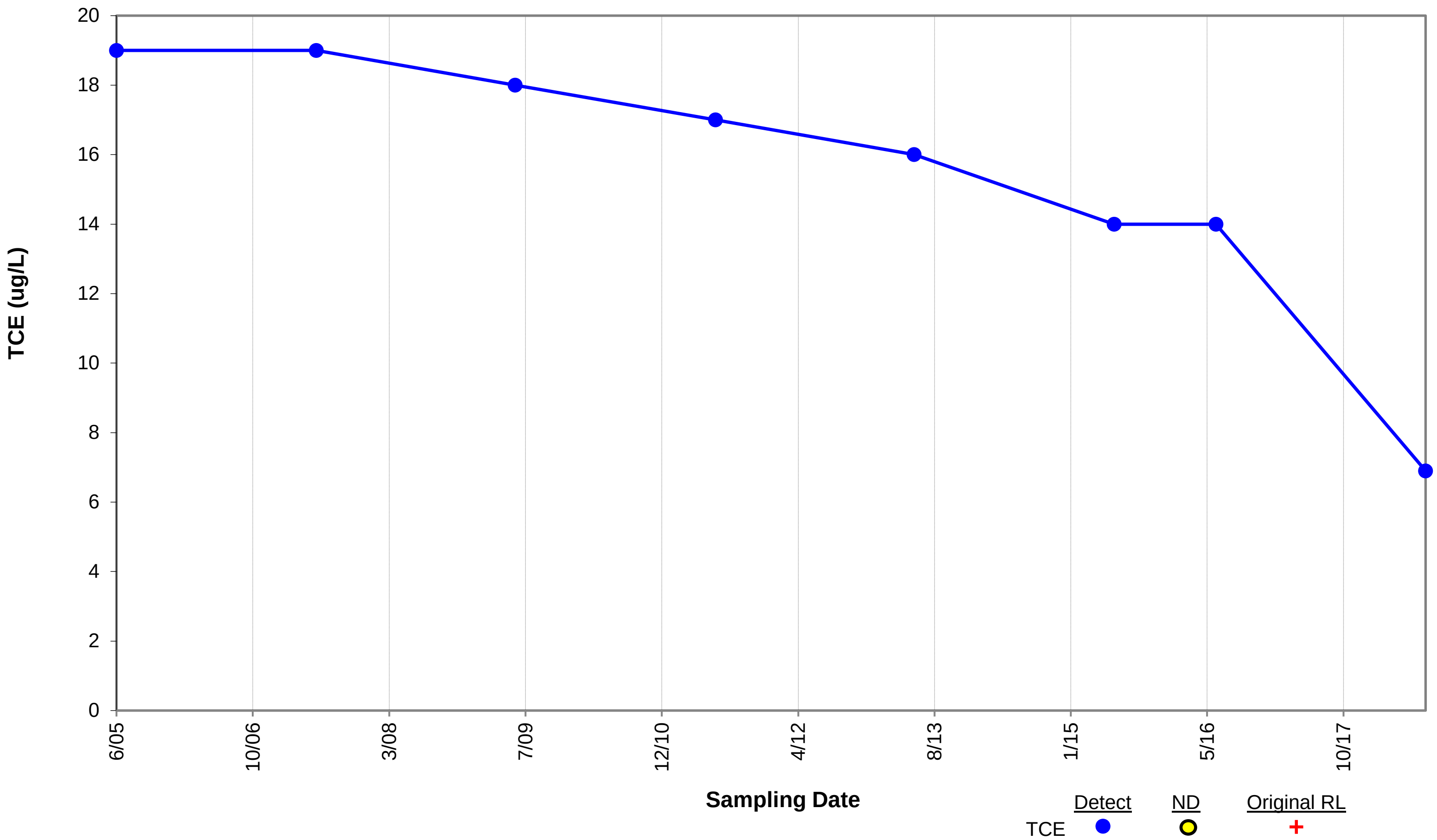
95% Confidence Interval = 6.3E-04 to 1.7E-02 ug/L per day

PIKA ARCADIS a joint venture

**Concentration vs. Time Plot – TCE in Well 03U805**

TCAAP

**Figure D.2.2-7**




**Mann-Kendall Test Result:** DECREASING TREND
p-value = <0.001

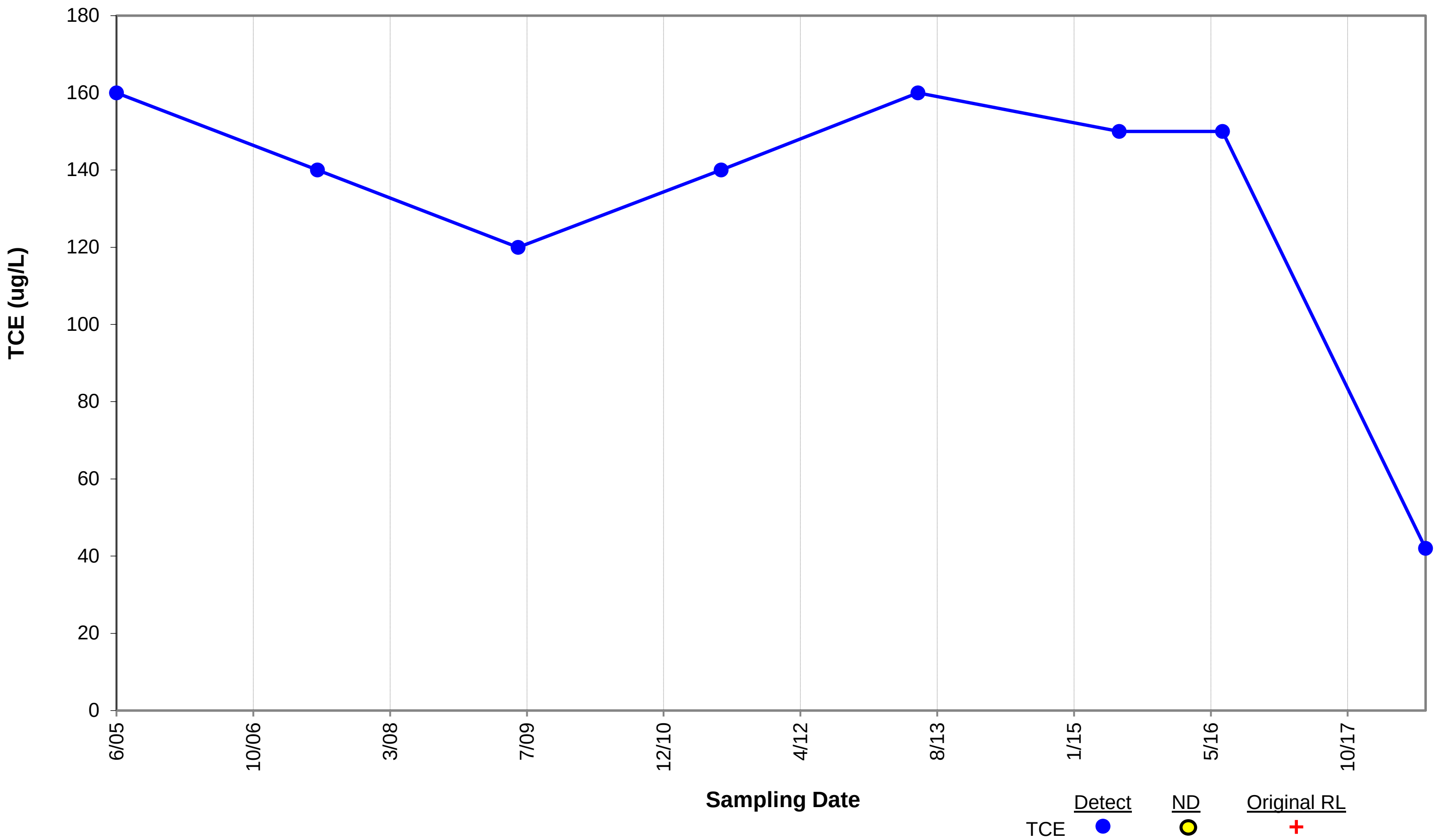
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** DECREASING TREND
Median Slope Estimate = -1.5E-03 ug/L per day
95% Confidence Interval = -2.9E-03 to -1.4E-03 ug/L per day

PIKA ARCADIS a joint venture

**Concentration vs. Time Plot – TCE in Well 03U821**
TCAAP

**Figure D.2.2-8**




**Mann-Kendall Test Result:** **No Significant Trend**
p-value = 0.317

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** **No Significant Trend**
Median Slope Estimate = -2.6E-03 ug/L per day
95% Confidence Interval = -2.7E-02 to 6.5E-03 ug/L per day

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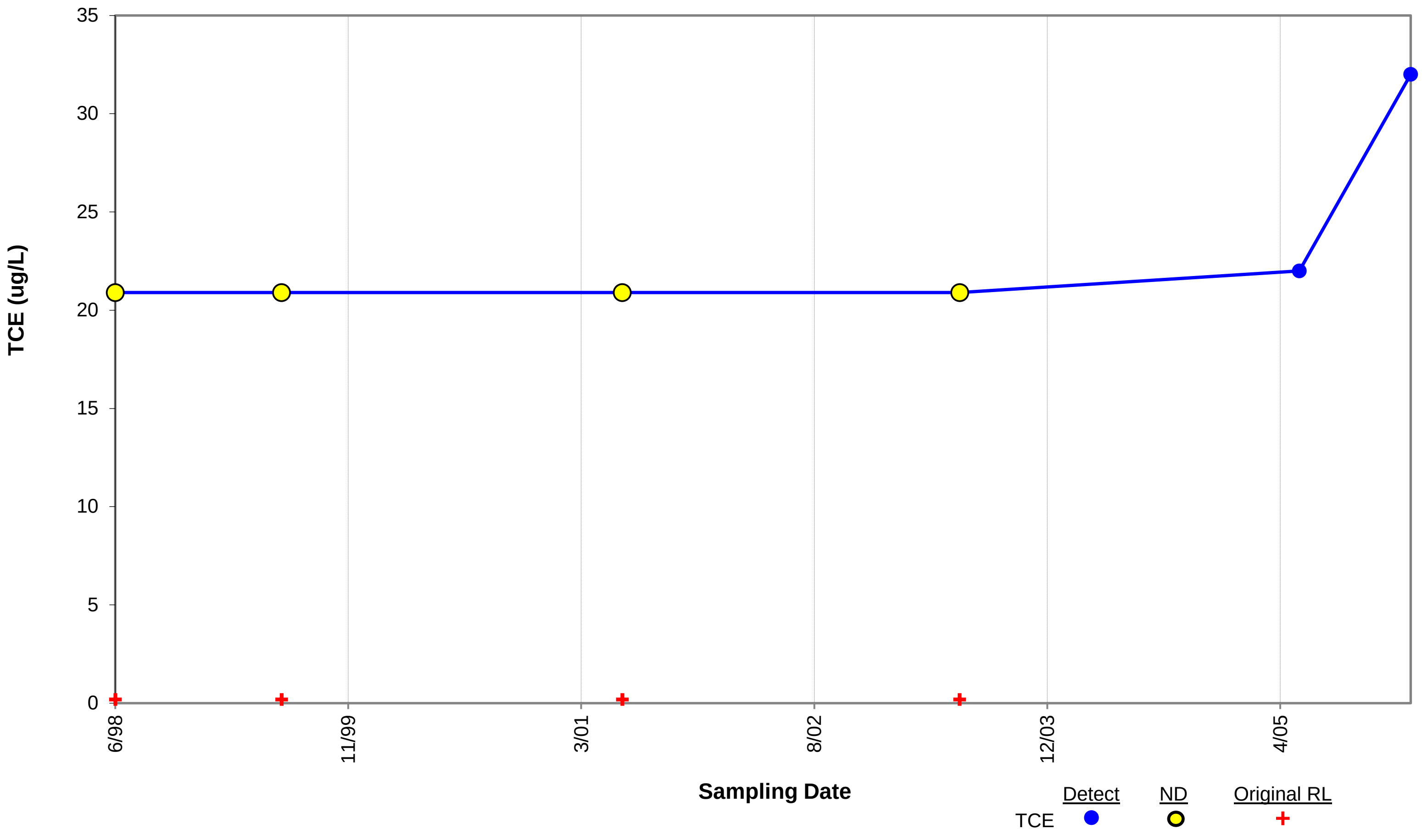
**Concentration vs. Time Plot – TCE in Well 03U822**
TCAAP

**Figure D.2.2-9**




| | | | | |
|---|---|---|---|---|
| **Mann-Kendall Test Result:** | **No Significant Trend** | | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). | |
| | p-value = | 0.068 | | |
| **Theil-Sen Trend Line Result:** | **No Significant Trend** | | | |
| | Median Slope Estimate = | 5.0E-04 | ug/L per day | |
| | 95% Confidence Interval = | 0.0E+00 | to 4.5E-03 | ug/L per day |

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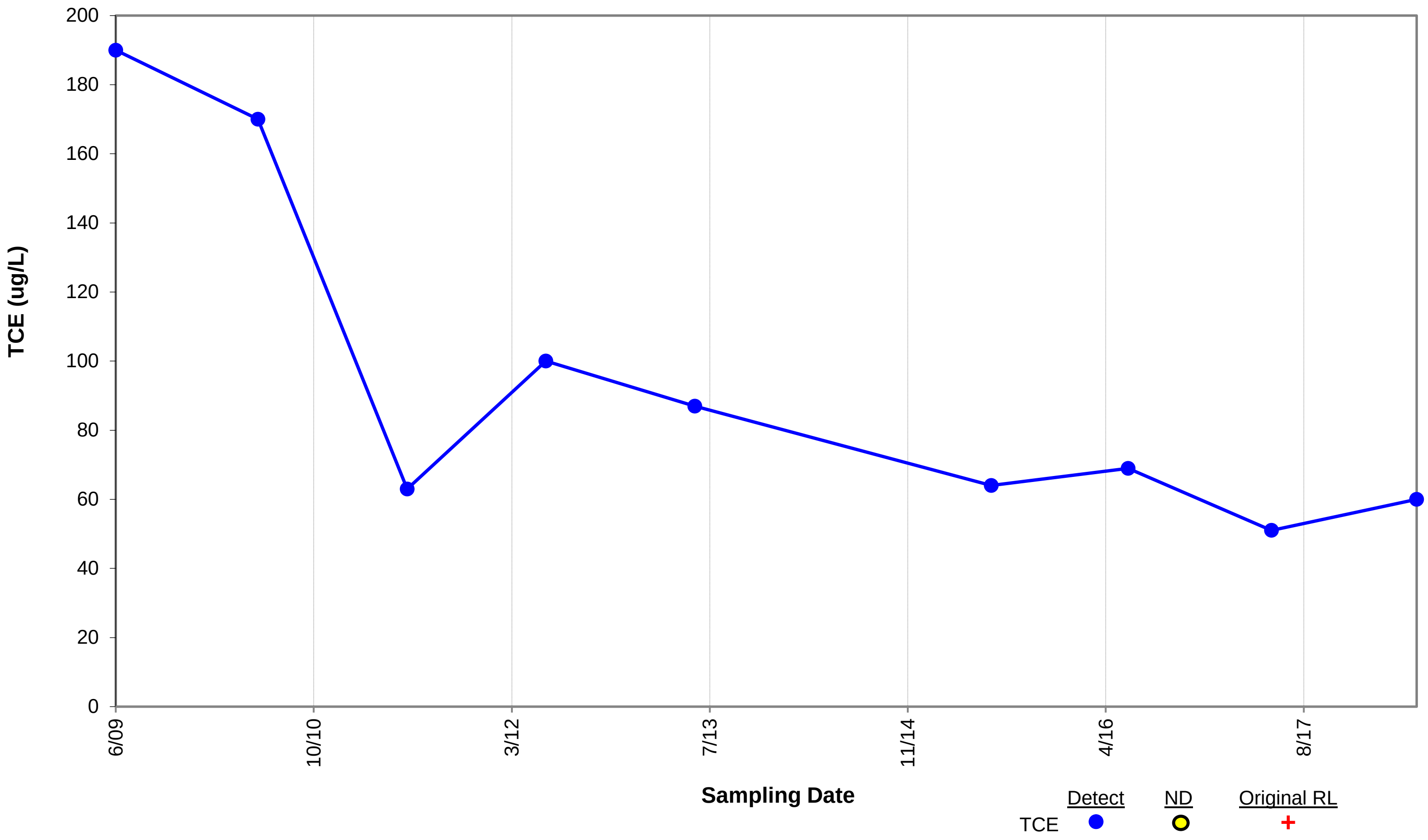
**Concentration vs. Time Plot – TCE in Well 03U831**

TCAAP

**Figure D.2.2-10**




**Mann-Kendall Test Result:** DECREASING TREND
p-value = 0.006

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** DECREASING TREND
Median Slope Estimate = -3.1E-02 ug/L per day
95% Confidence Interval = -5.6E-02 to -9.6E-03 ug/L per day

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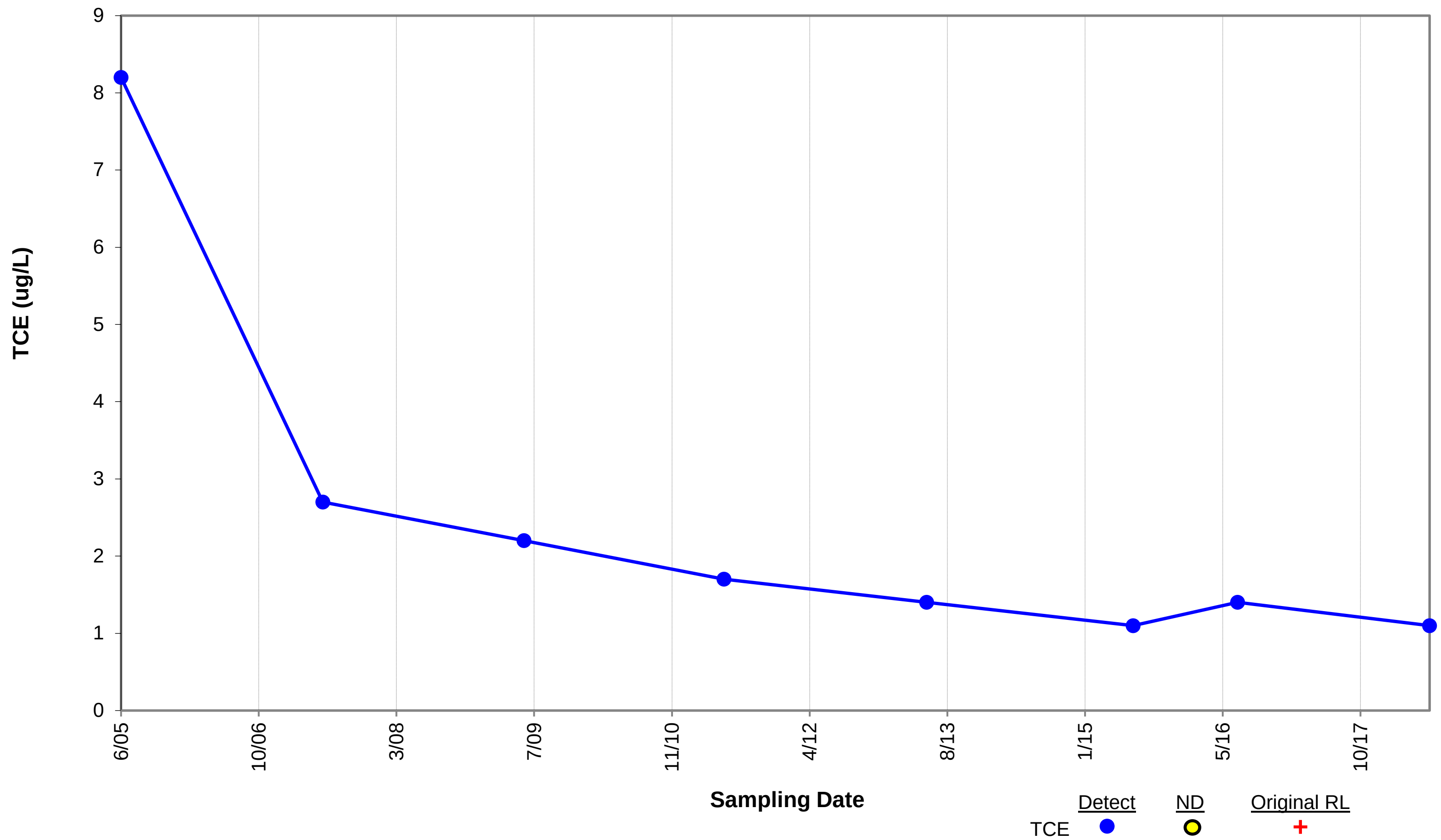
**Concentration vs. Time Plot – TCE in Well 04J077**
TCAAP

**Figure D.2.2-11**




| | | | | |
|---|---|---|---|---|
| **Mann-Kendall Test Result:** | DECREASING TREND | | | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| | p-value = | <0.001 | | |
| **Theil-Sen Trend Line Result:** | DECREASING TREND | | | |
| | Median Slope Estimate = | -4.6E-04 | ug/L per day | |
| | 95% Confidence Interval = | -1.6E-03 | to -3.1E-04 | ug/L per day |

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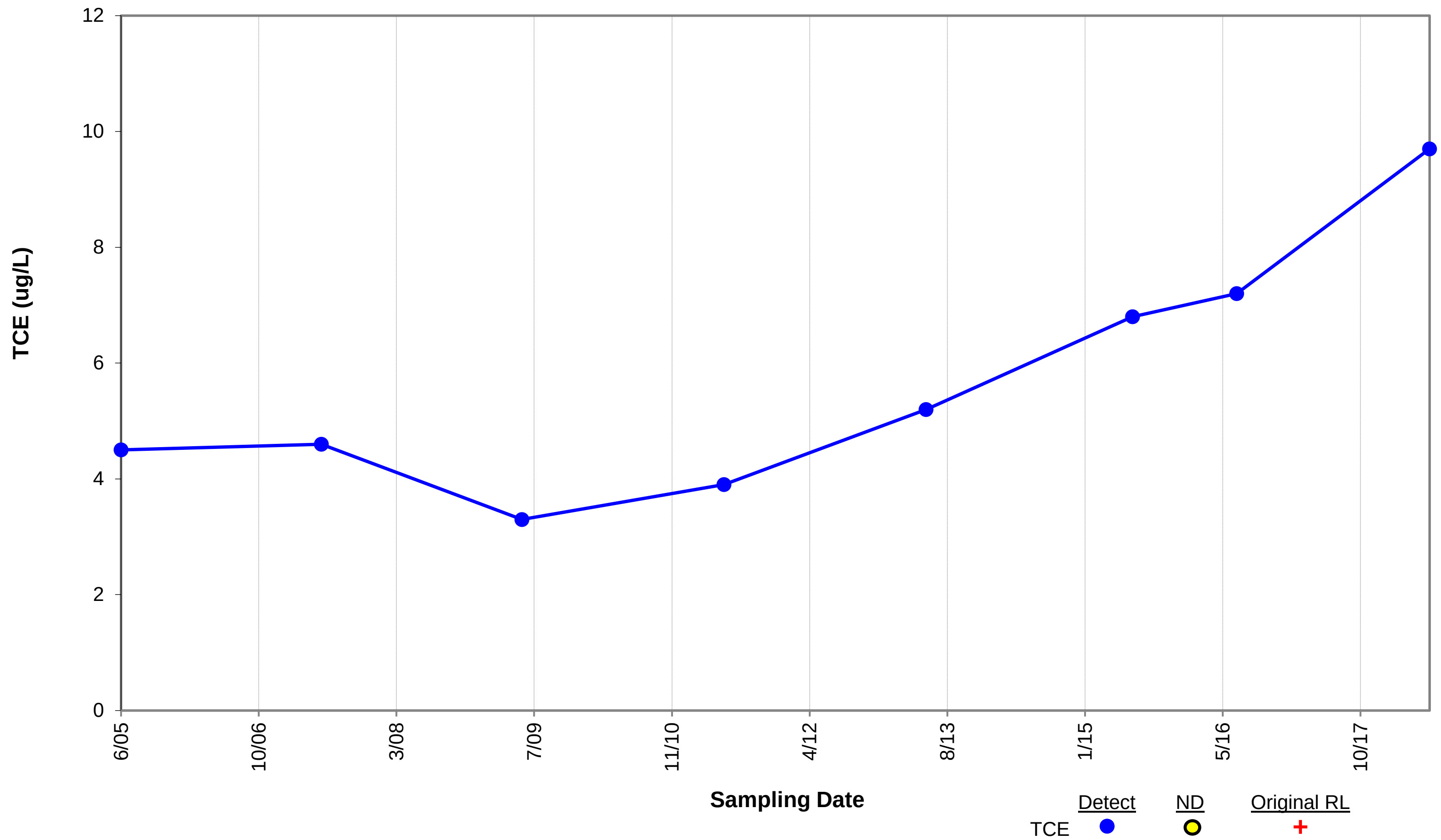
**Concentration vs. Time Plot – TCE in Well 04J702**

TCAAP

**Figure D.2.2-12**




| | | | | | |
|---|---|---|---|---|---|
| **Mann-Kendall Test Result:** | **INCREASING TREND** | | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). | | |
| | p-value = | 0.007 | | | |
| **Theil-Sen Trend Line Result:** | **INCREASING TREND** | | | | |
| | Median Slope Estimate = | 1.2E-03 | ug/L per day | | |
| | 95% Confidence Interval = | 2.4E-04 | to | 1.9E-03 | ug/L per day |

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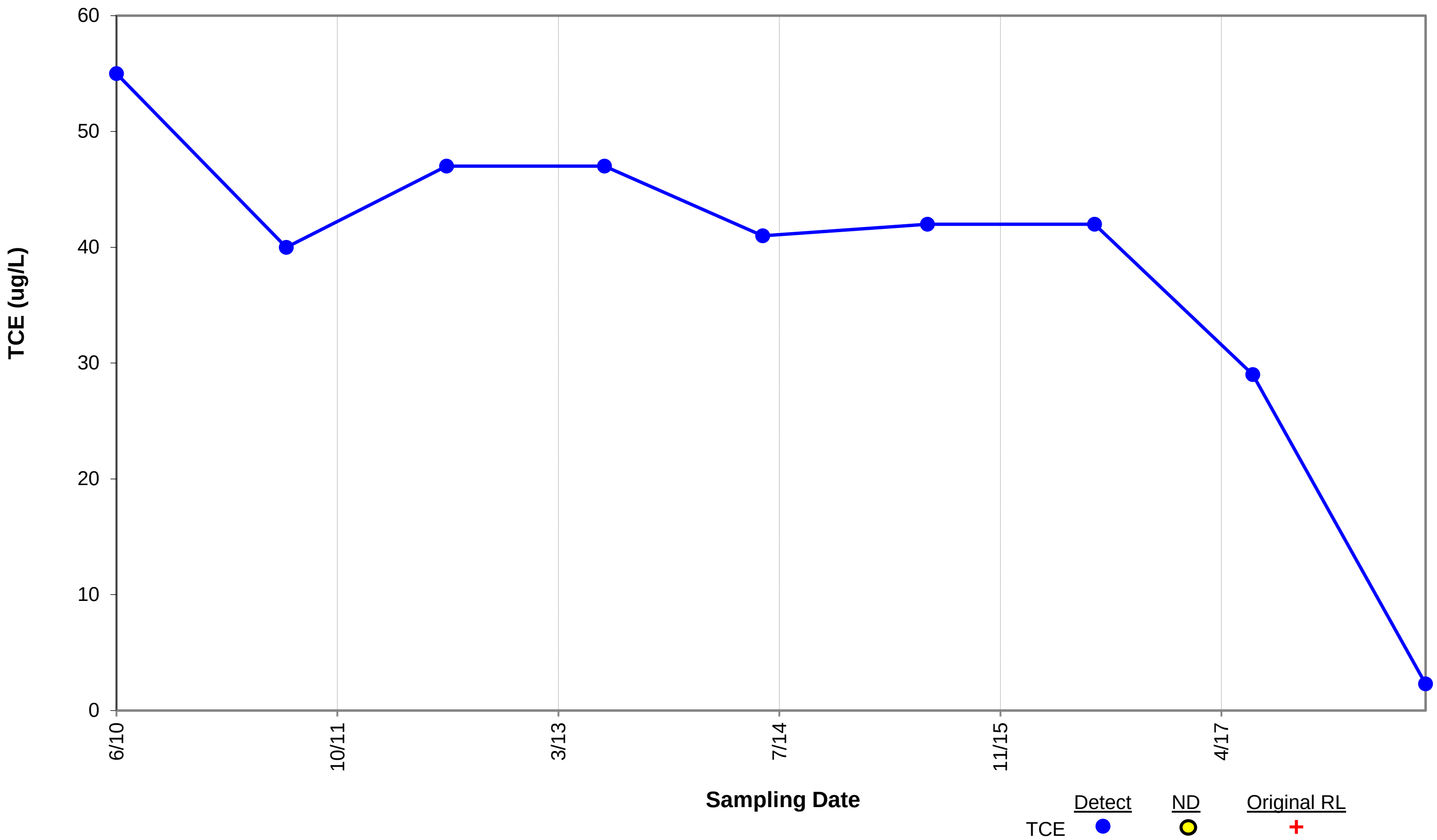
**Concentration vs. Time Plot – TCE in Well 04J708**
TCAAP

**Figure D.2.2-13**




| | | | |
|---|---|---|---|
| **Mann-Kendall Test Result:** | DECREASING TREND | | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| | p-value = | 0.022 | |
| **Theil-Sen Trend Line Result:** | DECREASING TREND | | |
| | Median Slope Estimate = | -9.0E-03 | ug/L per day |
| | 95% Confidence Interval = | -1.9E-02 to -2.4E-03 | ug/L per day |

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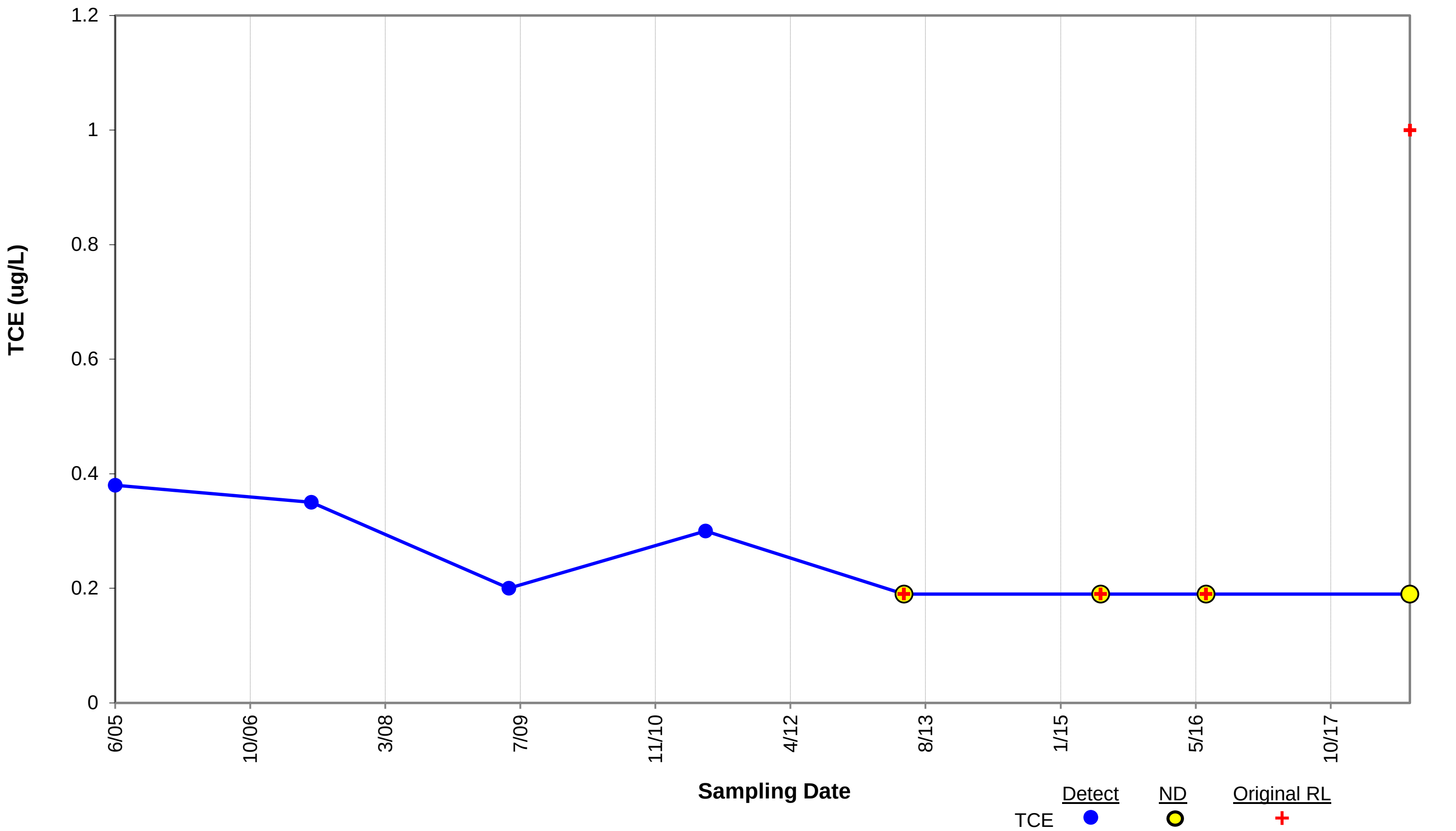
**Concentration vs. Time Plot – TCE in Well 04J822**

TCAAP

**Figure D.2.2-14**




**Mann-Kendall Test Result:** DECREASING TREND
p-value = 0.007

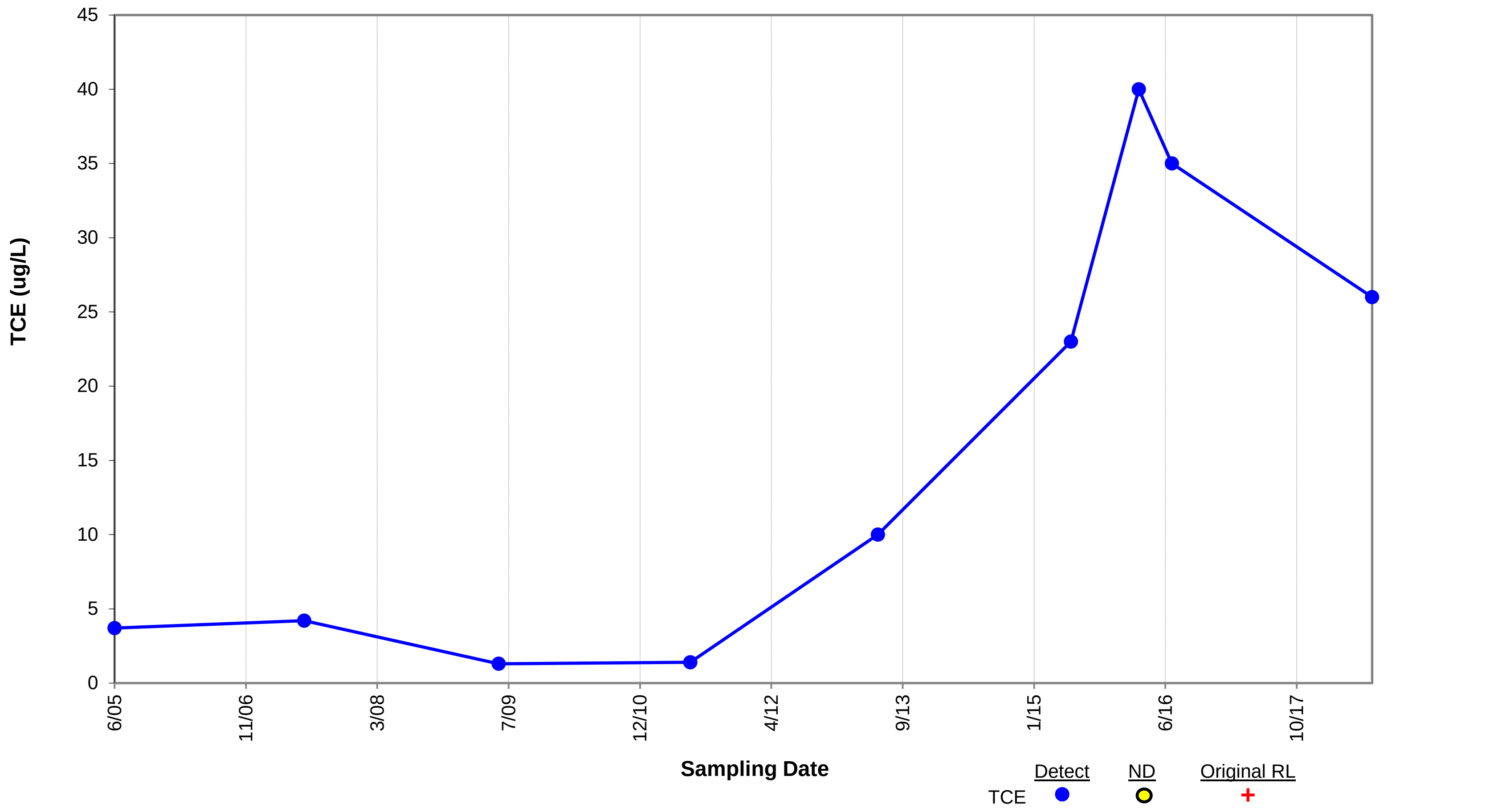
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** DECREASING TREND
Median Slope Estimate = -3.9E-05 ug/L per day
95% Confidence Interval = -6.2E-05 to -1.9E-06 ug/L per day

PIKA ARCADIS a joint venture

**Concentration vs. Time Plot – TCE in Well 04J834**
TCAAP

**Figure D.2.2-15**




**Mann-Kendall Test Result:** INCREASING TREND
p-value = 0.012

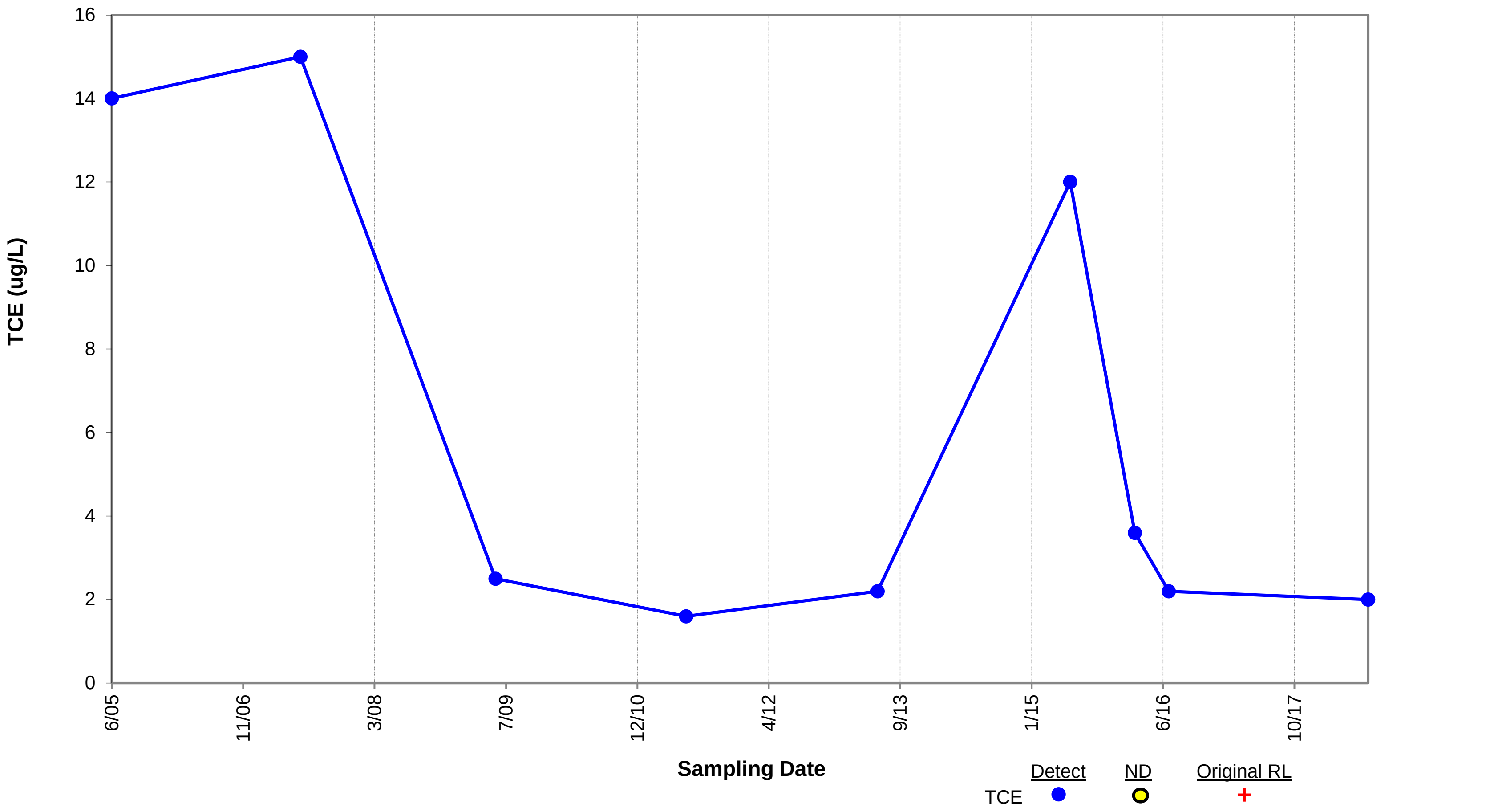
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** INCREASING TREND
Median Slope Estimate = 7.6E-03 ug/L per day
95% Confidence Interval = 4.7E-04 to 1.4E-02 ug/L per day

PIKA ARCADIS a joint venture

**Concentration vs. Time Plot – TCE in Well 04J836**
TCAAP

**Figure D.2.2-16**



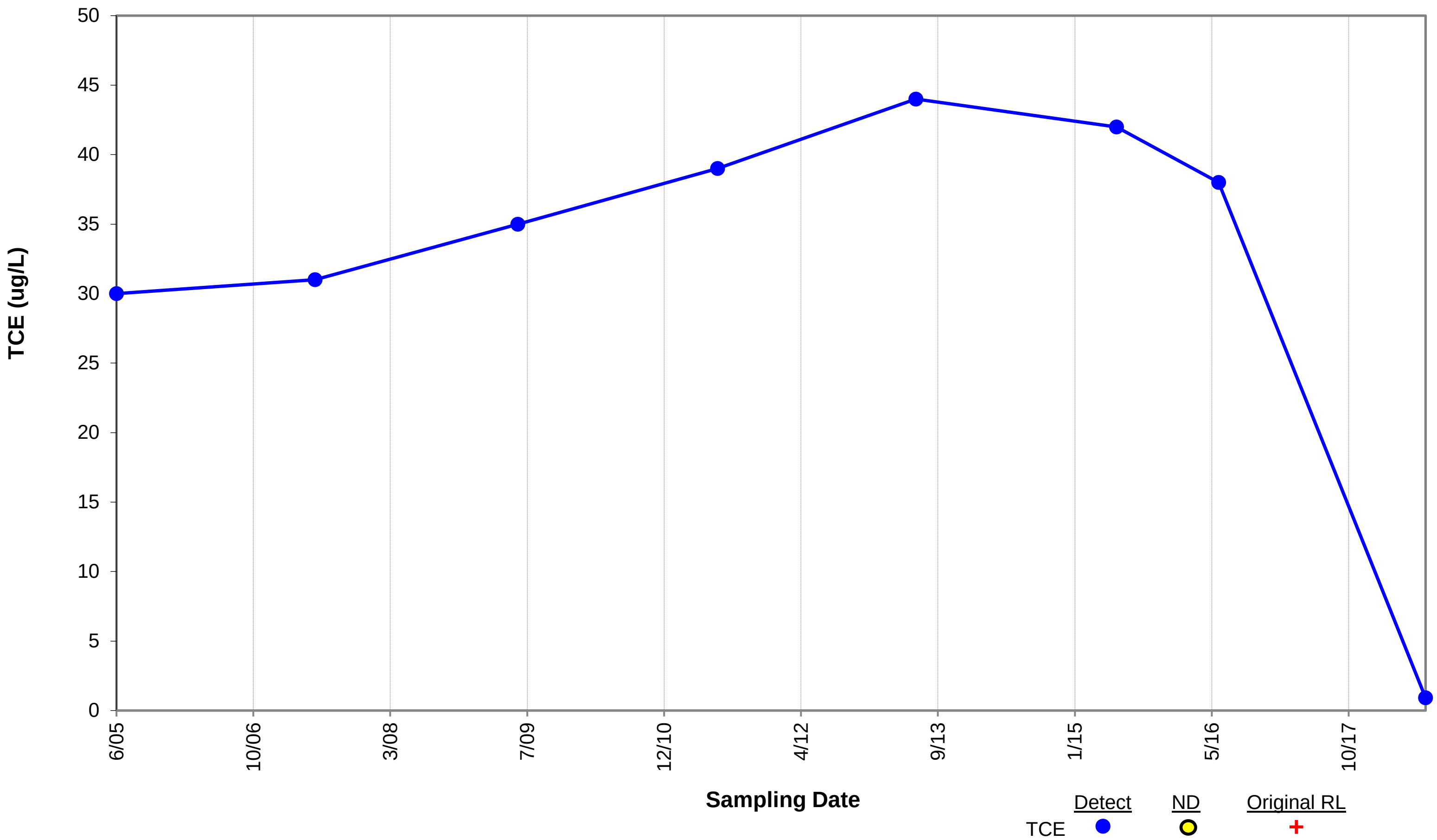

| | | | |
|---|---|---|---|
| **Mann-Kendall Test Result:** | **No Significant Trend** | | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| | p-value = | 0.075 | |
| **Theil-Sen Trend Line Result:** | **No Significant Trend** | | |
| | Median Slope Estimate = | -1.1E-03 | ug/L per day |
| | 95% Confidence Interval = | -5.7E-03 to 2.1E-04 | ug/L per day |

PIKA ARCADIS a joint venture

**Concentration vs. Time Plot – TCE in Well 04J837**

TCAAP

**Figure D.2.2-17**




| | | |
|---|---|---|
| **Mann-Kendall Test Result:** | **No Significant Trend**<br>p-value = 0.274 | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| **Theil-Sen Trend Line Result:** | **No Significant Trend**<br>Median Slope Estimate = 2.0E-03 ug/L per day<br>95% Confidence Interval = -1.0E-02 to 4.7E-03 ug/L per day | |

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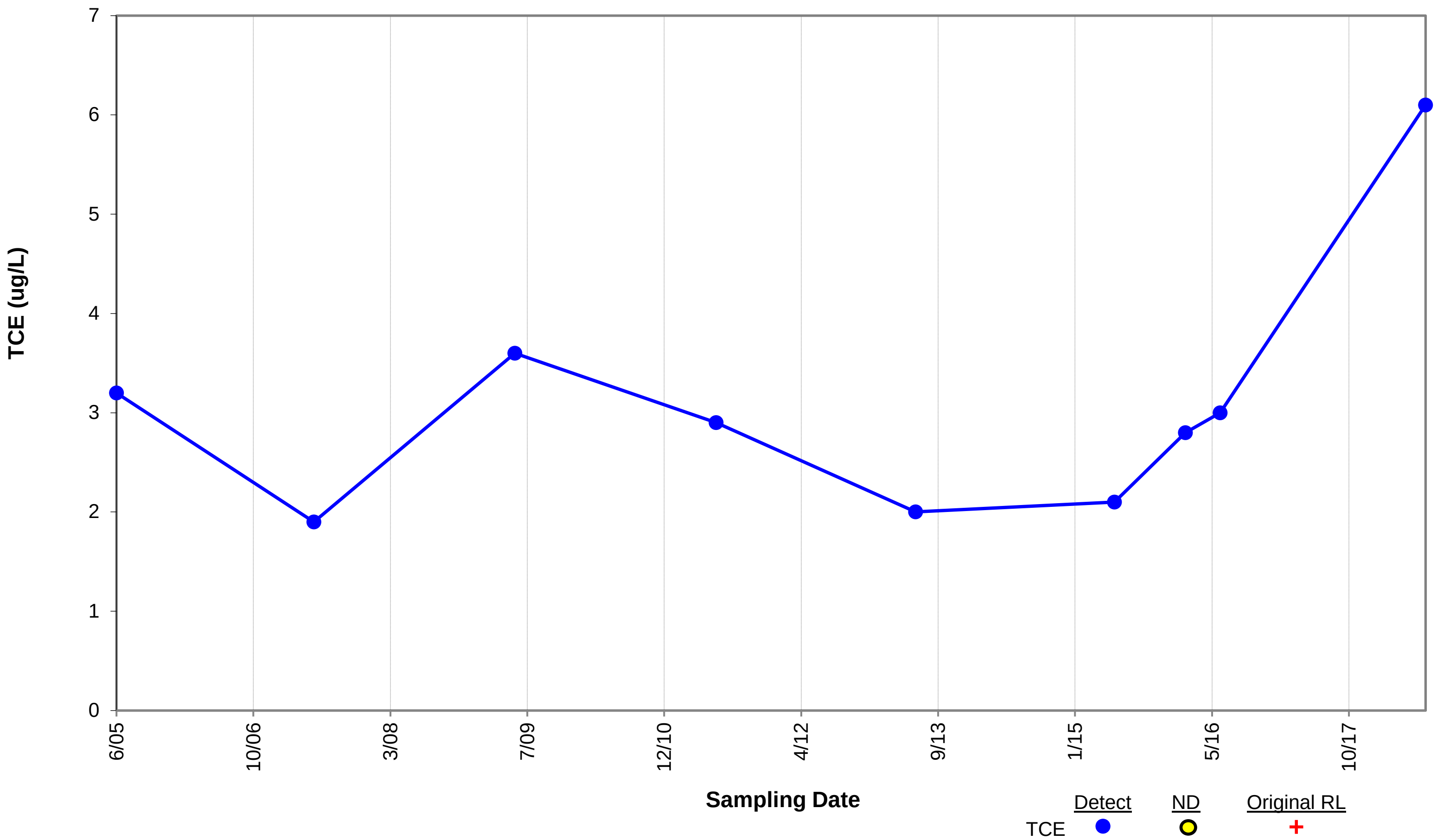
**Concentration vs. Time Plot – TCE in Well 04J838**
TCAAP

**Figure D.2.2-18**




**Mann-Kendall Test Result:** **No Significant Trend**
p-value = 0.238

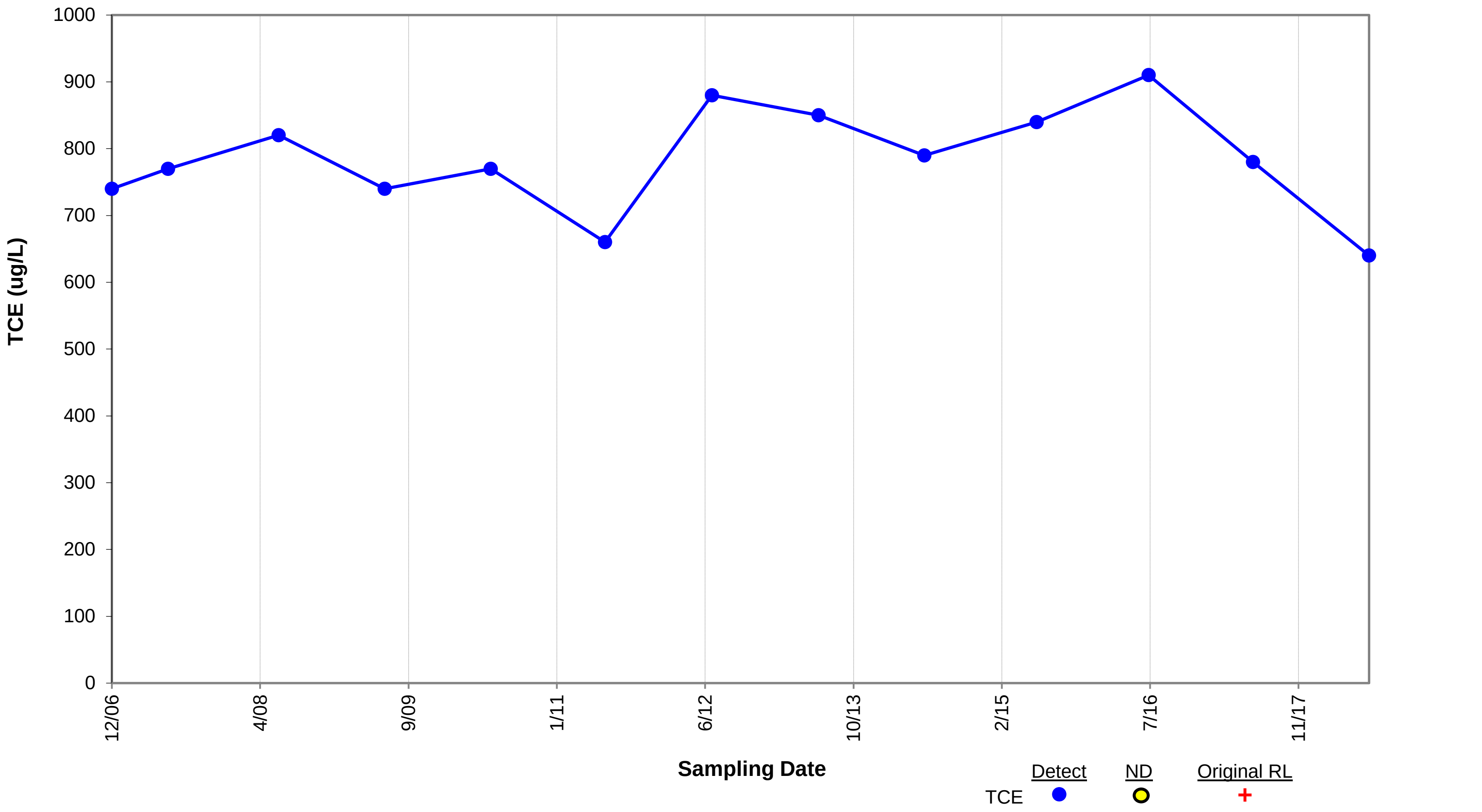
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** **No Significant Trend**
Median Slope Estimate = 2.1E-04 ug/L per day
95% Confidence Interval = -3.1E-04 to 1.1E-03 ug/L per day

PIKA ARCADIS a joint venture

**Concentration vs. Time Plot – TCE in Well 04J839**
TCAAP

**Figure D.2.2-19**




| | | |
|---|---|---|
| **Mann-Kendall Test Result:** | **No Significant Trend** | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| | p-value = 0.250 | |
| **Theil-Sen Trend Line Result:** | **No Significant Trend** | |
| | Median Slope Estimate = 1.2E-02 ug/L per day | |
| | 95% Confidence Interval = -4.1E-02 to 4.6E-02 ug/L per day | |

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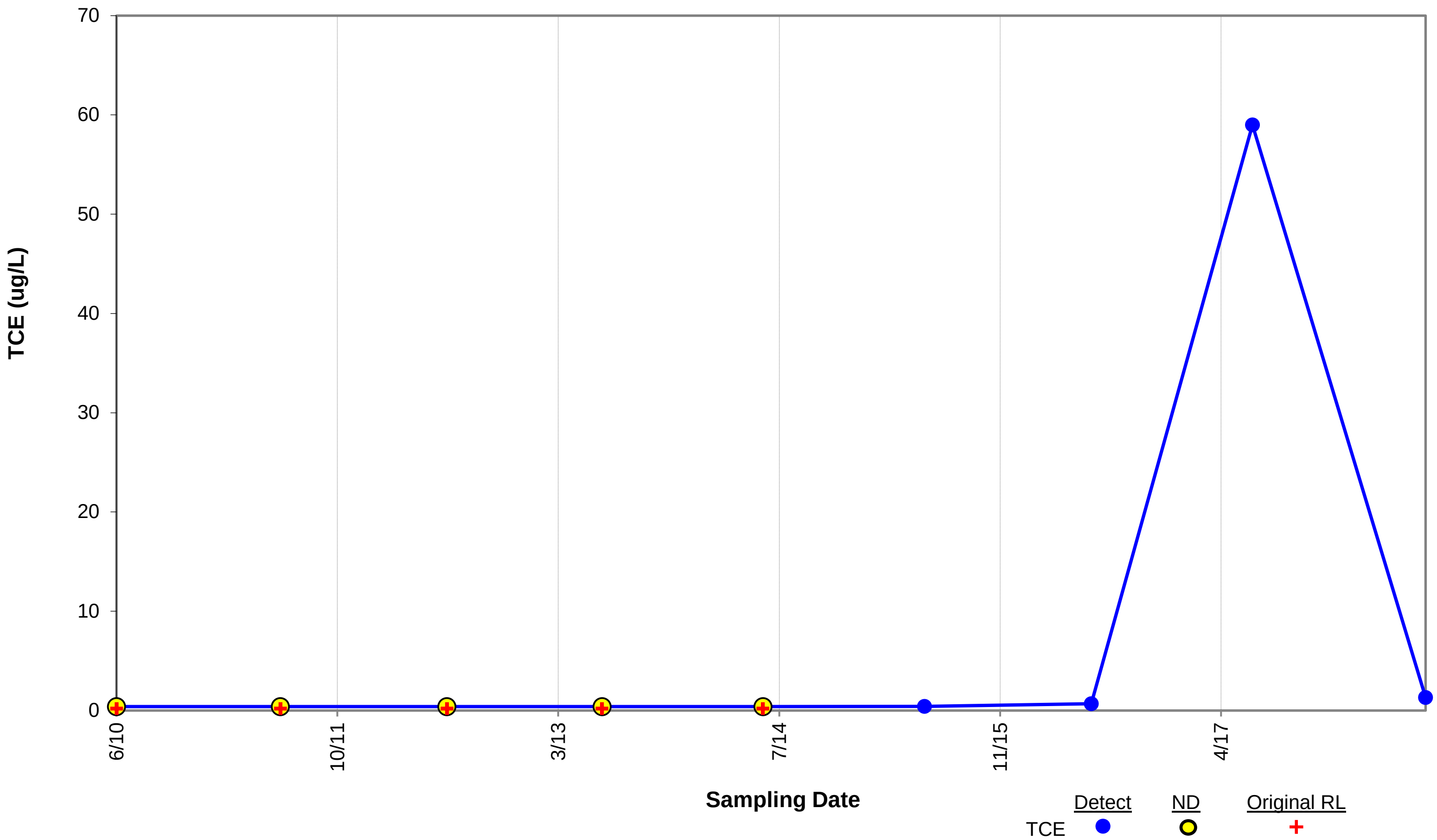
**Concentration vs. Time Plot – TCE in Well 04J847**
TCAAP

**Figure D.2.2-20**




| | | | |
|---|---|---|---|
| **Mann-Kendall Test Result:** | INCREASING TREND | | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| | p-value = | 0.006 | |
| **Theil-Sen Trend Line Result:** | **No Significant Trend** | | |
| | Median Slope Estimate = | 1.9E-04 | ug/L per day |
| | 95% Confidence Interval = | 0.0E+00 to 6.7E-04 | ug/L per day |

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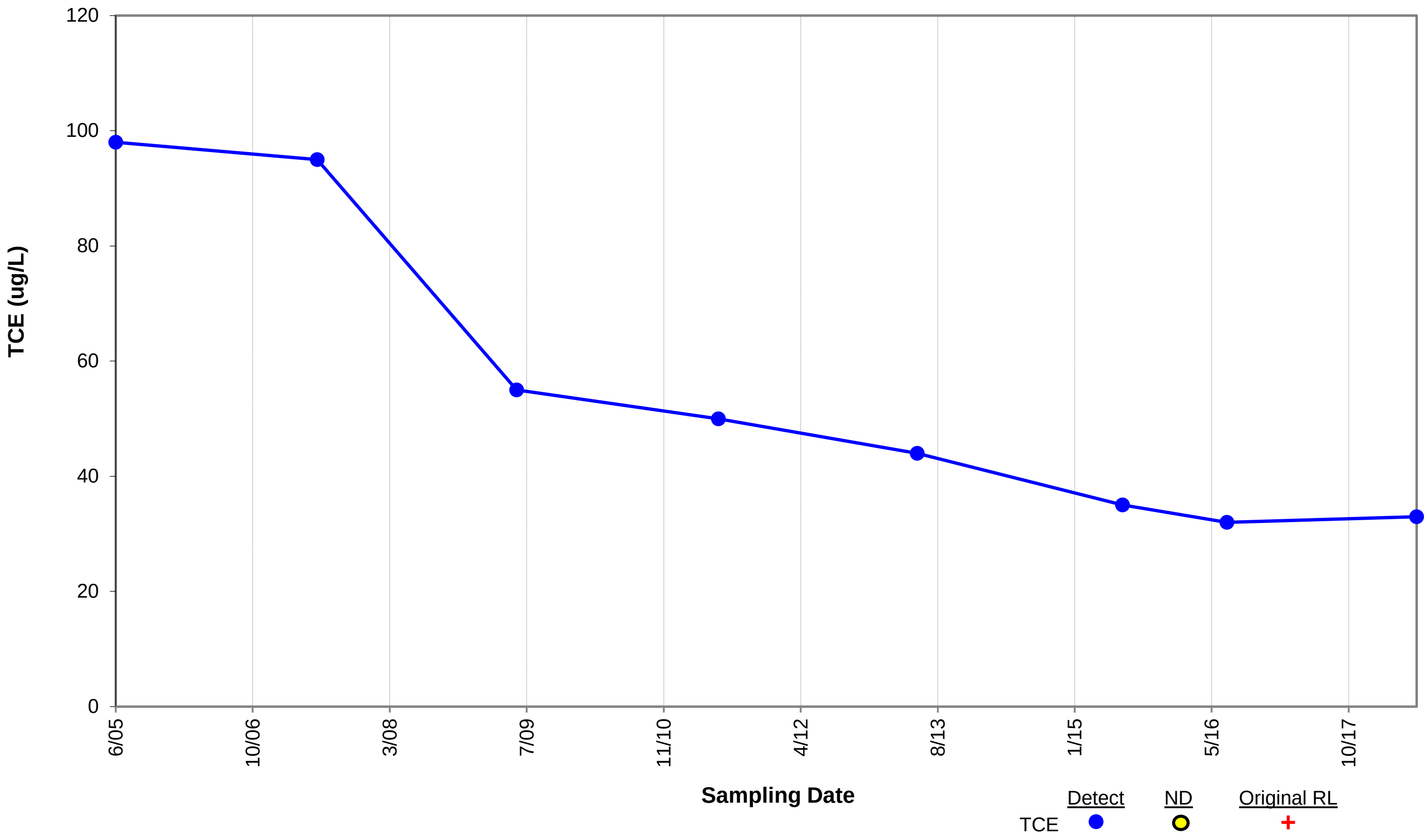
**Concentration vs. Time Plot – TCE in Well 04J849**

TCAAP

**Figure D.2.2-21**




| | | | |
|---|---|---|---|
| **Mann-Kendall Test Result:** | **DECREASING TREND** | | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| | p-value = | <0.001 | |
| **Theil-Sen Trend Line Result:** | **DECREASING TREND** | | |
| | Median Slope Estimate = | -1.0E-02 | ug/L per day |
| | 95% Confidence Interval = | -2.0E-02 to -6.9E-03 | ug/L per day |

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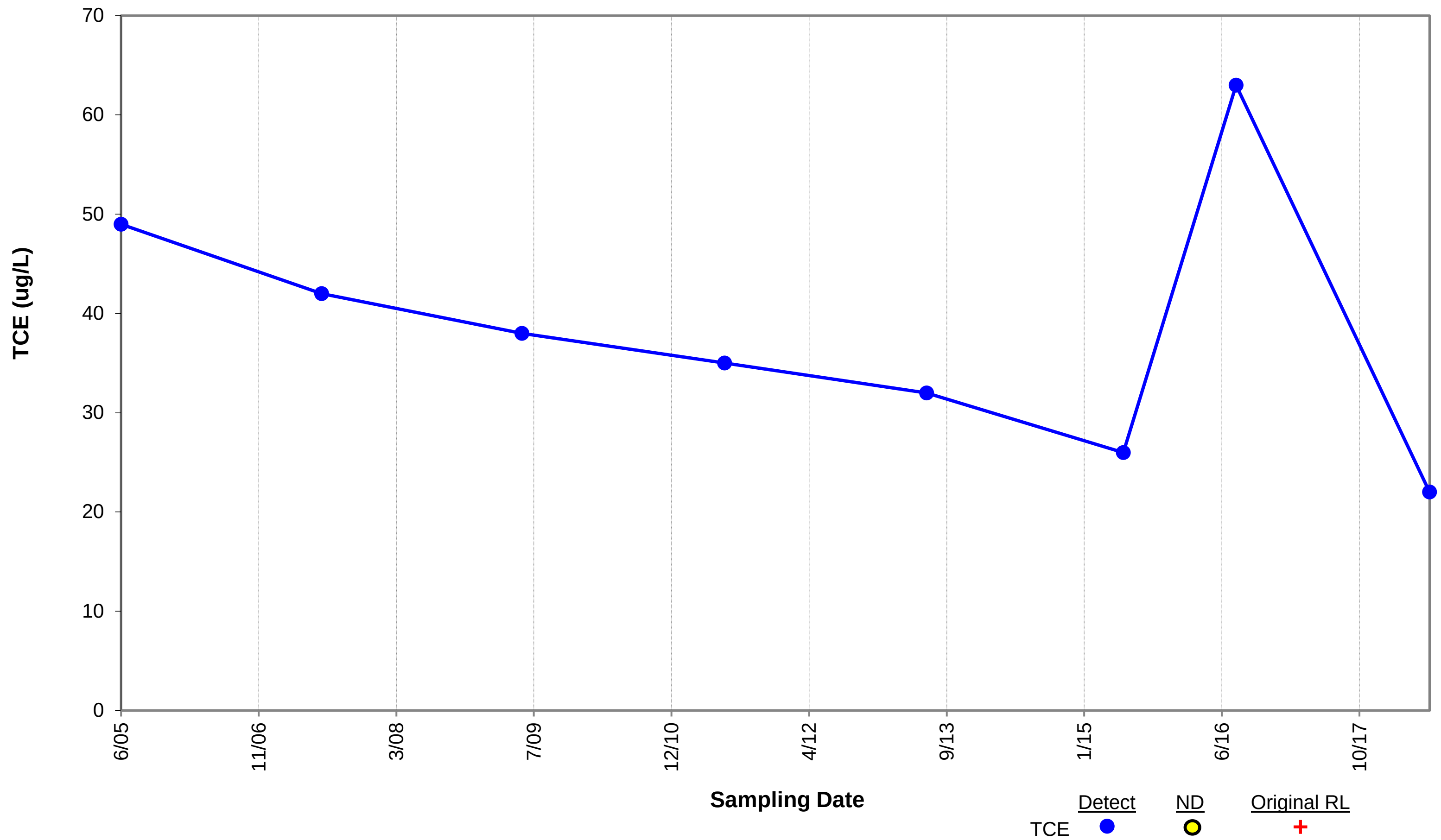
**Concentration vs. Time Plot – TCE in Well 04U077**

TCAAP

**Figure D.2.2-22**




**Mann-Kendall Test Result:** DECREASING TREND

p-value = 0.031

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** DECREASING TREND

Median Slope Estimate = -5.0E-03 ug/L per day

95% Confidence Interval = -6.3E-03 to -3.6E-03 ug/L per day

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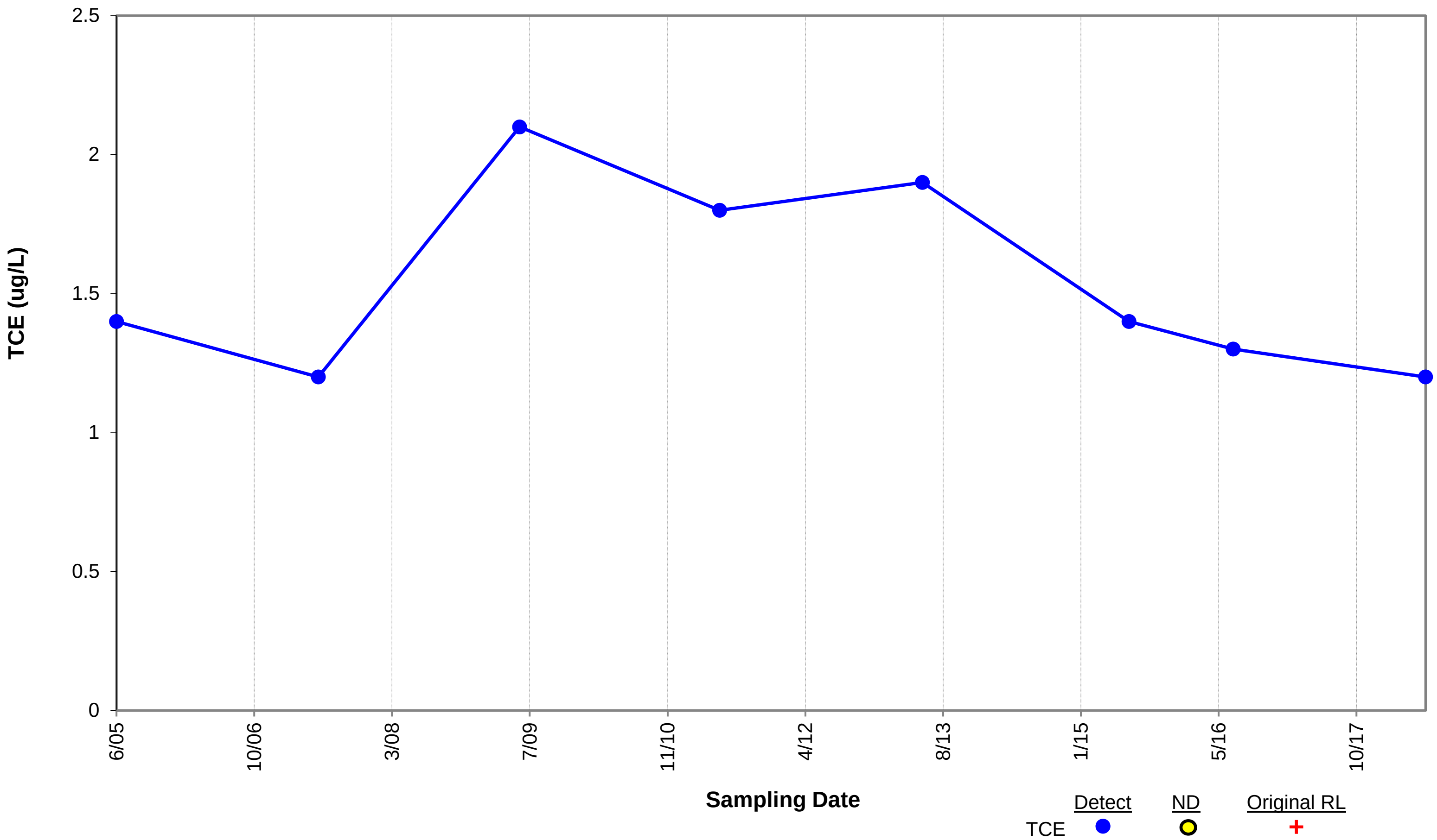
**Concentration vs. Time Plot – TCE in Well 04U673**

TCAAP

**Figure D.2.2-23**




**Mann-Kendall Test Result:** **No Significant Trend**
p-value = 0.199

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** **No Significant Trend**
Median Slope Estimate = -1.4E-04 ug/L per day
95% Confidence Interval = -3.0E-04 to 1.2E-04 ug/L per day

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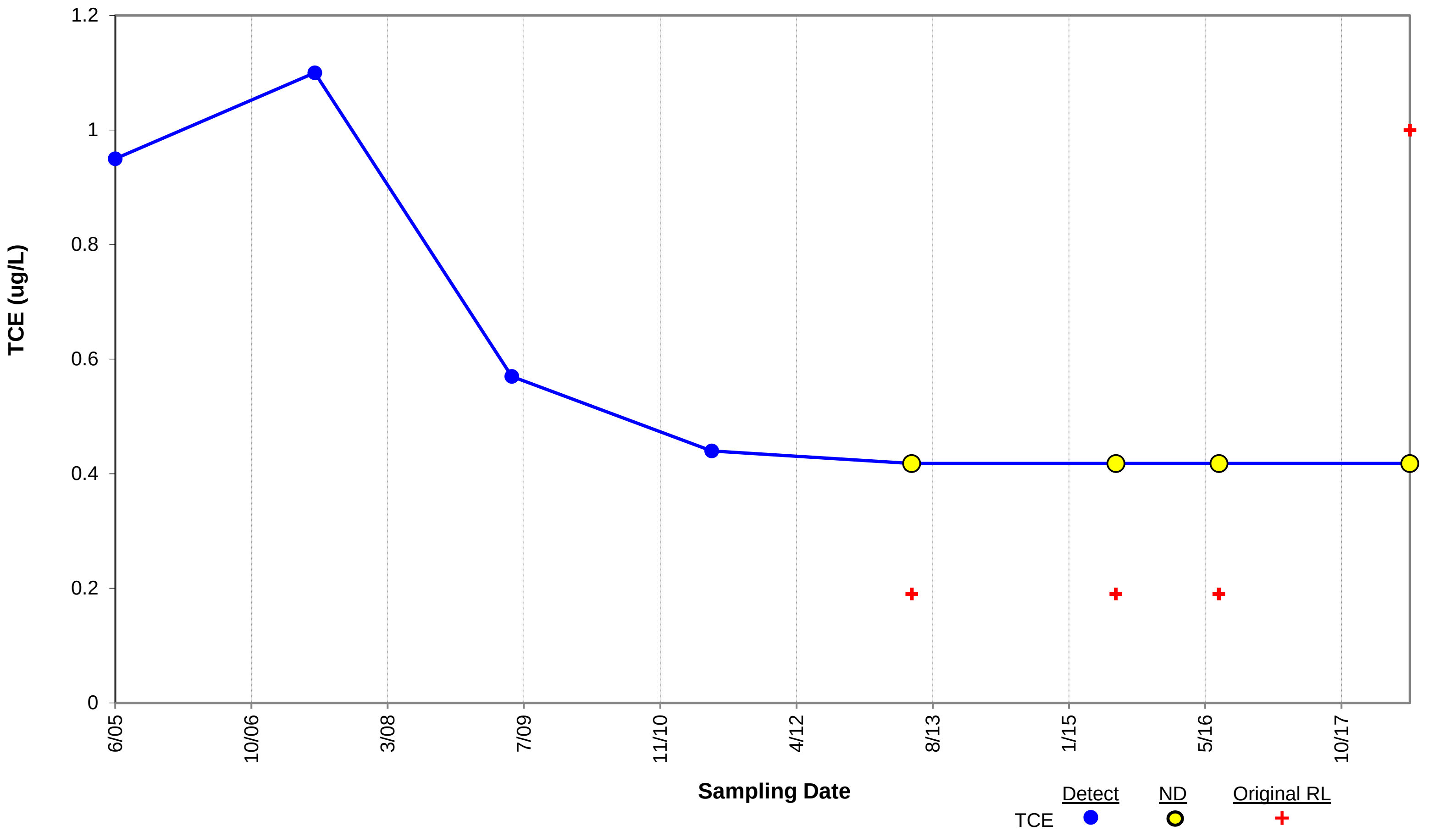
**Concentration vs. Time Plot – TCE in Well 04U702**
TCAAP

**Figure D.2.2-24**




**Mann-Kendall Test Result:** DECREASING TREND
p-value = 0.007

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** DECREASING TREND
Median Slope Estimate = -8.6E-05 ug/L per day
95% Confidence Interval = -2.2E-04 to -5.3E-06 ug/L per day

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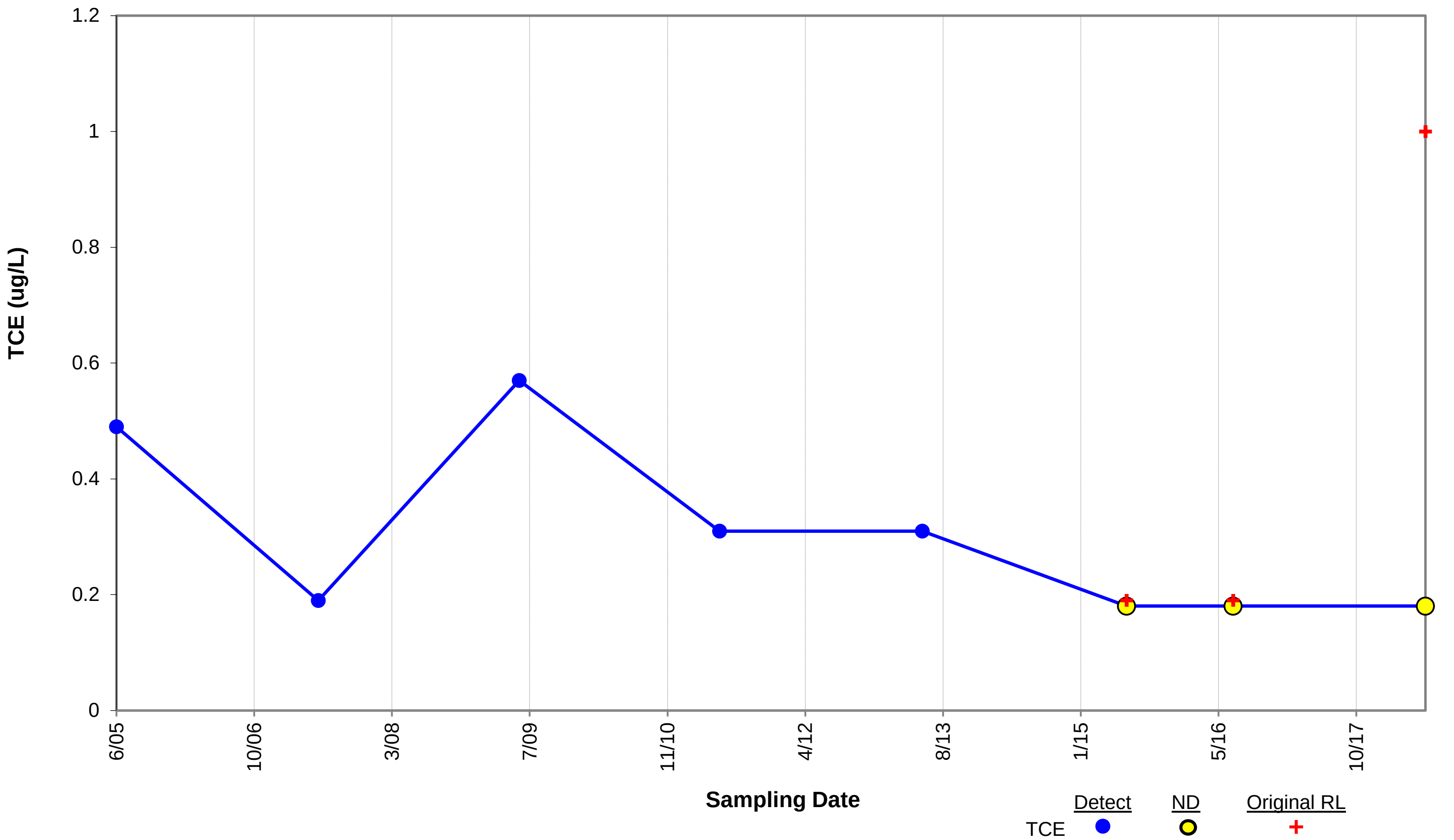
**Concentration vs. Time Plot – TCE in Well 04U708**
TCAAP

**Figure D.2.2-25**




**Mann-Kendall Test Result:** DECREASING TREND
p-value = 0.031

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** **No Significant Trend**
Median Slope Estimate = -6.7E-05 ug/L per day
95% Confidence Interval = -1.4E-04 to 0.0E+00 ug/L per day

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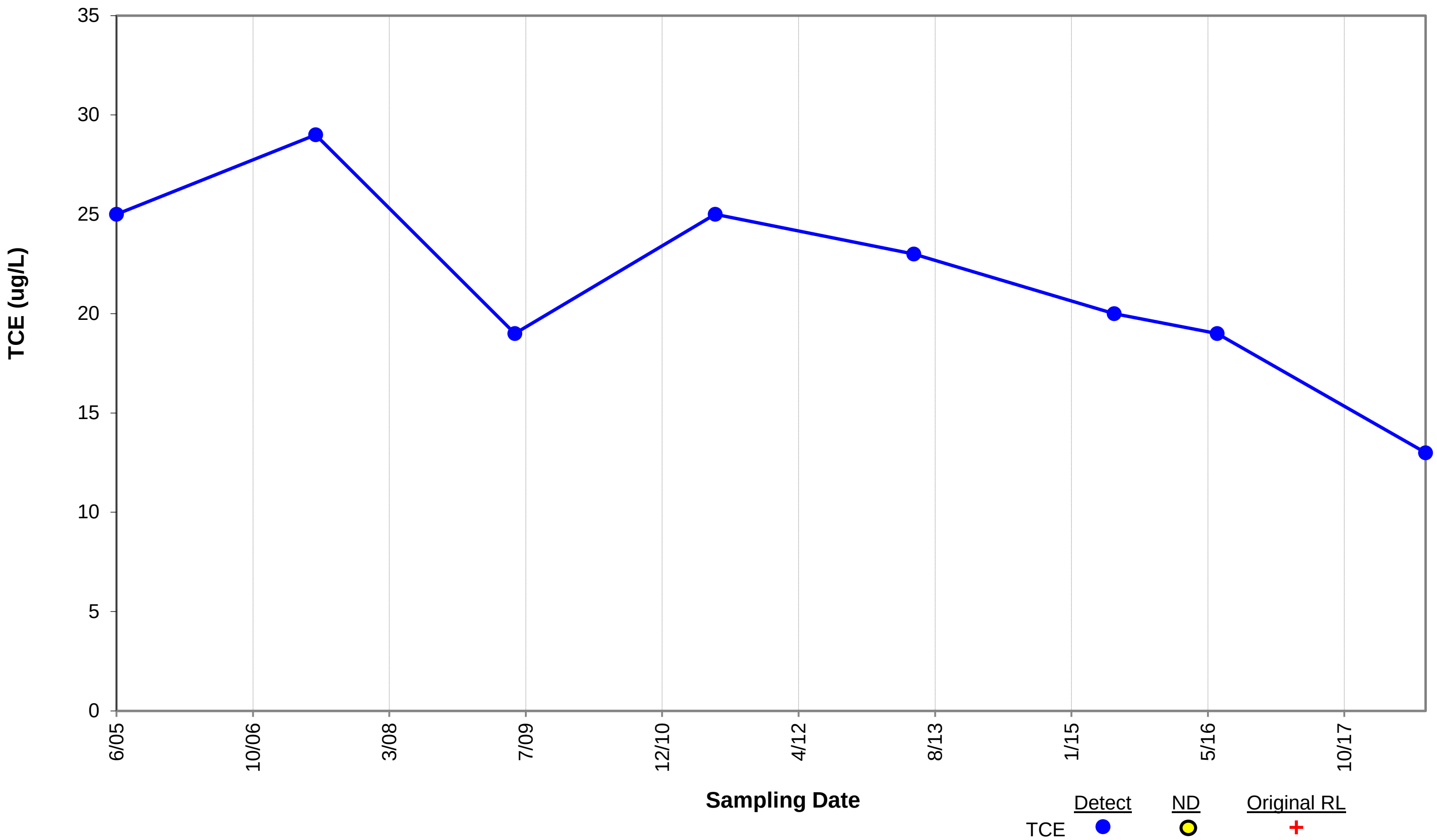
**Concentration vs. Time Plot – TCE in Well 04U713**
TCAAP

**Figure D.2.2-26**




**Mann-Kendall Test Result:** DECREASING TREND
p-value = 0.016

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** DECREASING TREND
Median Slope Estimate = -2.7E-03 ug/L per day
95% Confidence Interval = -4.1E-03 to -8.2E-04 ug/L per day

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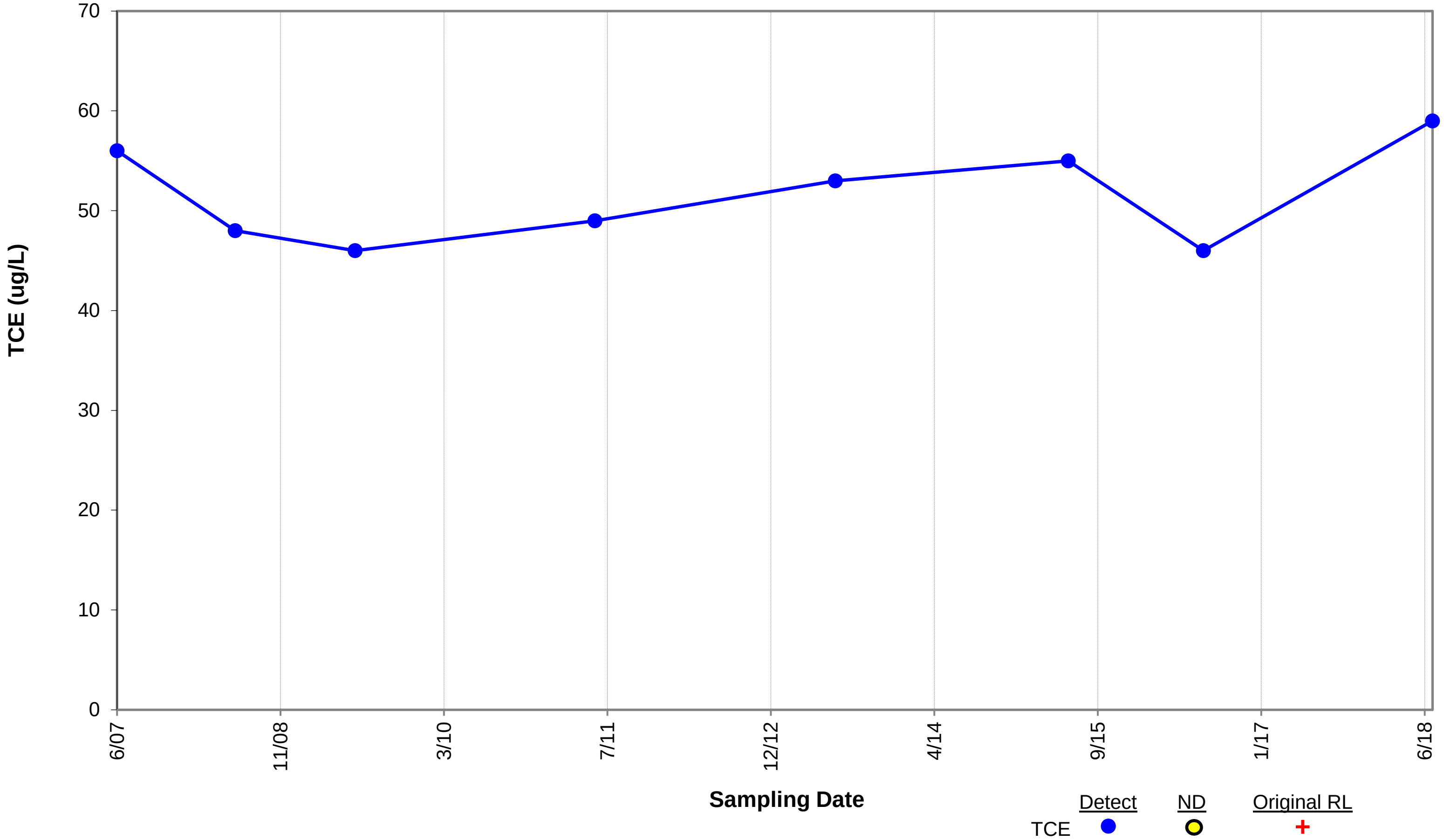
**Concentration vs. Time Plot – TCE in Well 04U821**
TCAAP

**Figure D.2.2-27**




| | | |
|---|---|---|
| **Mann-Kendall Test Result:** | **No Significant Trend**<br>p-value = 0.317 | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| **Theil-Sen Trend Line Result:** | **No Significant Trend**<br>Median Slope Estimate = 1.8E-03 ug/L per day<br>95% Confidence Interval = -4.5E-03 to 3.9E-03 ug/L per day | |

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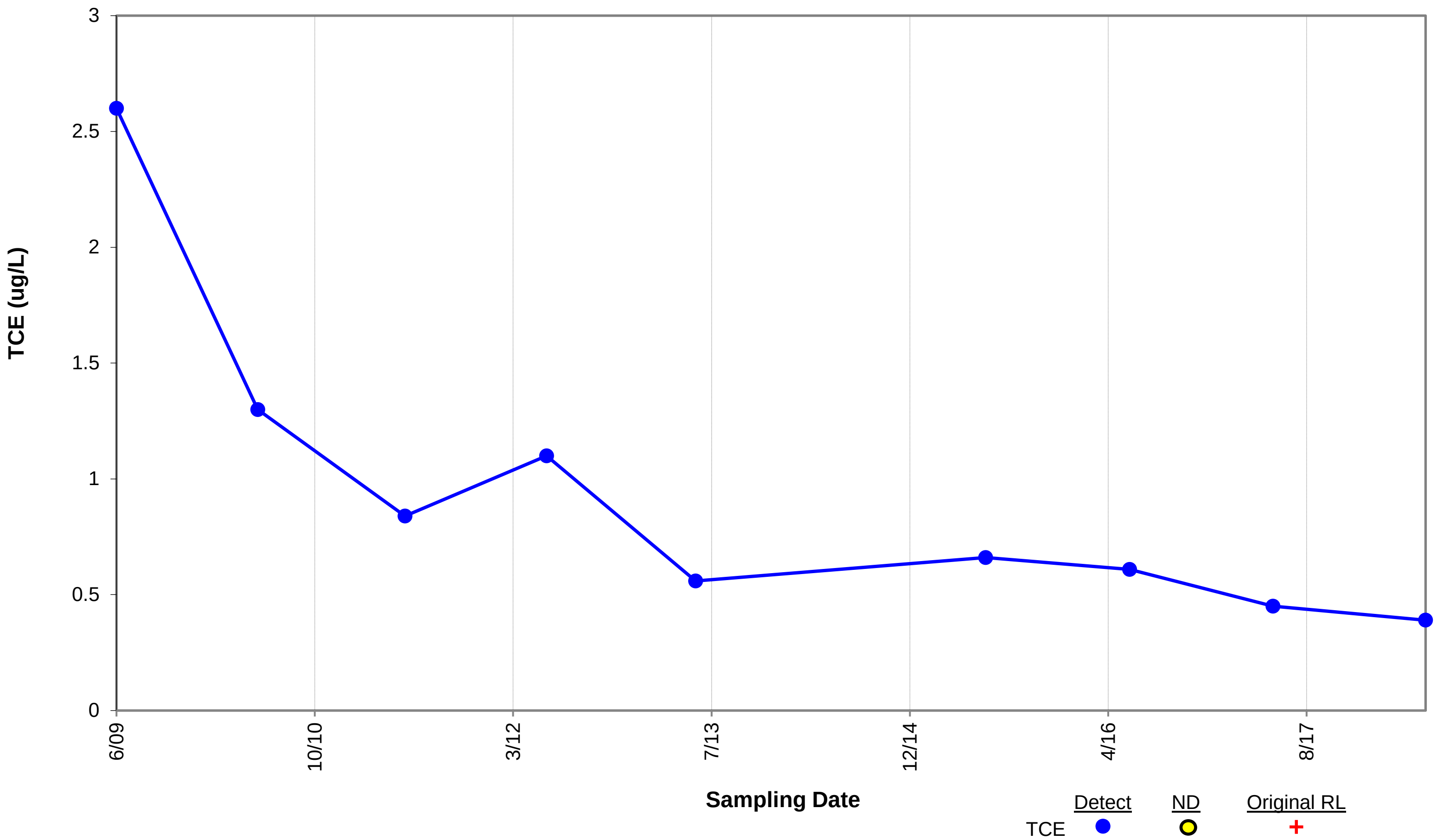
**Concentration vs. Time Plot – TCE in Well 04U832**
TCAAP

**Figure D.2.2-28**




| | | | |
|---|---|---|---|
| **Mann-Kendall Test Result:** | **DECREASING TREND** | | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| | p-value = | <0.001 | |
| **Theil-Sen Trend Line Result:** | **DECREASING TREND** | | |
| | Median Slope Estimate = | -3.3E-04 | ug/L per day |
| | 95% Confidence Interval = | -7.5E-04 to -1.7E-04 | ug/L per day |

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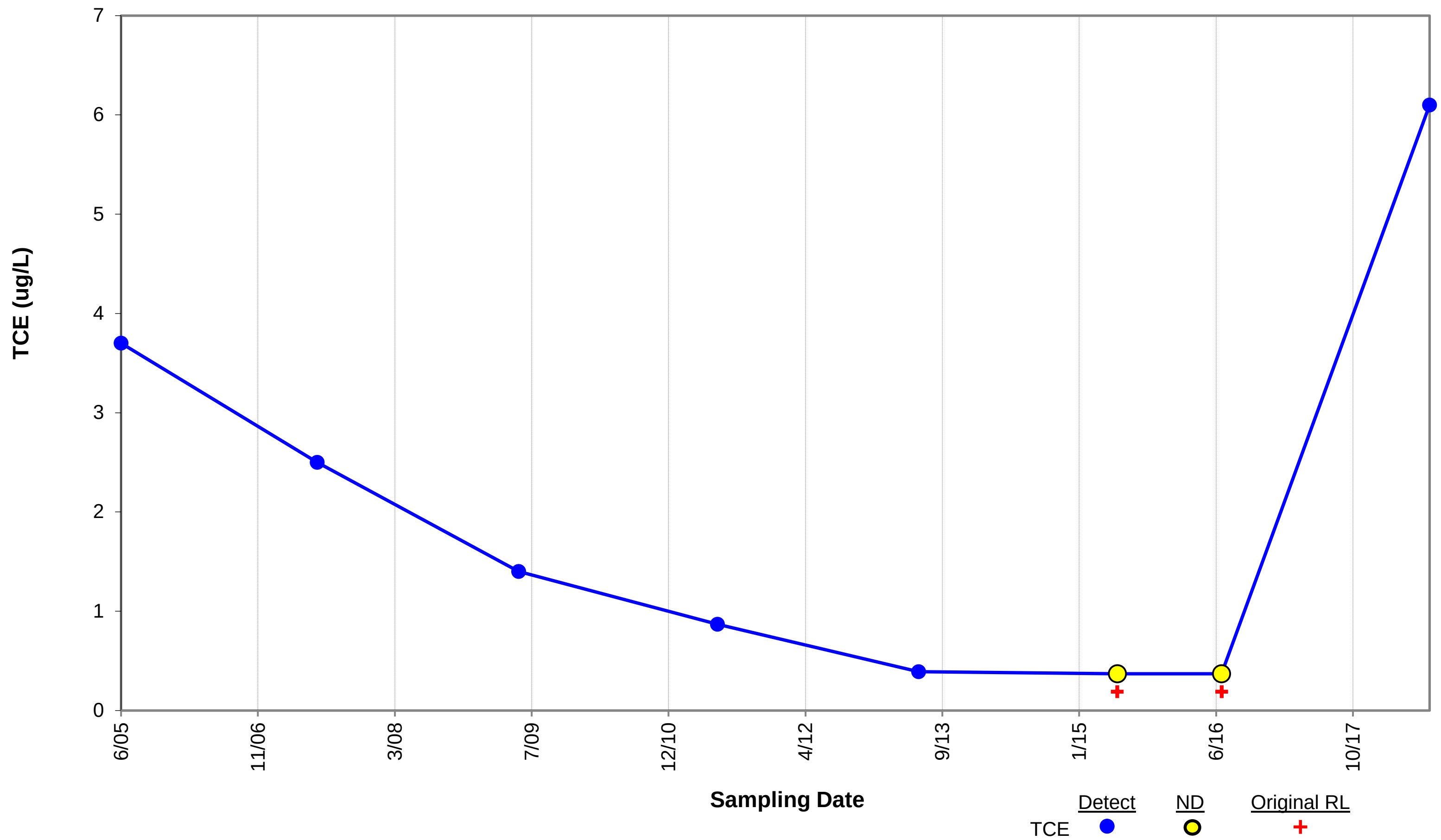
**Concentration vs. Time Plot – TCE in Well 04U833**

TCAAP

**Figure D.2.2-29**




**Mann-Kendall Test Result:** **No Significant Trend**
p-value = 0.072

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** **No Significant Trend**
Median Slope Estimate = -5.6E-04 ug/L per day
95% Confidence Interval = -1.1E-03 to 4.3E-04 ug/L per day

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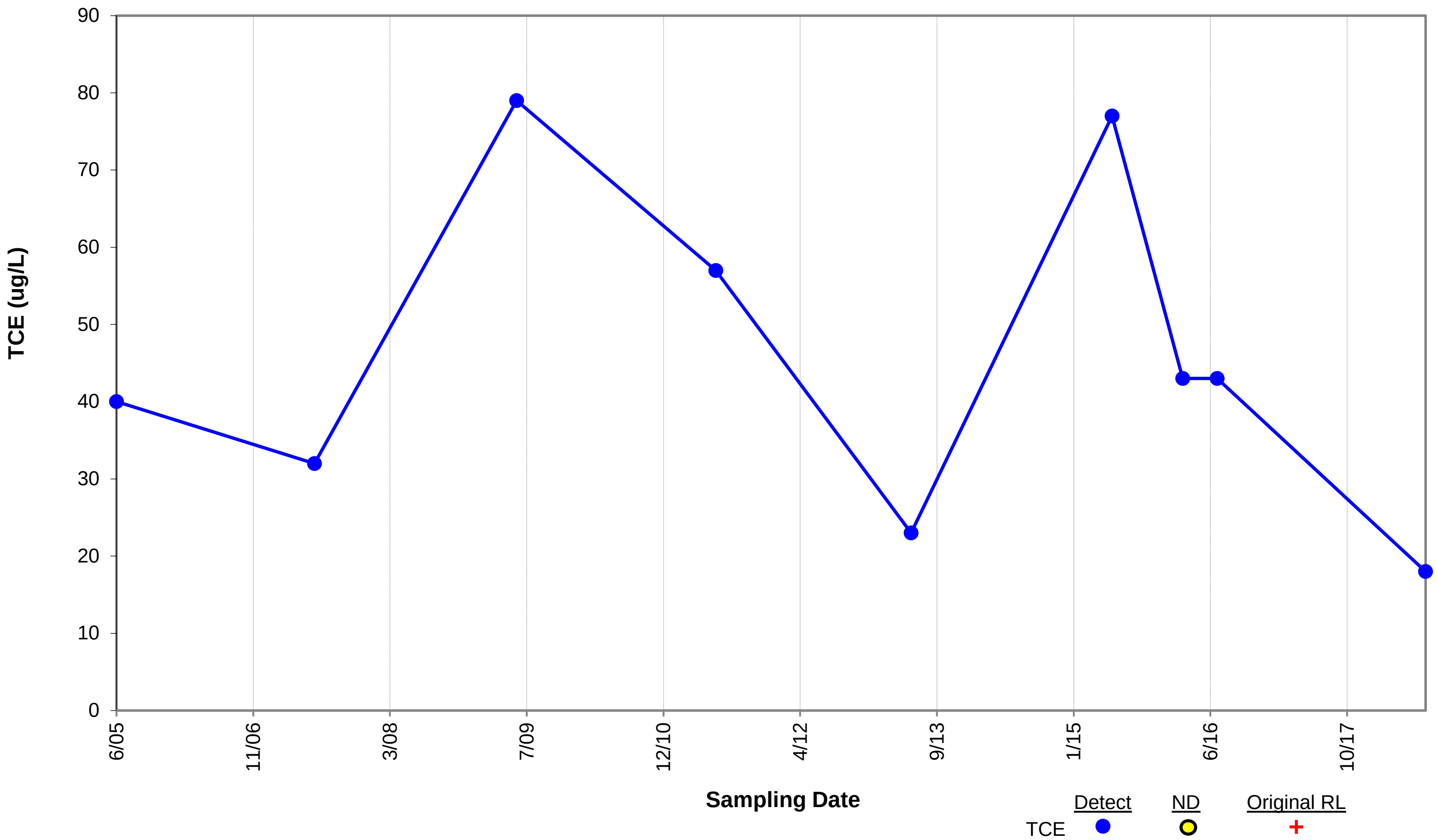
**Concentration vs. Time Plot – TCE in Well 04U834**
TCAAP

**Figure D.2.2-30**




| | | | |
|---|---|---|---|
| **Mann-Kendall Test Result:** | **No Significant Trend** | | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| | p-value = | 0.272 | |
| **Theil-Sen Trend Line Result:** | **No Significant Trend** | | |
| | Median Slope Estimate = | -3.8E-03 | ug/L per day |
| | 95% Confidence Interval = | -2.2E-02 to 8.6E-03 | ug/L per day |

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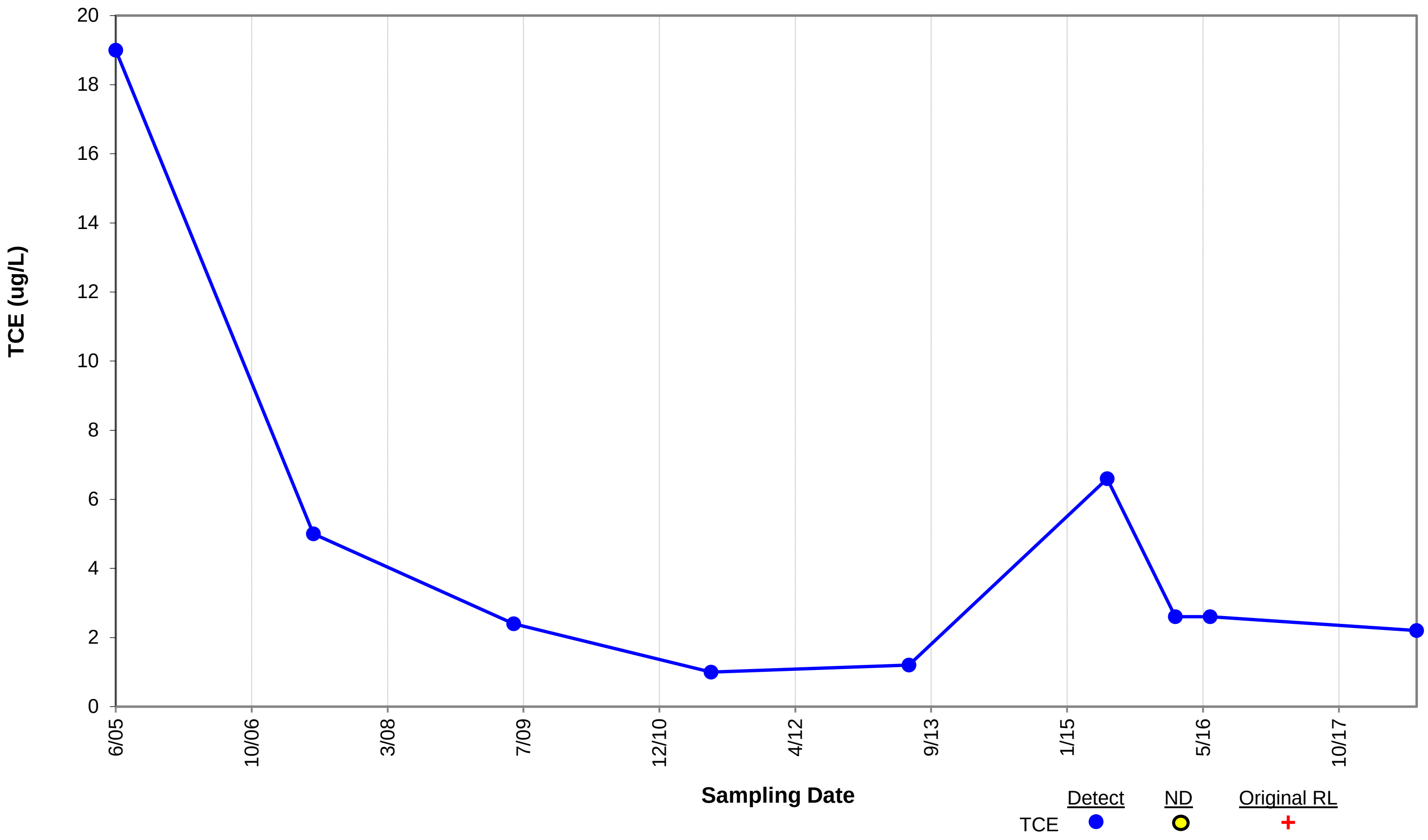
**Concentration vs. Time Plot – TCE in Well 04U836**

TCAAP

**Figure D.2.2-31**




| | | | | |
|---|---|---|---|---|
| **Mann-Kendall Test Result:** | **No Significant Trend** | | | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| | p-value = | 0.209 | | |
| **Theil-Sen Trend Line Result:** | **No Significant Trend** | | | |
| | Median Slope Estimate = | -7.1E-04 | ug/L per day | |
| | 95% Confidence Interval = | -3.9E-03 | to 4.9E-04 | ug/L per day |

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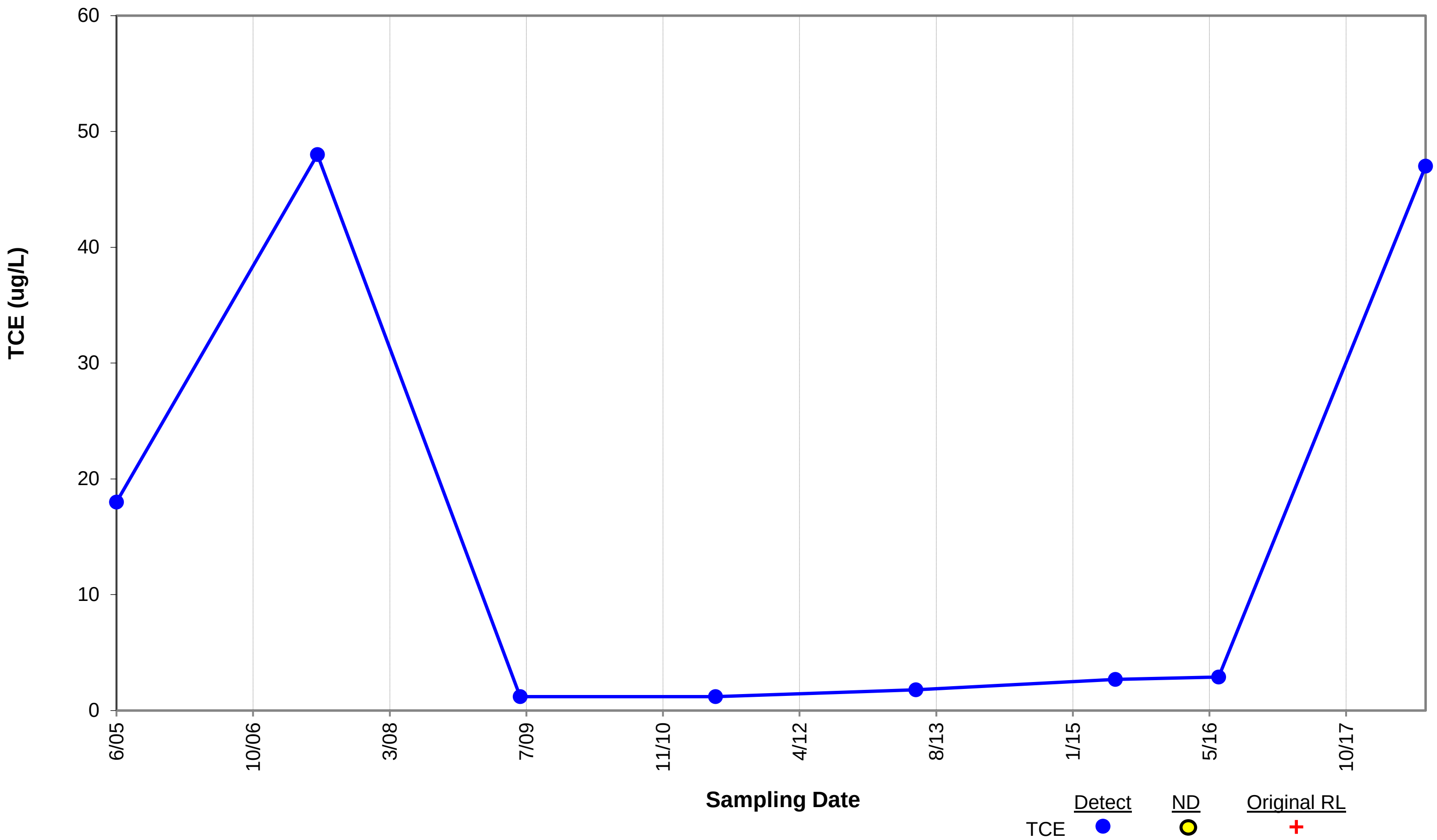
**Concentration vs. Time Plot – TCE in Well 04U837**

TCAAP

**Figure D.2.2-32**




**Mann-Kendall Test Result:** **No Significant Trend**
p-value = 0.317

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** **No Significant Trend**
Median Slope Estimate = 6.0E-04 ug/L per day
95% Confidence Interval = -1.1E-02 to 5.4E-03 ug/L per day

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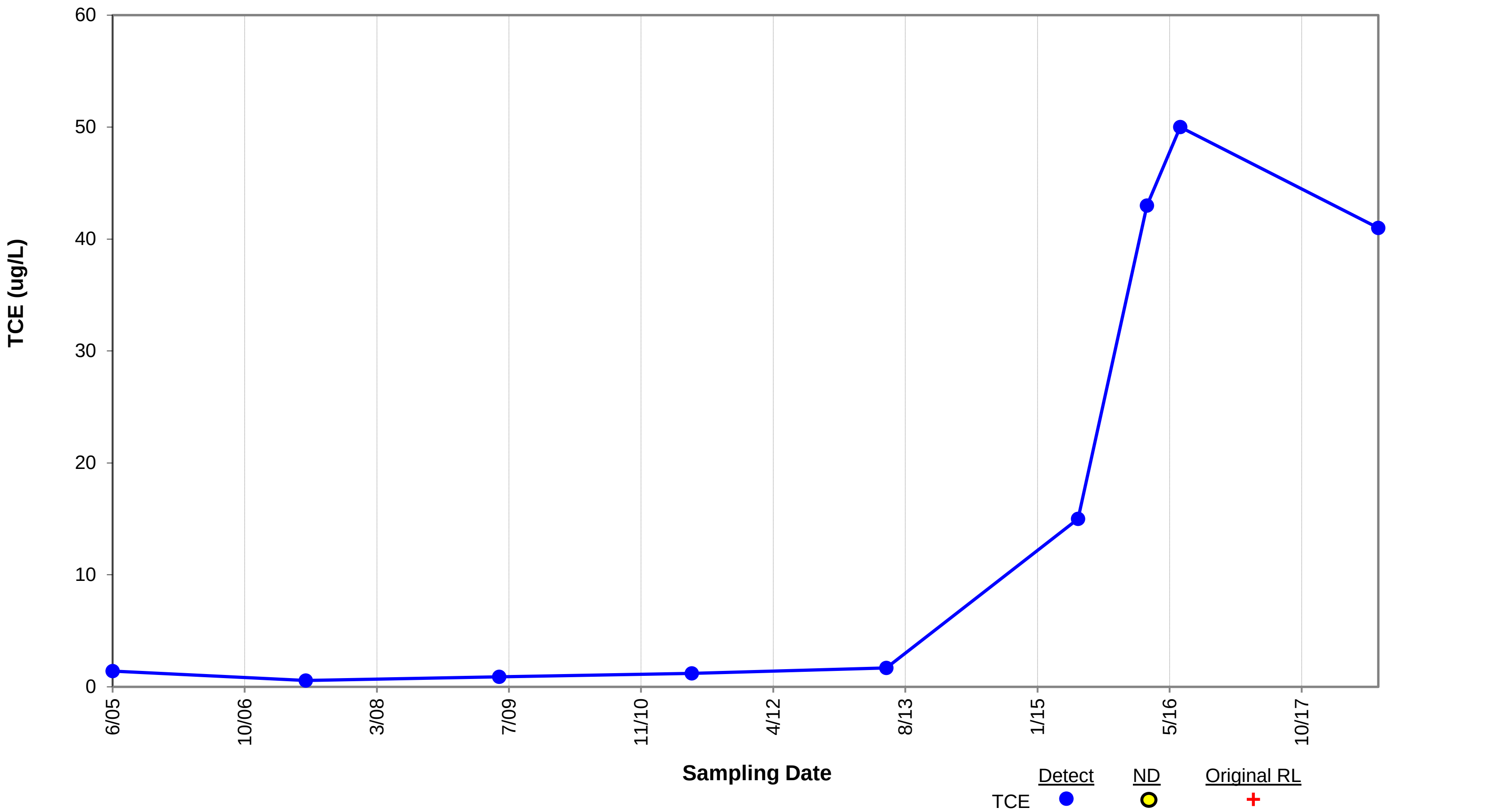
**Concentration vs. Time Plot – TCE in Well 04U838**
TCAAP

**Figure D.2.2-33**




**Mann-Kendall Test Result:** INCREASING TREND

p-value = 0.003

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** INCREASING TREND

Median Slope Estimate = 1.0E-02 ug/L per day

95% Confidence Interval = 4.3E-04 to 2.0E-02 ug/L per day

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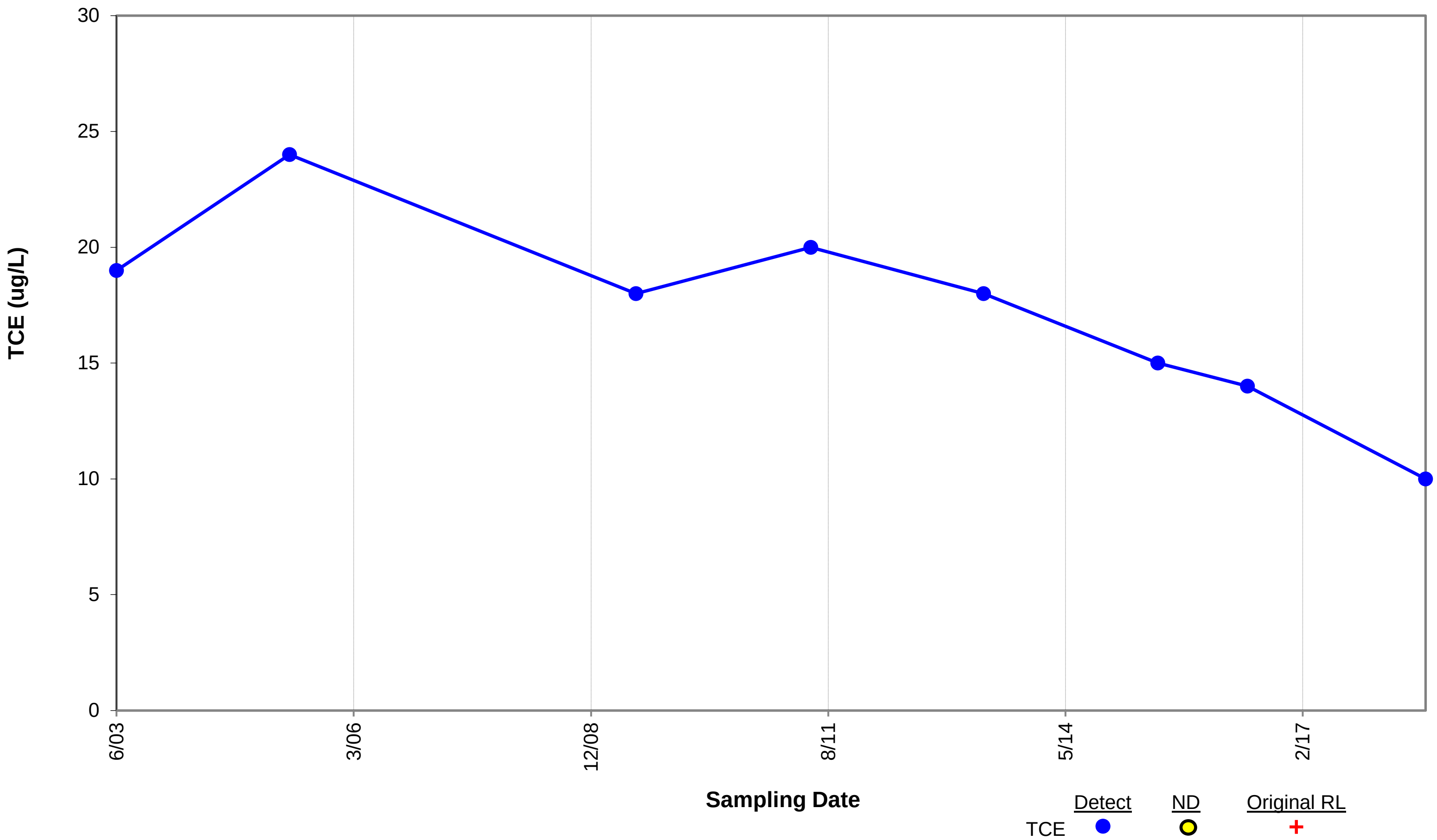
**Concentration vs. Time Plot – TCE in Well 04U839**

TCAAP

**Figure D.2.2-34**




**Mann-Kendall Test Result:** DECREASING TREND

p-value = 0.005

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** DECREASING TREND

Median Slope Estimate = -2.4E-03 ug/L per day

95% Confidence Interval = -3.8E-03 to -9.3E-04 ug/L per day

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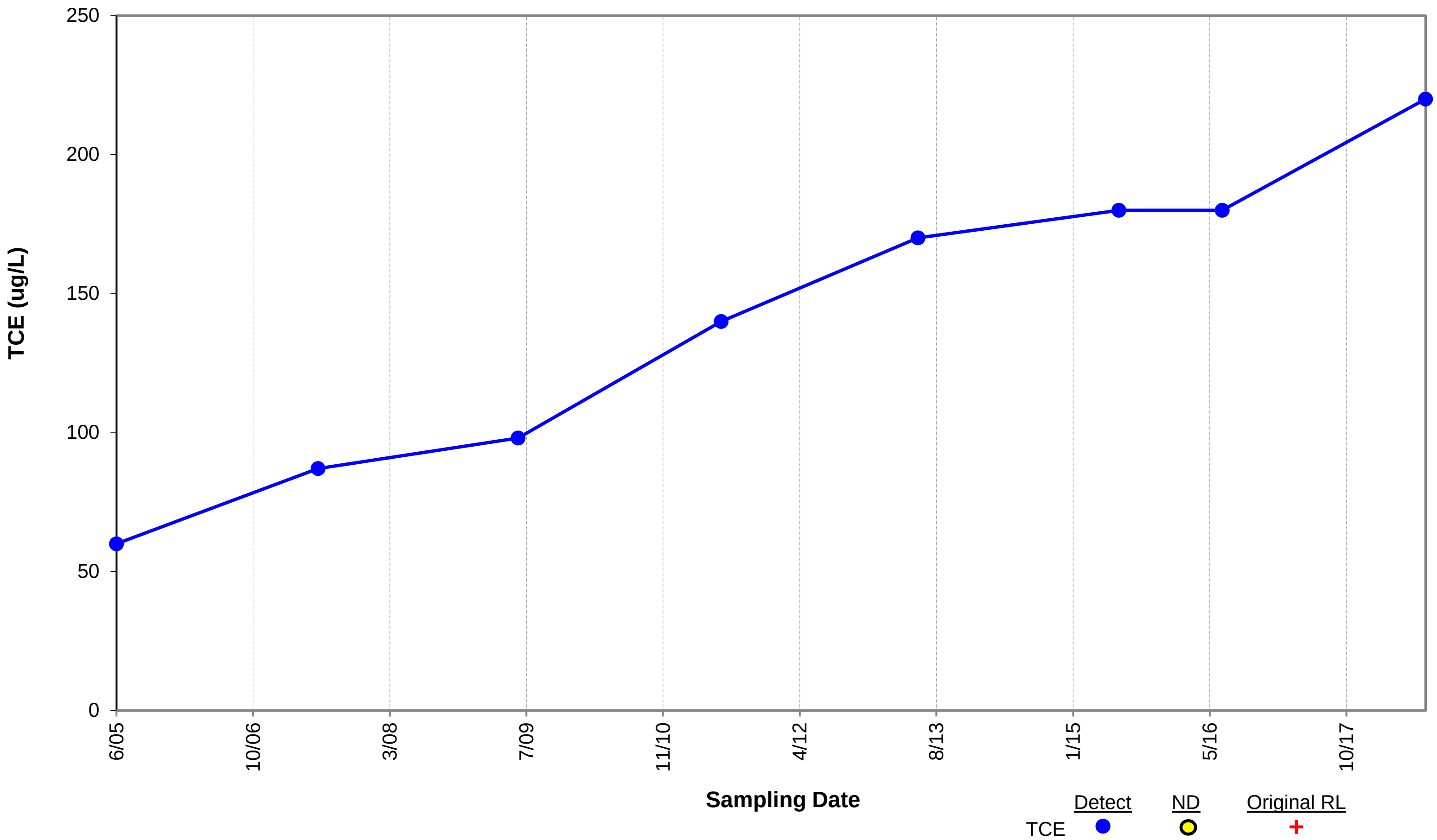
**Concentration vs. Time Plot – TCE in Well 04U841**

TCAAP

**Figure D.2.2-35**




**Mann-Kendall Test Result:** INCREASING TREND
p-value = <0.001

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** INCREASING TREND
Median Slope Estimate = 3.3E-02 ug/L per day
95% Confidence Interval = 2.6E-02 to 3.7E-02 ug/L per day

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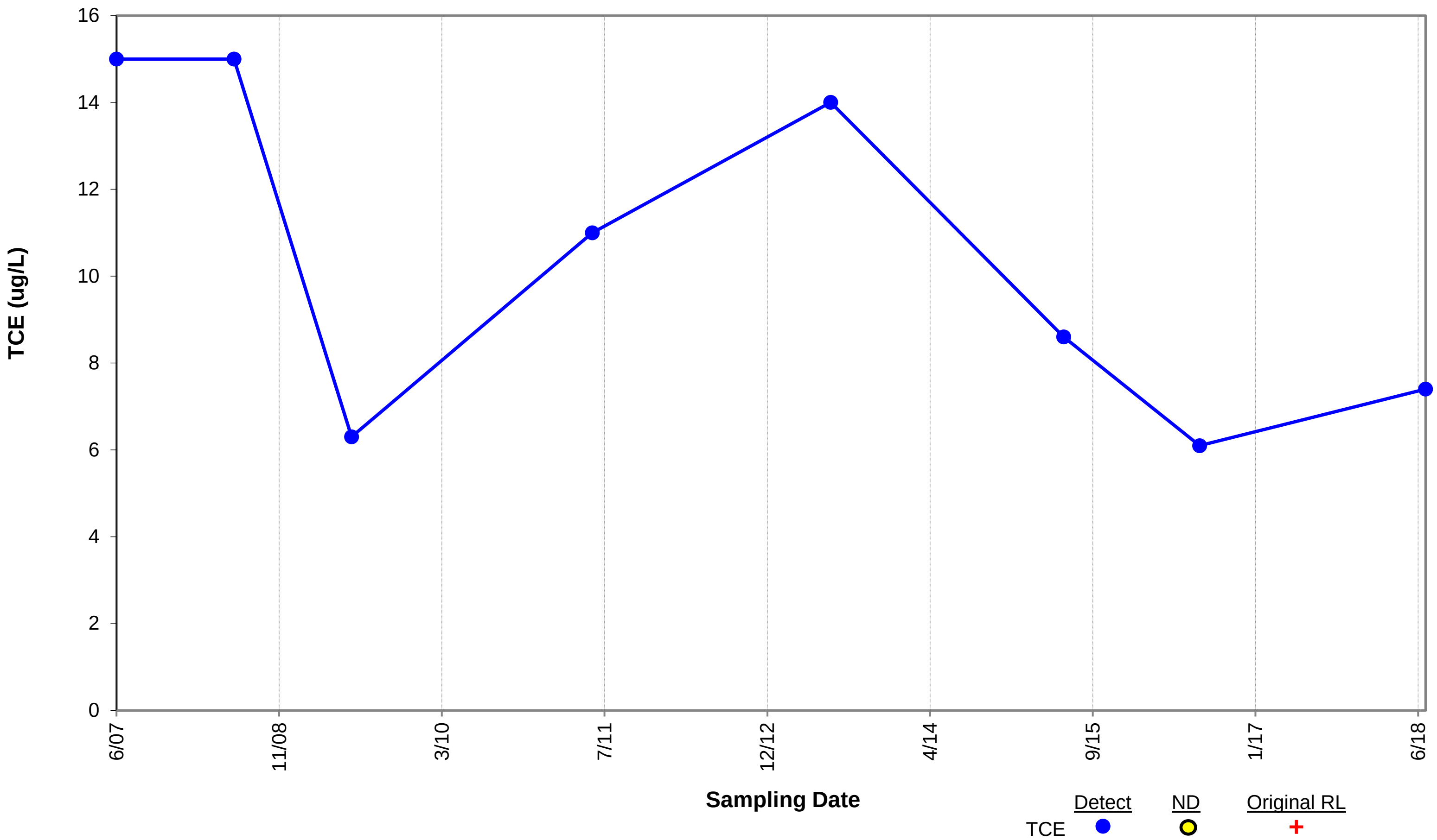
**Concentration vs. Time Plot – TCE in Well 04U843**
TCAAP

**Figure D.2.2-36**




**Mann-Kendall Test Result:** DECREASING TREND

p-value = 0.043

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** DECREASING TREND

Median Slope Estimate = -2.0E-03 ug/L per day

95% Confidence Interval = -3.6E-03 to -1.1E-05 ug/L per day

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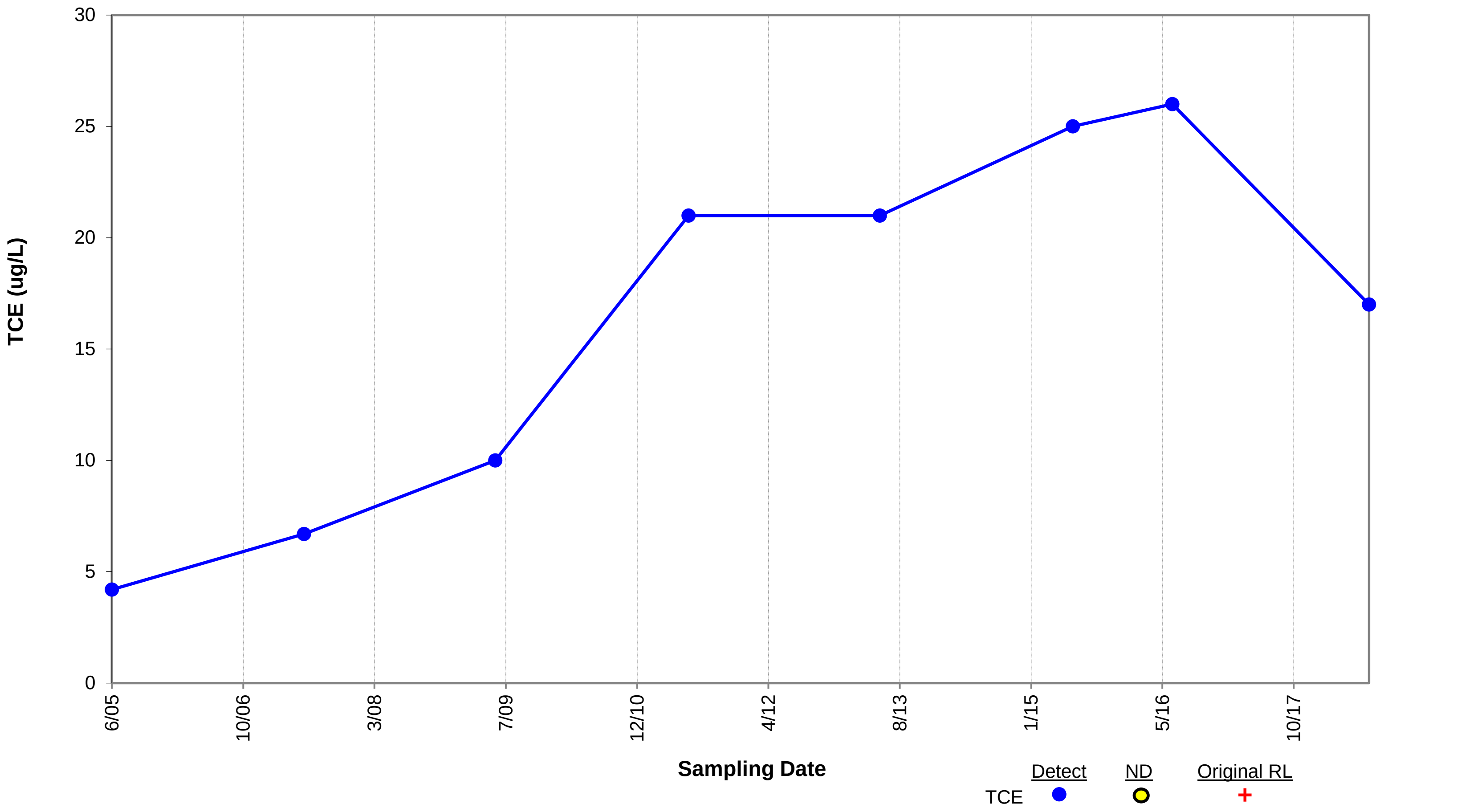
**Concentration vs. Time Plot – TCE in Well 04U845**

TCAAP

**Figure D.2.2-37**




| | | | |
|---|---|---|---|
| **Mann-Kendall Test Result:** | INCREASING TREND | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). | |
| | p-value = 0.012 | | |
| **Theil-Sen Trend Line Result:** | INCREASING TREND | | |
| | Median Slope Estimate = | 4.5E-03 | ug/L per day |
| | 95% Confidence Interval = | 2.2E-03 to 6.2E-03 | ug/L per day |

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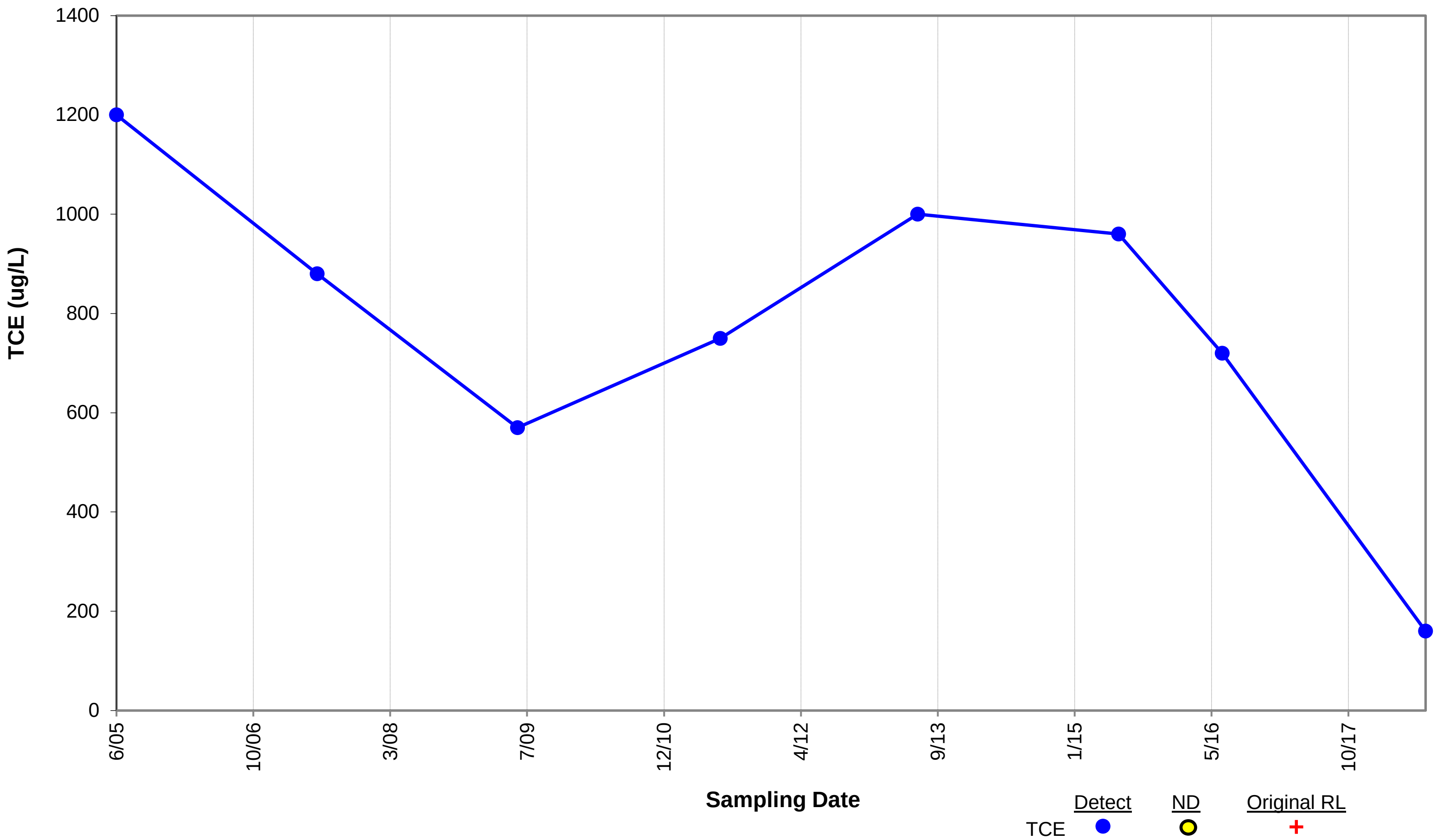
**Concentration vs. Time Plot – TCE in Well 04U846**

TCAAP

**Figure D.2.2-38**




| | | | |
|---|---|---|---|
| **Mann-Kendall Test Result:** | **No Significant Trend** | | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| | p-value = | 0.089 | |
| **Theil-Sen Trend Line Result:** | **No Significant Trend** | | |
| | Median Slope Estimate = | -1.0E-01 | ug/L per day |
| | 95% Confidence Interval = | -4.3E-01 to 5.3E-02 | ug/L per day |

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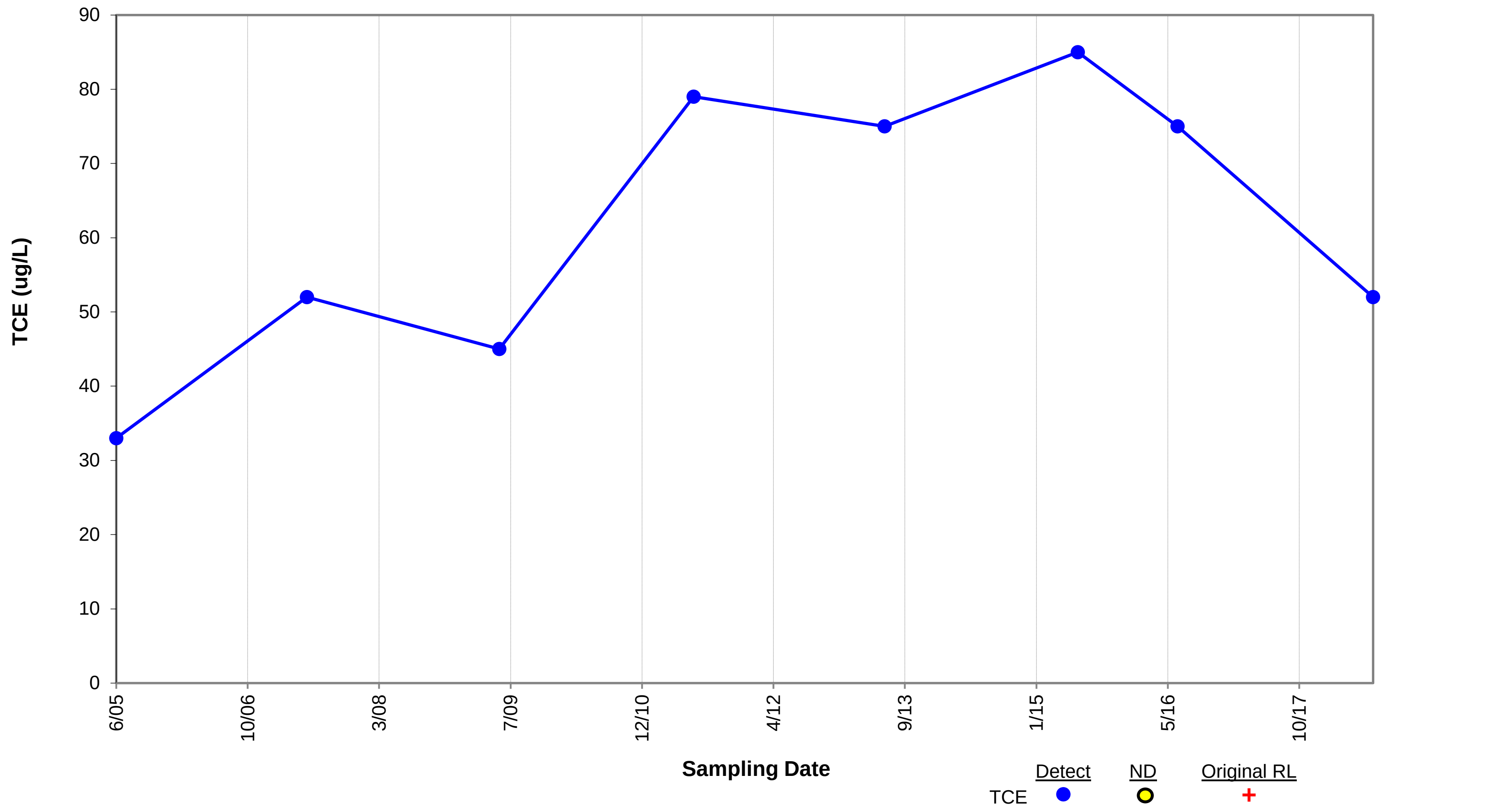
**Concentration vs. Time Plot – TCE in Well 04U847**

TCAAP

**Figure D.2.2-39**




**Mann-Kendall Test Result:** **No Significant Trend**
p-value = 0.138

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** **No Significant Trend**
Median Slope Estimate = 7.6E-03 ug/L per day
95% Confidence Interval = -8.7E-03 to 1.4E-02 ug/L per day

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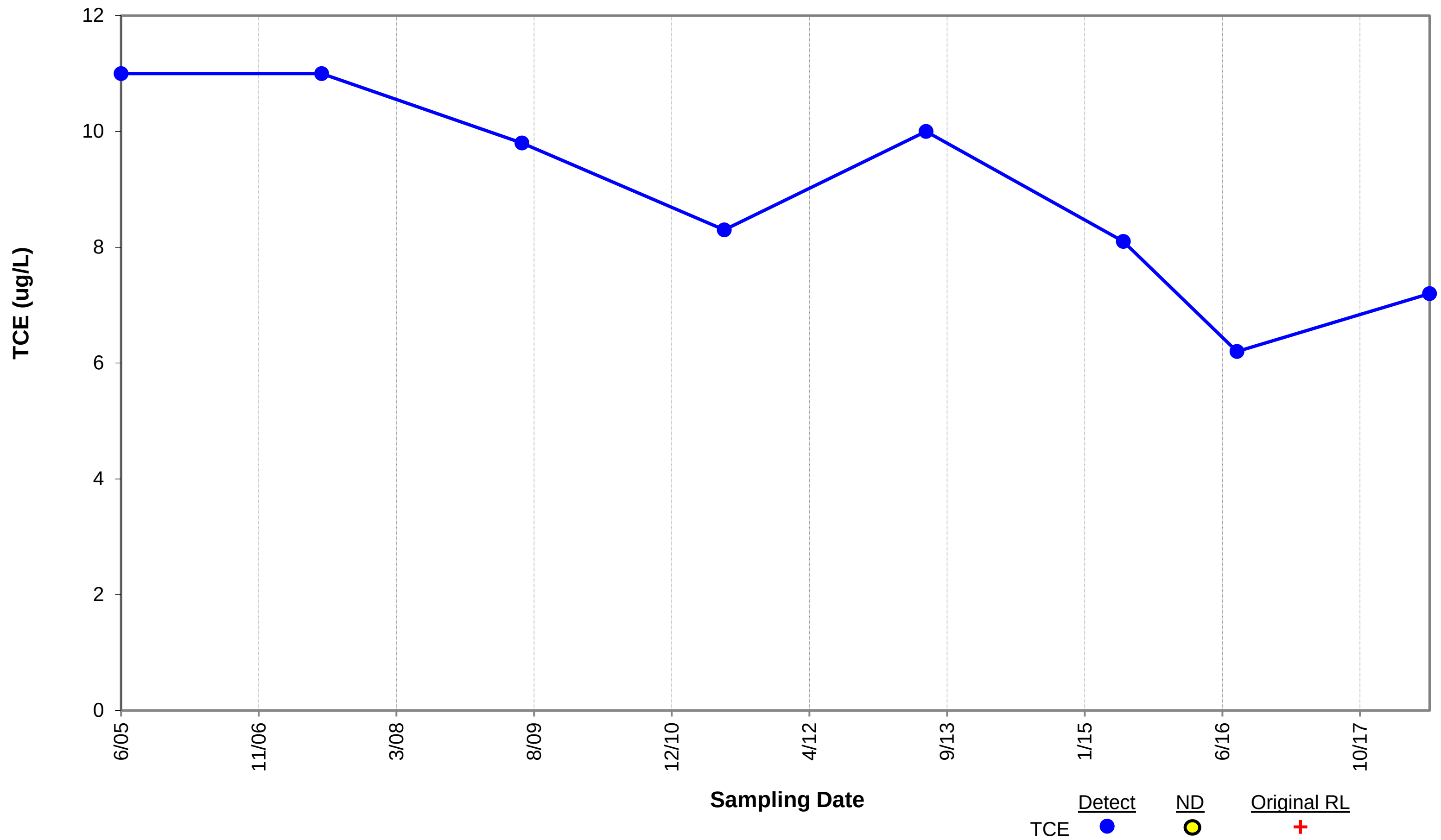
**Concentration vs. Time Plot – TCE in Well 04U849**
TCAAP

**Figure D.2.2-40**




| | | |
|---|---|---|
| **Mann-Kendall Test Result:** | **DECREASING TREND** p-value = 0.005 | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| **Theil-Sen Trend Line Result:** | **DECREASING TREND** Median Slope Estimate = -8.8E-04 ug/L per day; 95% Confidence Interval = -1.6E-03 to -4.3E-04 ug/L per day | |

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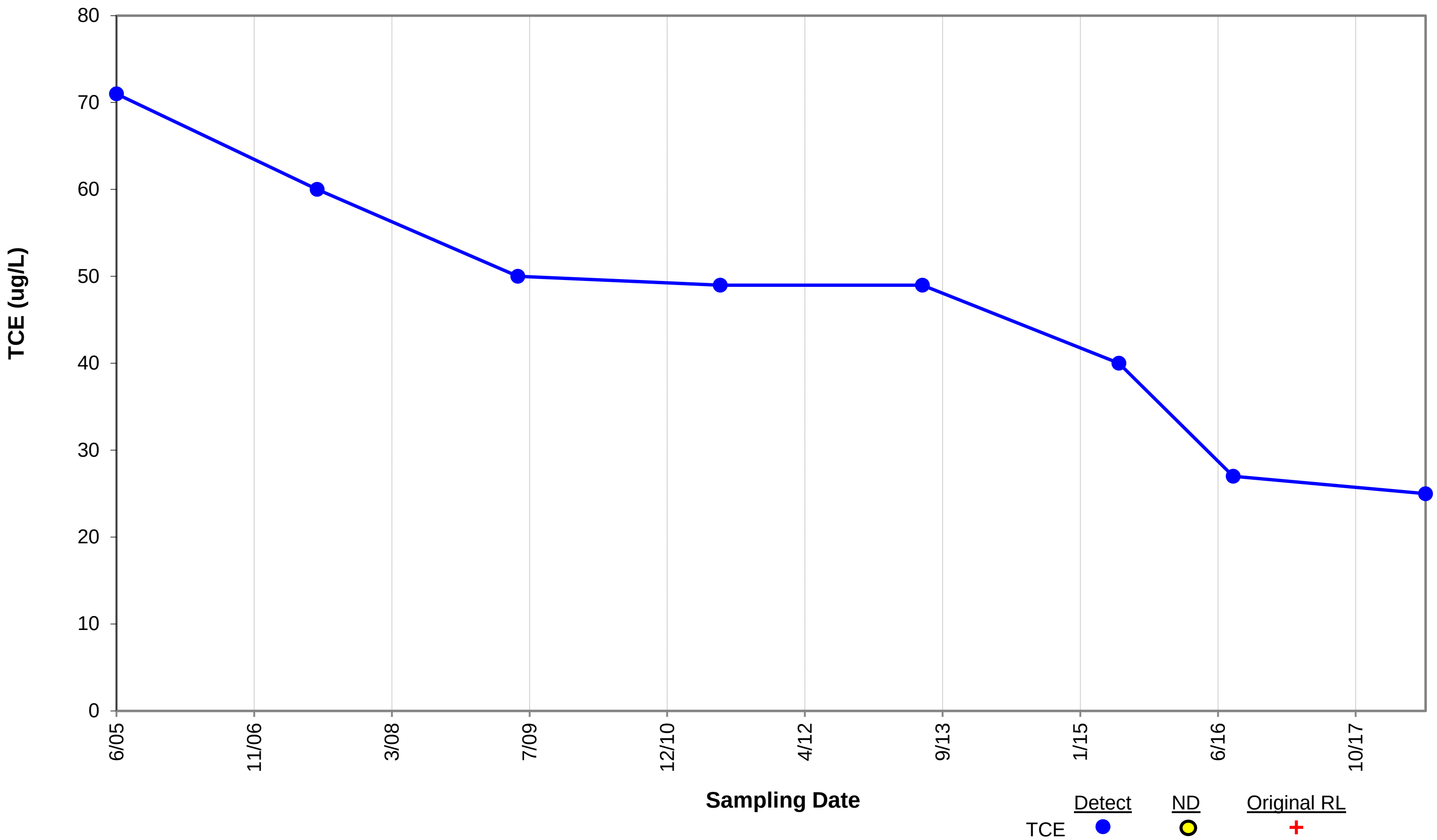
**Concentration vs. Time Plot – TCE in Well 04U854**
TCAAP

**Figure D.2.2-41**




**Mann-Kendall Test Result:** DECREASING TREND
p-value = <0.001

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** DECREASING TREND
Median Slope Estimate = -9.1E-03 ug/L per day
95% Confidence Interval = -1.3E-02 to -6.3E-03 ug/L per day

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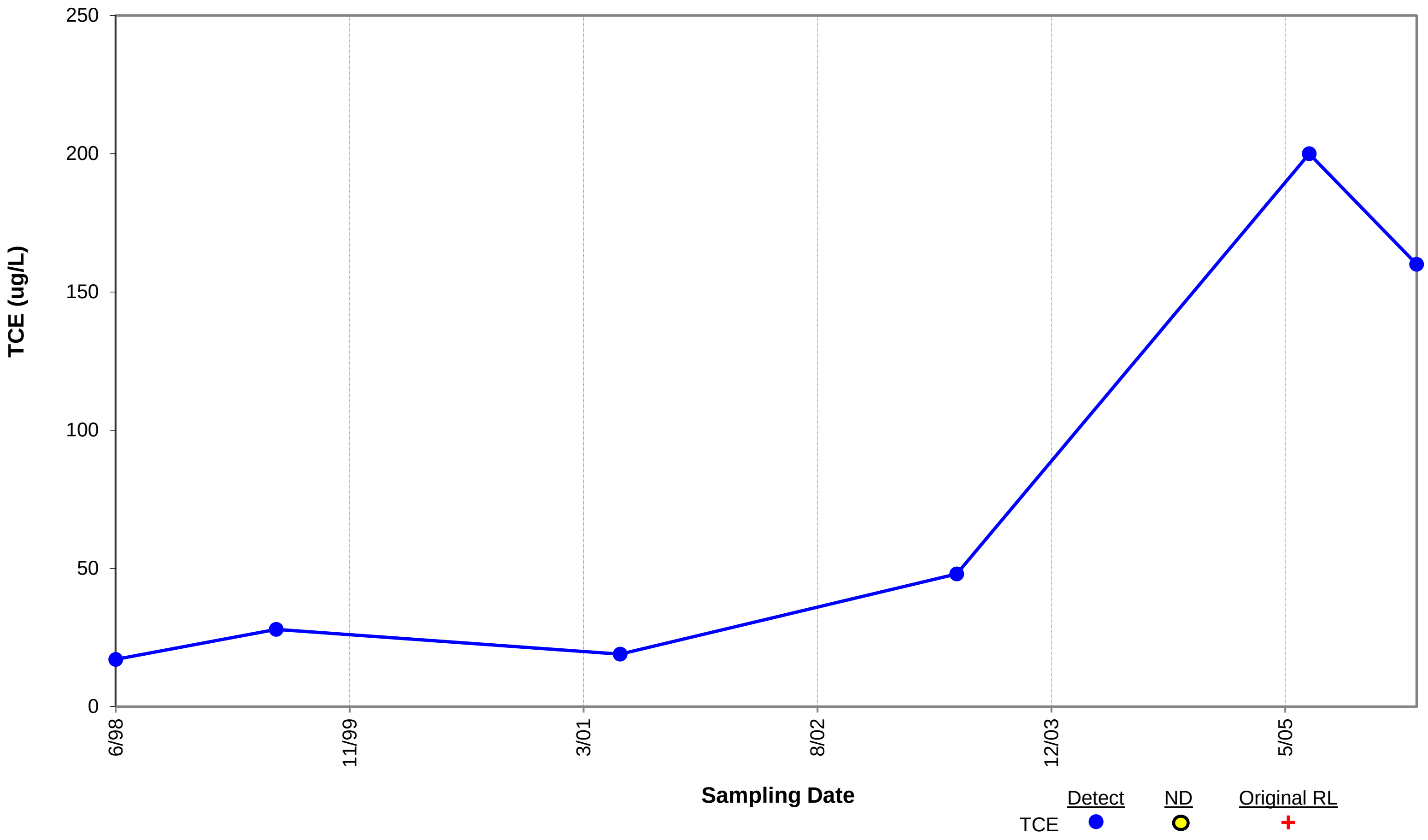
**Concentration vs. Time Plot – TCE in Well 04U859**
TCAAP

**Figure D.2.2-42**




**Mann-Kendall Test Result:** INCREASING TREND
p-value = 0.028

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** **No Significant Trend**
Median Slope Estimate = 5.1E-02 ug/L per day
95% Confidence Interval = -8.3E-03 to 1.1E-01 ug/L per day

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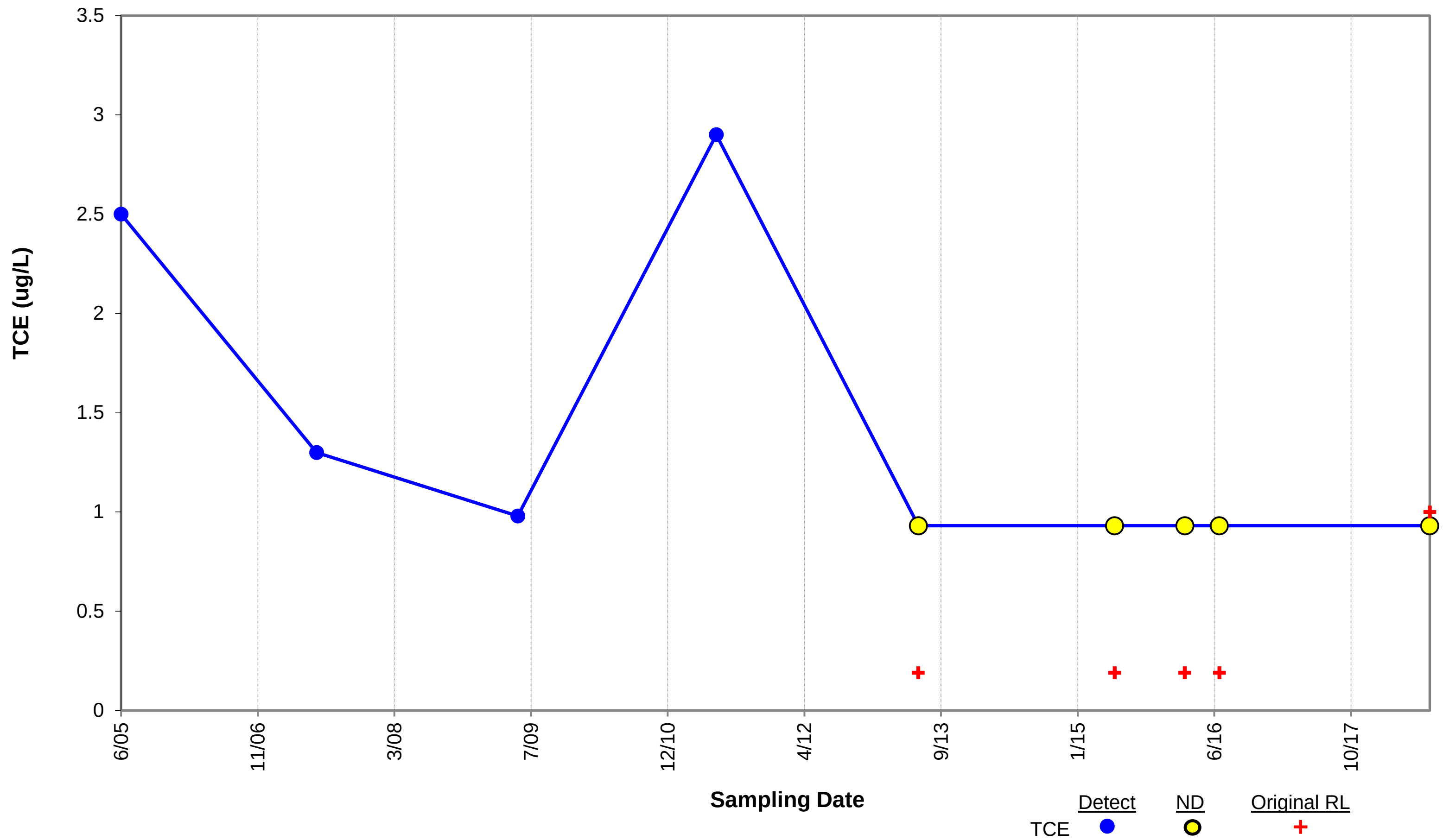
**Concentration vs. Time Plot – TCE in Well 04U861**
TCAAP

**Figure D.2.2-43**




**Mann-Kendall Test Result:** **DECREASING TREND**
p-value = 0.022

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** **No Significant Trend**
Median Slope Estimate = -6.2E-05 ug/L per day
95% Confidence Interval = -4.3E-04 to 0.0E+00 ug/L per day

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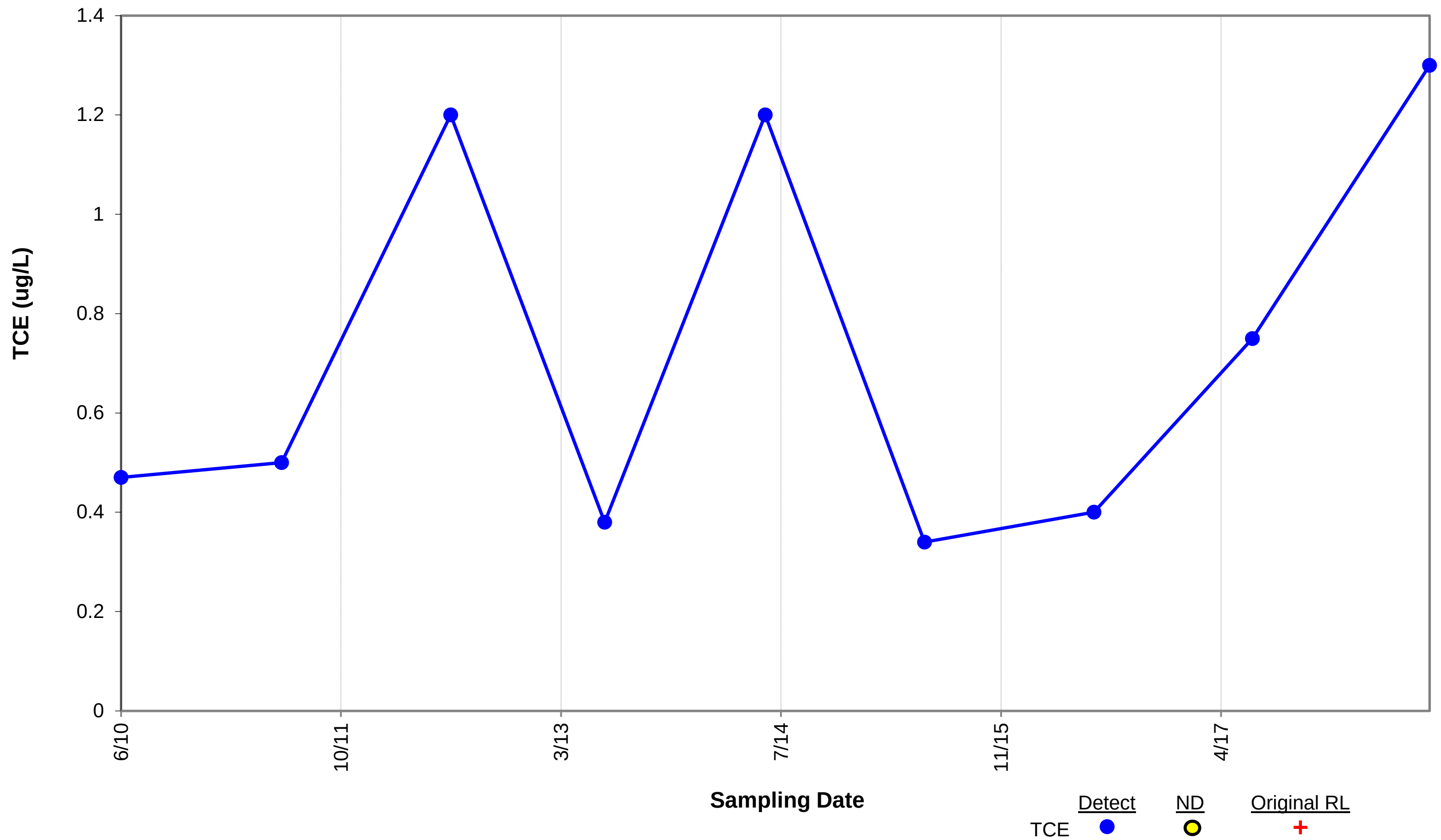
**Concentration vs. Time Plot – TCE in Well 04U875**
TCAAP

**Figure D.2.2-44**




**Mann-Kendall Test Result:** **No Significant Trend**
p-value = 0.272

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** **No Significant Trend**
Median Slope Estimate = 7.4E-05 ug/L per day
95% Confidence Interval = -1.3E-04 to 5.2E-04 ug/L per day

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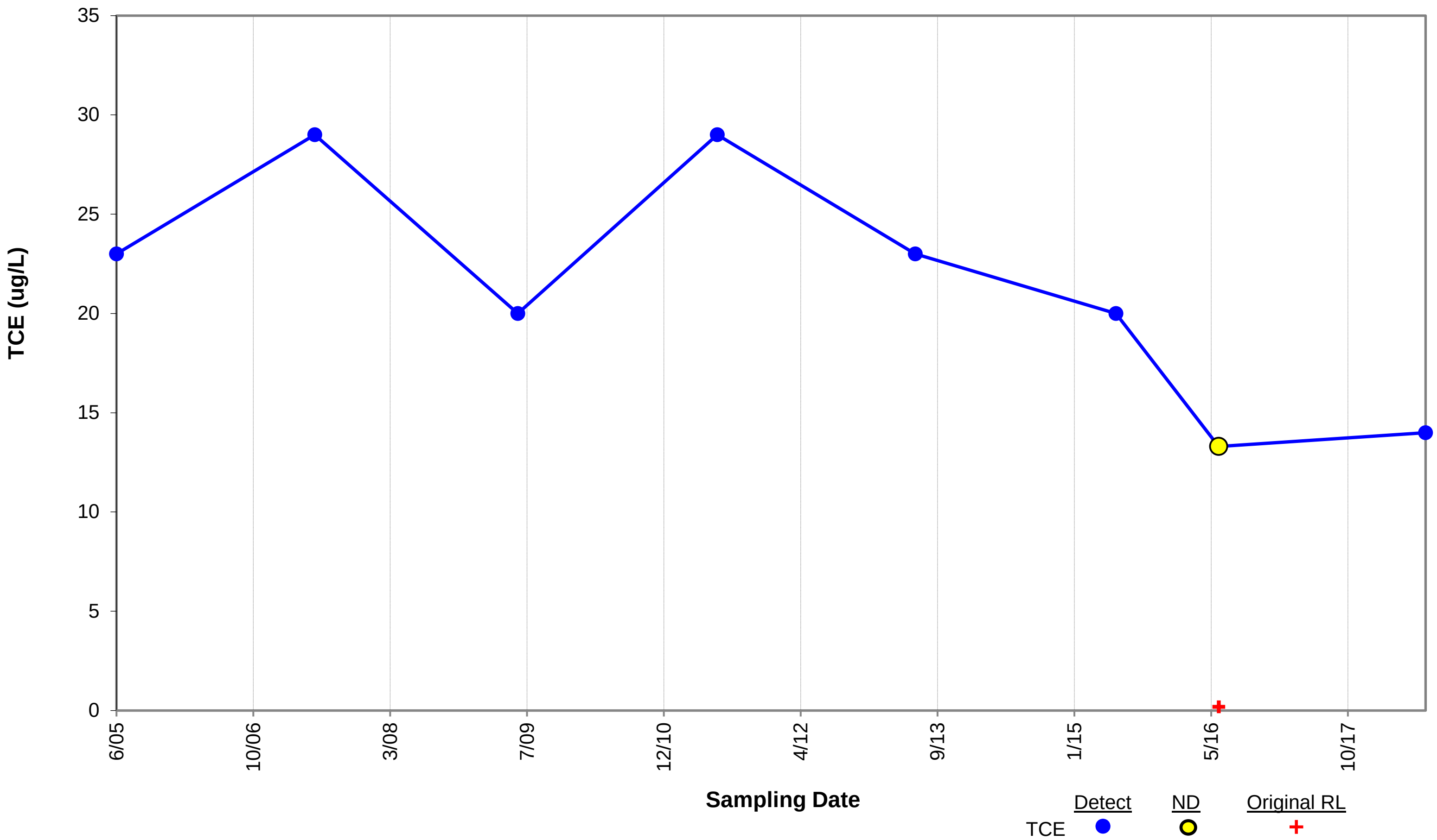
**Concentration vs. Time Plot – TCE in Well 04U877**
TCAAP

**Figure D.2.2-45**




| | | | | |
|---|---|---|---|---|
| **Mann-Kendall Test Result:** | **DECREASING TREND** | | | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| | p-value = | 0.043 | | |
| **Theil-Sen Trend Line Result:** | **No Significant Trend** | | | |
| | Median Slope Estimate = | -2.7E-03 | ug/L per day | |
| | 95% Confidence Interval = | -6.1E-03 | to 0.0E+00 | ug/L per day |

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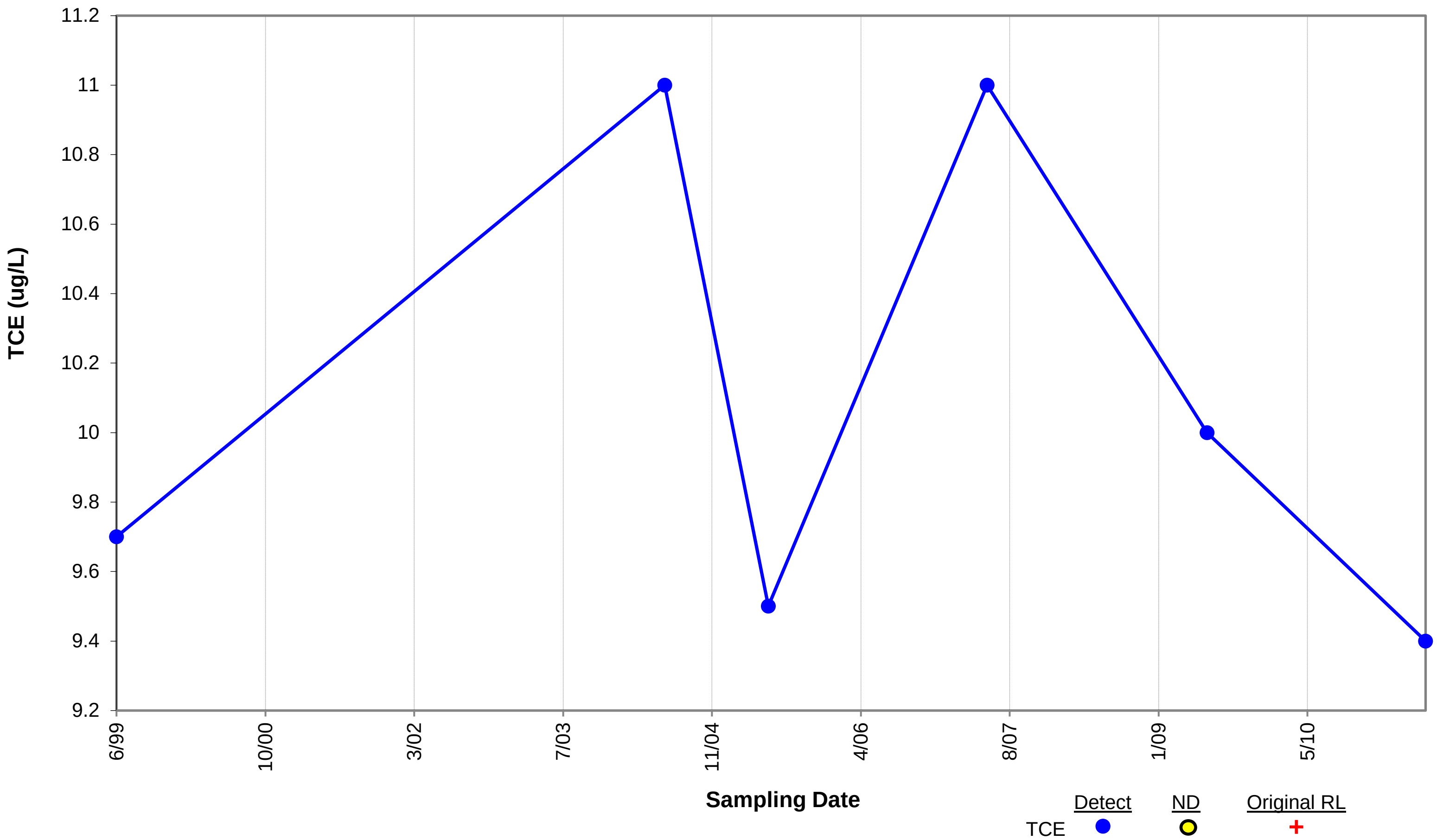
**Concentration vs. Time Plot – TCE in Well 04U882**

TCAAP

**Figure D.2.2-46**




**Mann-Kendall Test Result:** **No Significant Trend**
p-value = 0.298

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** **No Significant Trend**
Median Slope Estimate = -6.8E-05 ug/L per day
95% Confidence Interval = -1.3E-03 to 4.0E-04 ug/L per day

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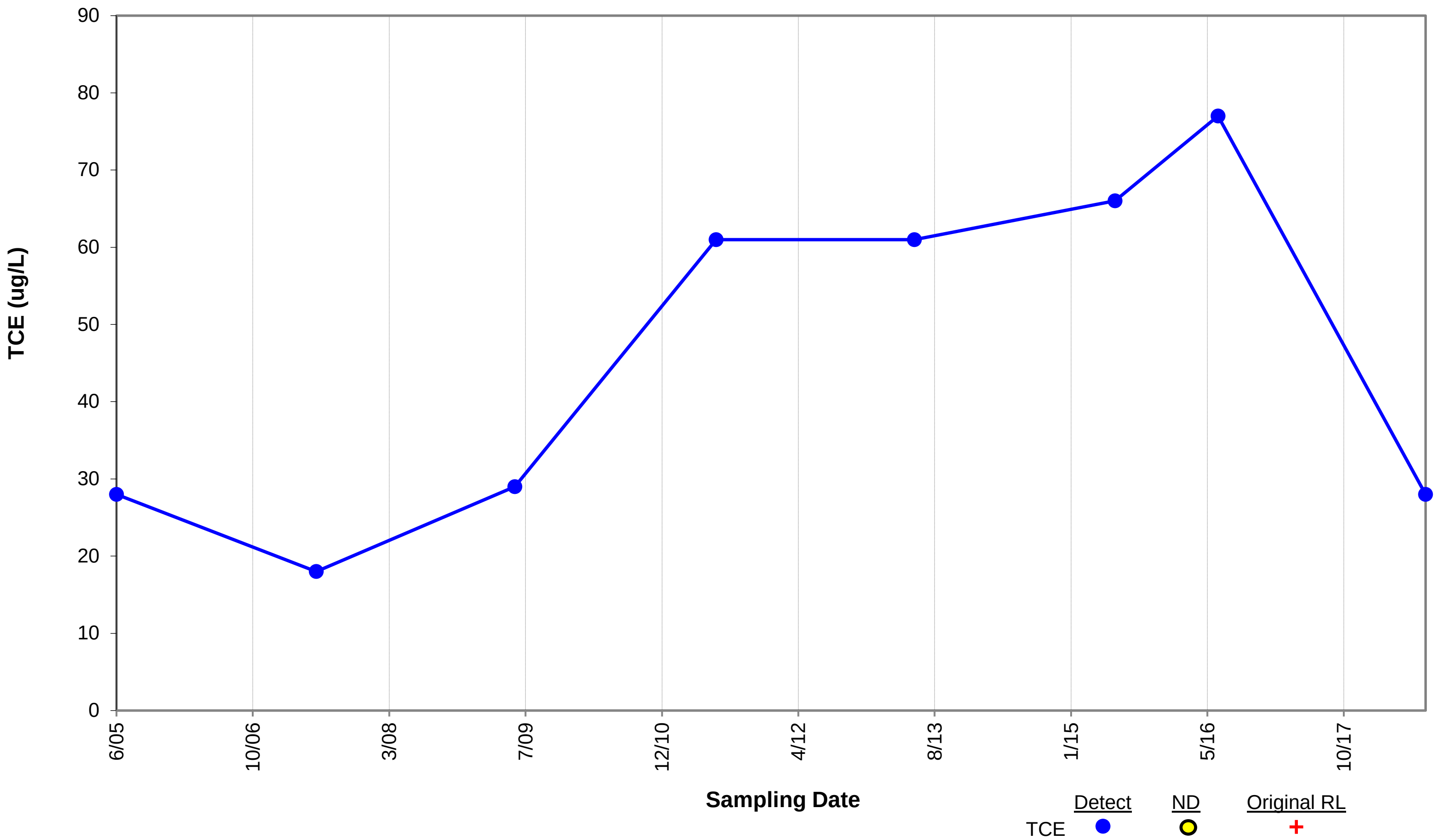
**Concentration vs. Time Plot – TCE in Well 206688**
TCAAP

**Figure D.2.2-47**




**Mann-Kendall Test Result:** **No Significant Trend**
p-value = 0.054

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** **No Significant Trend**
Median Slope Estimate = 1.1E-02 ug/L per day
95% Confidence Interval = -2.4E-04 to 1.8E-02 ug/L per day

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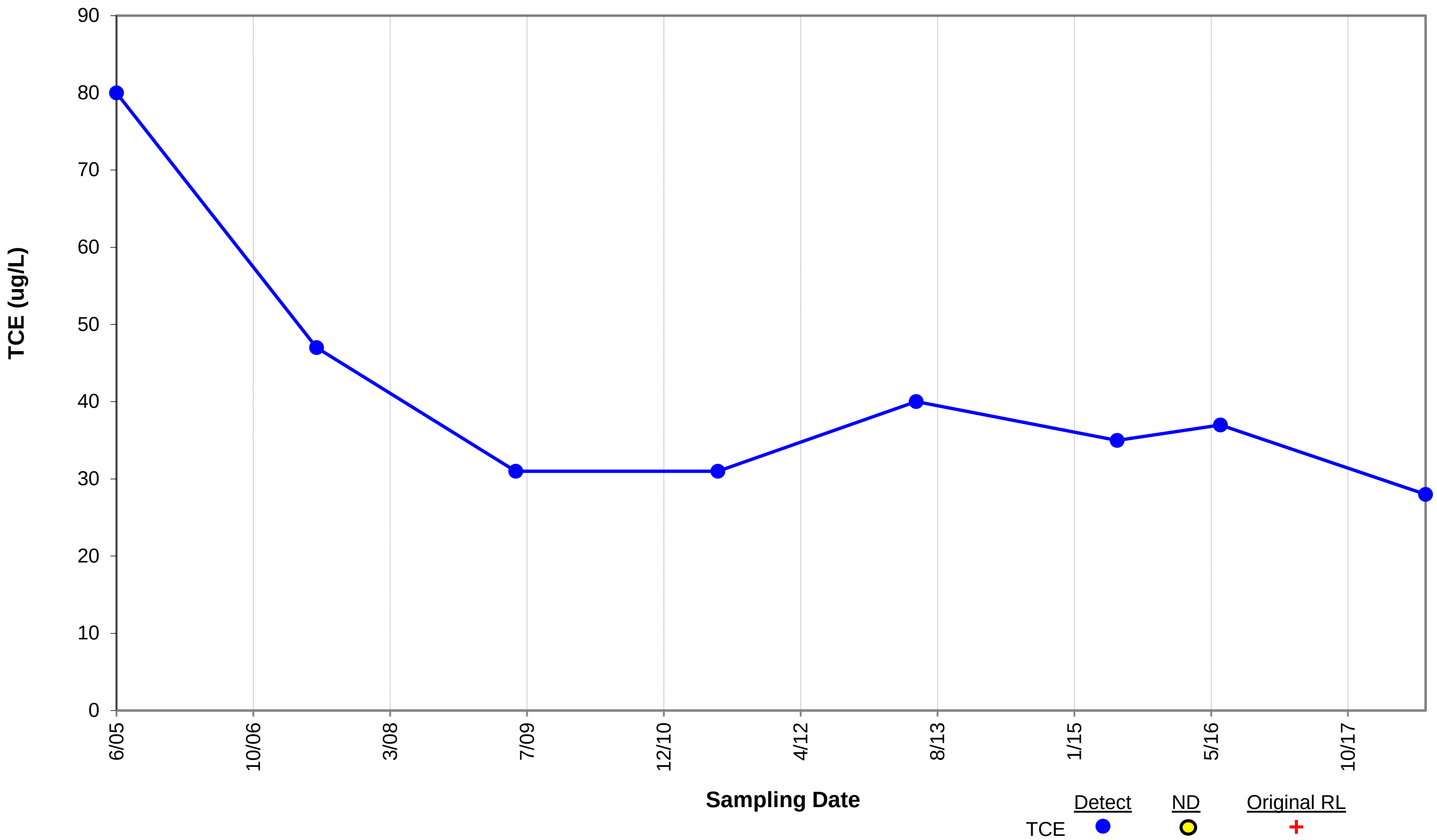
**Concentration vs. Time Plot – TCE in Well 409549**
TCAAP

**Figure D.2.2-48**



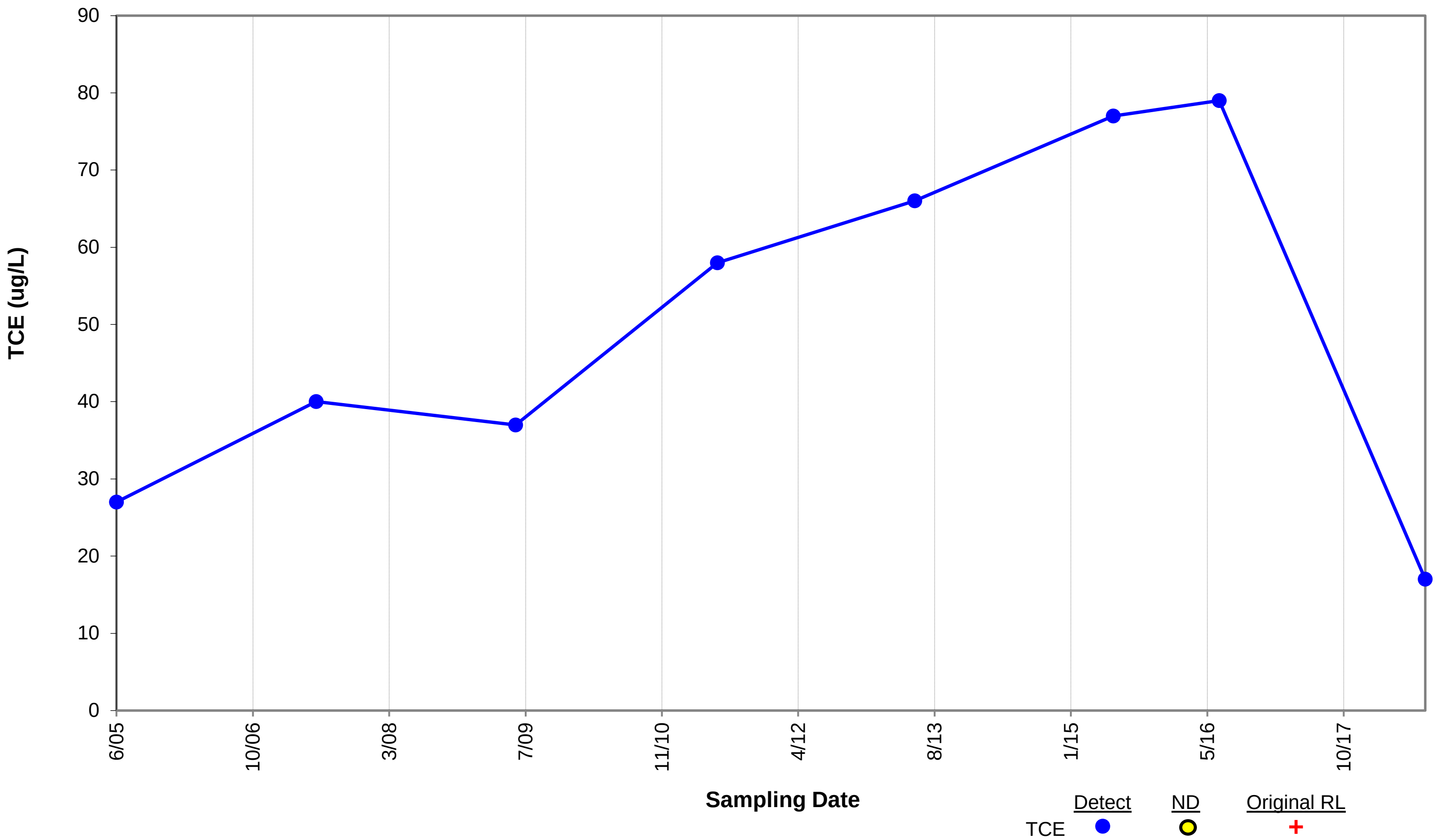

| | | | | | |
|---|---|---|---|---|---|
| **Mann-Kendall Test Result:** | **No Significant Trend** | | | | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| | p-value = | 0.072 | | | |
| **Theil-Sen Trend Line Result:** | **No Significant Trend** | | | | |
| | Median Slope Estimate = | -4.4E-03 | ug/L per day | | |
| | 95% Confidence Interval = | -1.2E-02 | to | 1.6E-03 | ug/L per day |

PIKA ARCADIS a joint venture

**Concentration vs. Time Plot – TCE in Well 409550**

TCAAP

**Figure D.2.2-49**



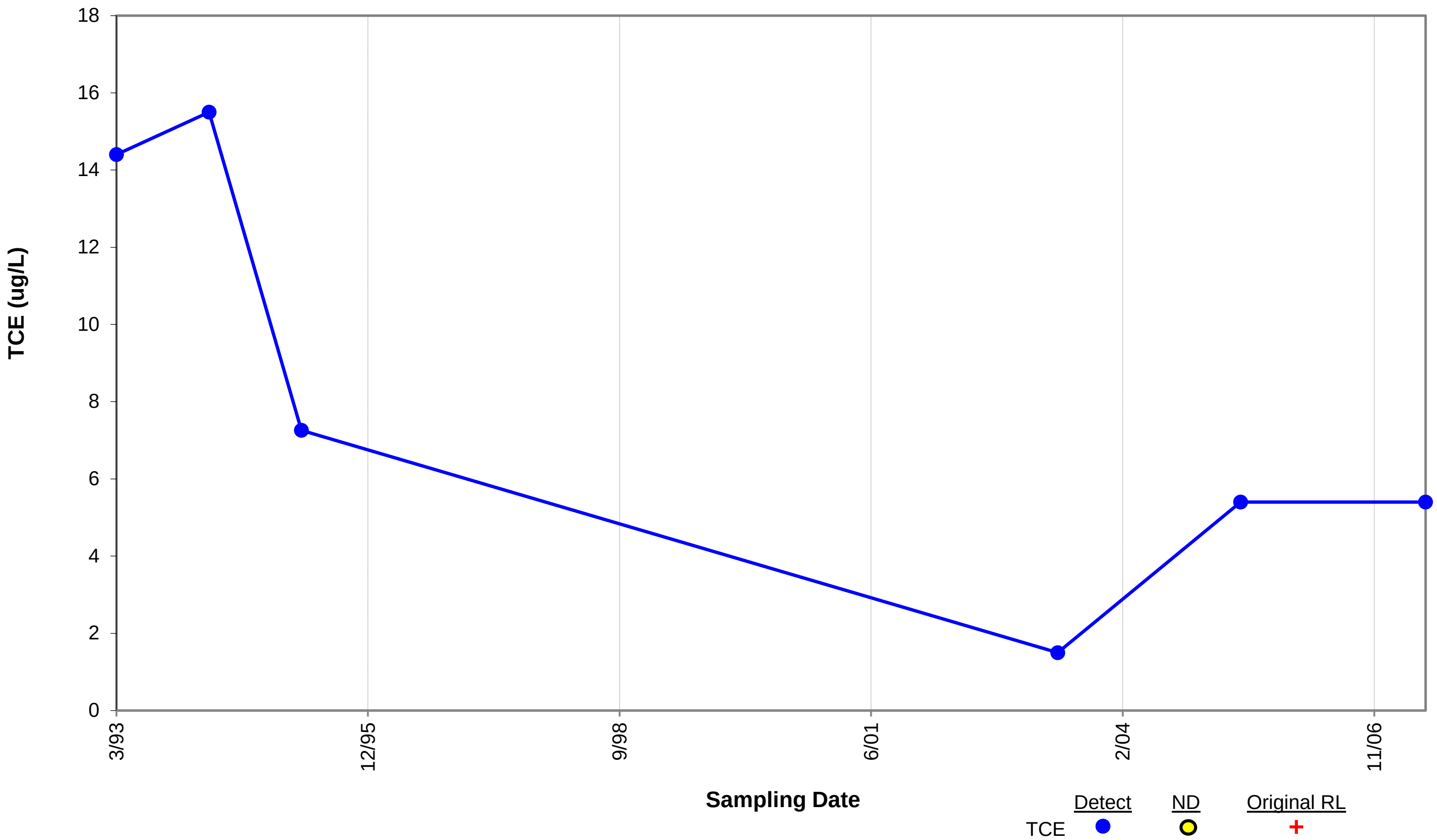

| | | |
|---|---|---|
| **Mann-Kendall Test Result:** | **No Significant Trend** | H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test). |
| | p-value = 0.089 | |
| **Theil-Sen Trend Line Result:** | **No Significant Trend** | |
| | Median Slope Estimate = 1.2E-02 ug/L per day | |
| | 95% Confidence Interval = -5.5E-03 to 1.4E-02 ug/L per day | |

PIKA ARCADIS a joint venture

**Concentration vs. Time Plot – TCE in Well 409557**

TCAAP

**Figure D.2.2-50**




**Mann-Kendall Test Result:** **No Significant Trend**
p-value = 0.102

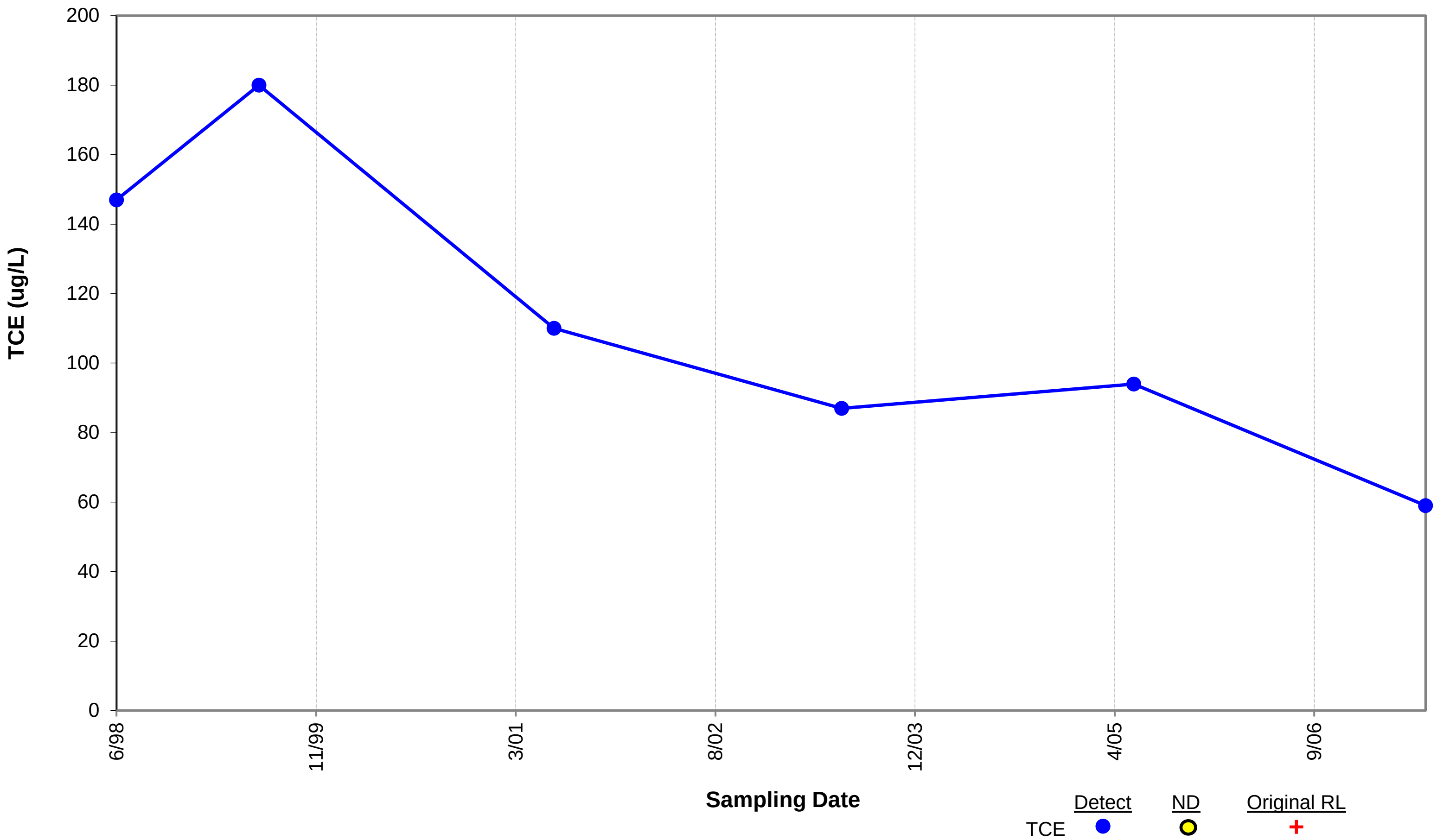
H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** **No Significant Trend**
Median Slope Estimate = -1.9E-03 ug/L per day
95% Confidence Interval = -7.6E-03 to 1.7E-03 ug/L per day

PIKA ARCADIS a joint venture

**Concentration vs. Time Plot – TCE in Well 409596**
TCAAP

**Figure D.2.2-51**




**Mann-Kendall Test Result:** DECREASING TREND
p-value = 0.028

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend for a one-tailed test).

**Theil-Sen Trend Line Result:** DECREASING TREND
Median Slope Estimate = -3.2E-02 ug/L per day
95% Confidence Interval = -5.9E-02 to -1.3E-02 ug/L per day

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**Concentration vs. Time Plot – TCE in Well 409597**
TCAAP

**Figure D.2.2-52**

**Figure D.2.3-1**
**New Brighton Municipal Wells: Regression Analysis Since 1998: Trichloroethene**

FY 2018 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, MN

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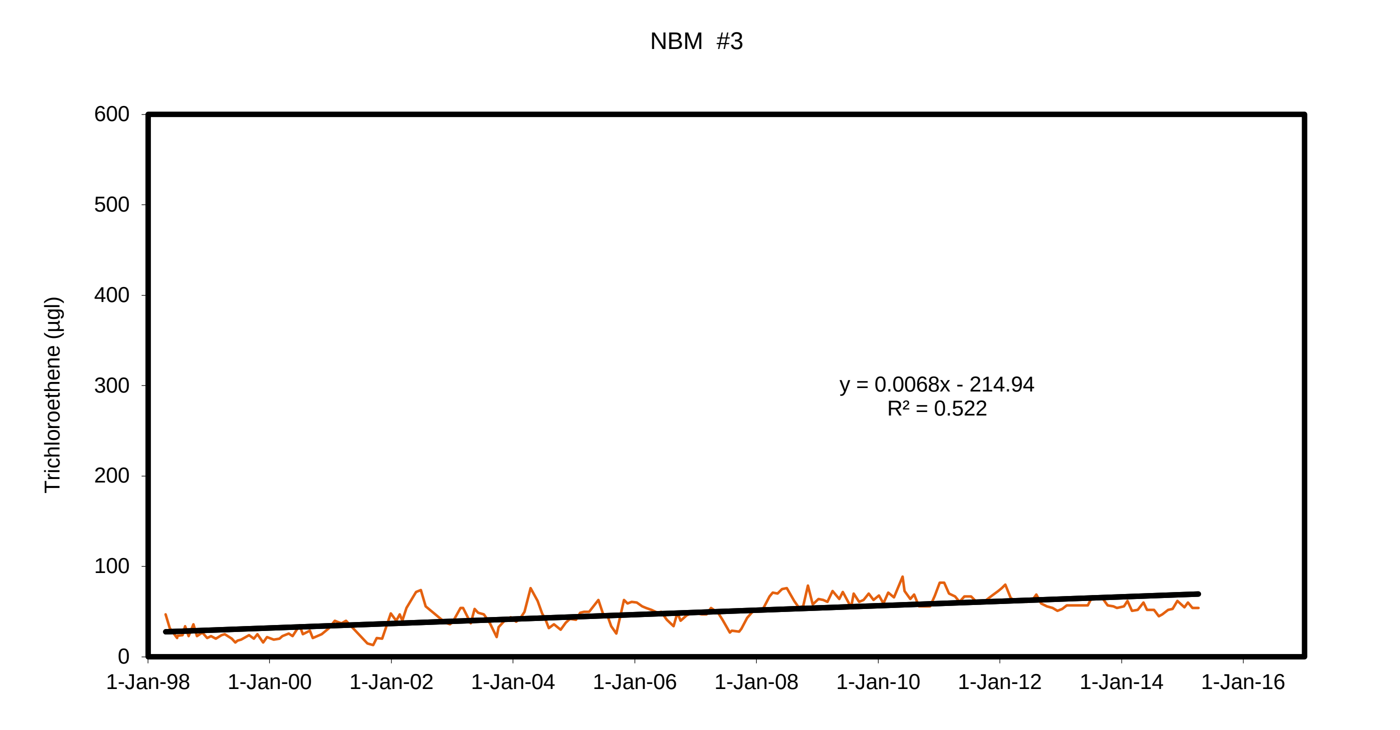
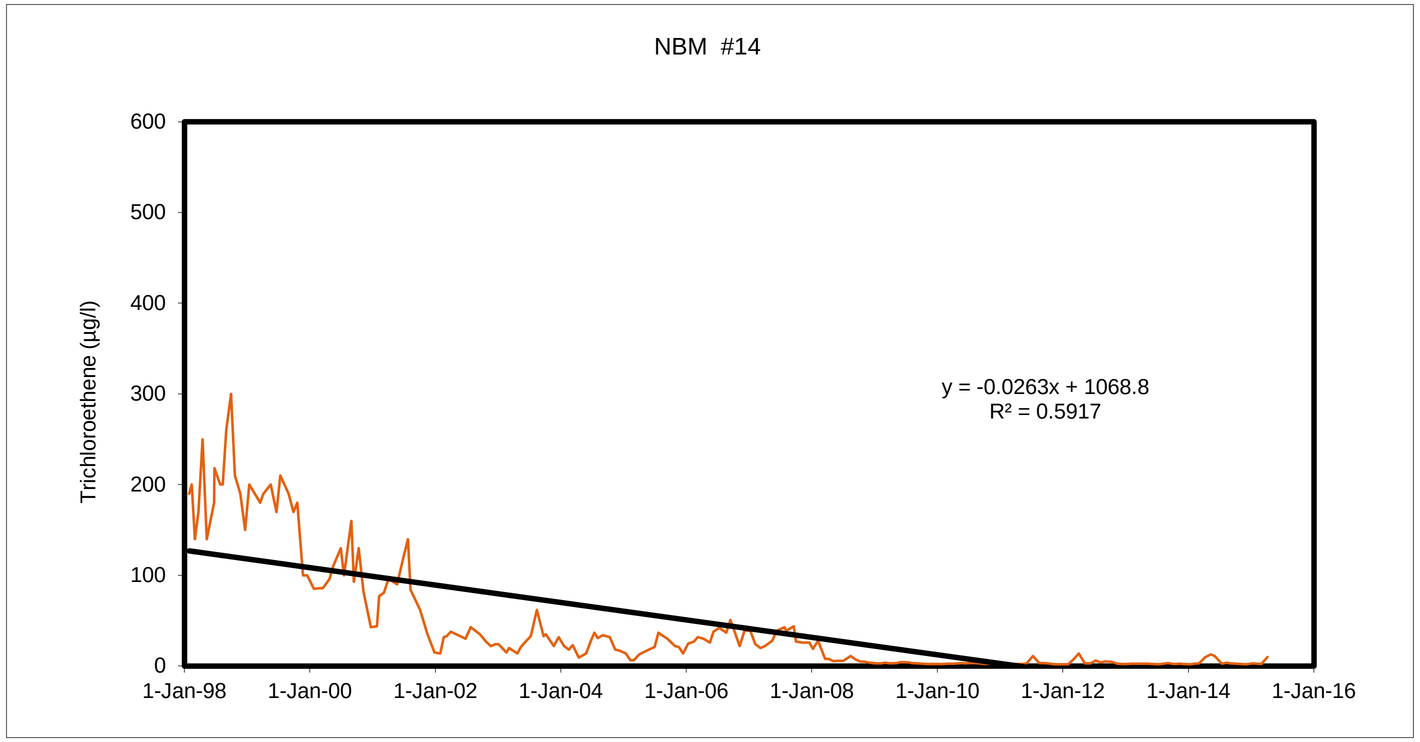
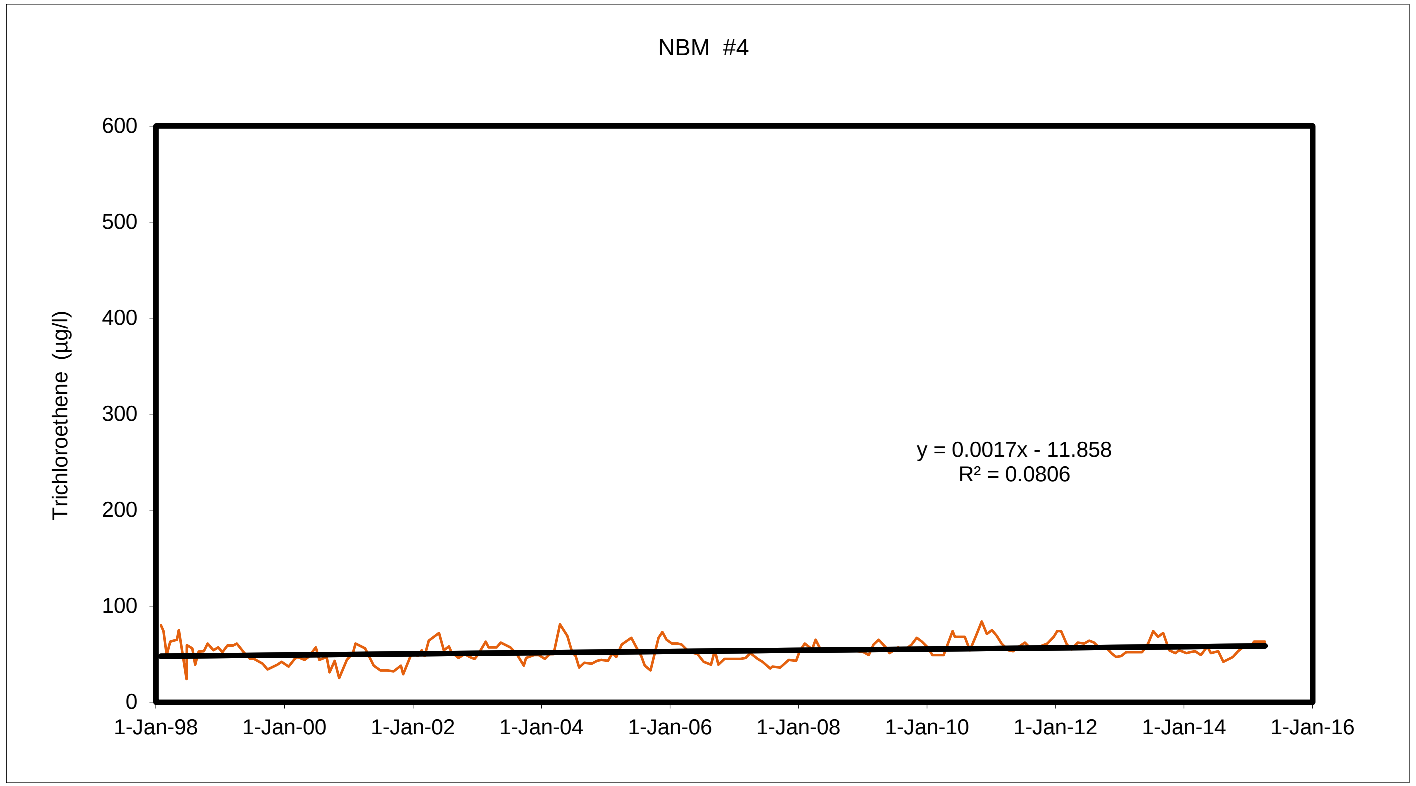


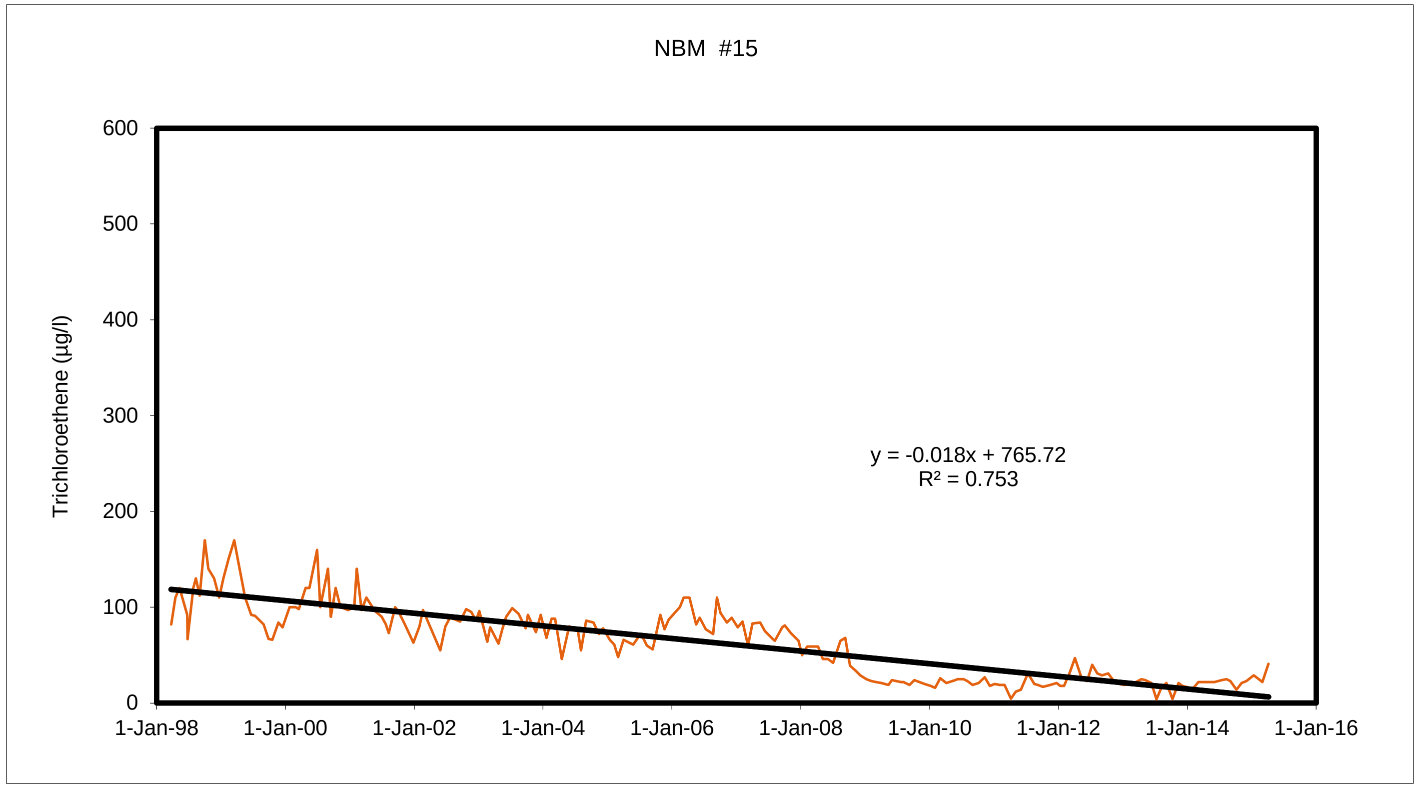
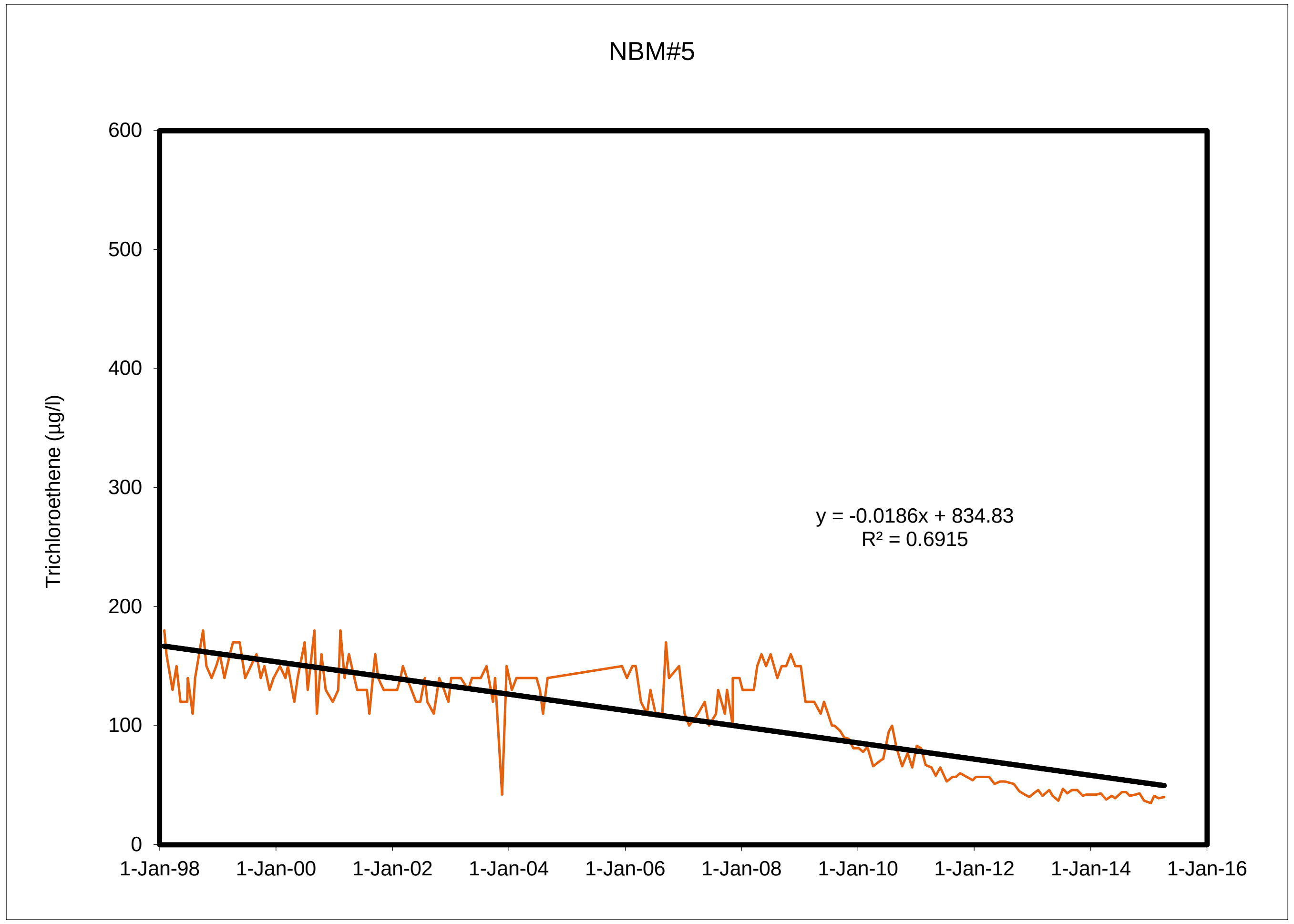
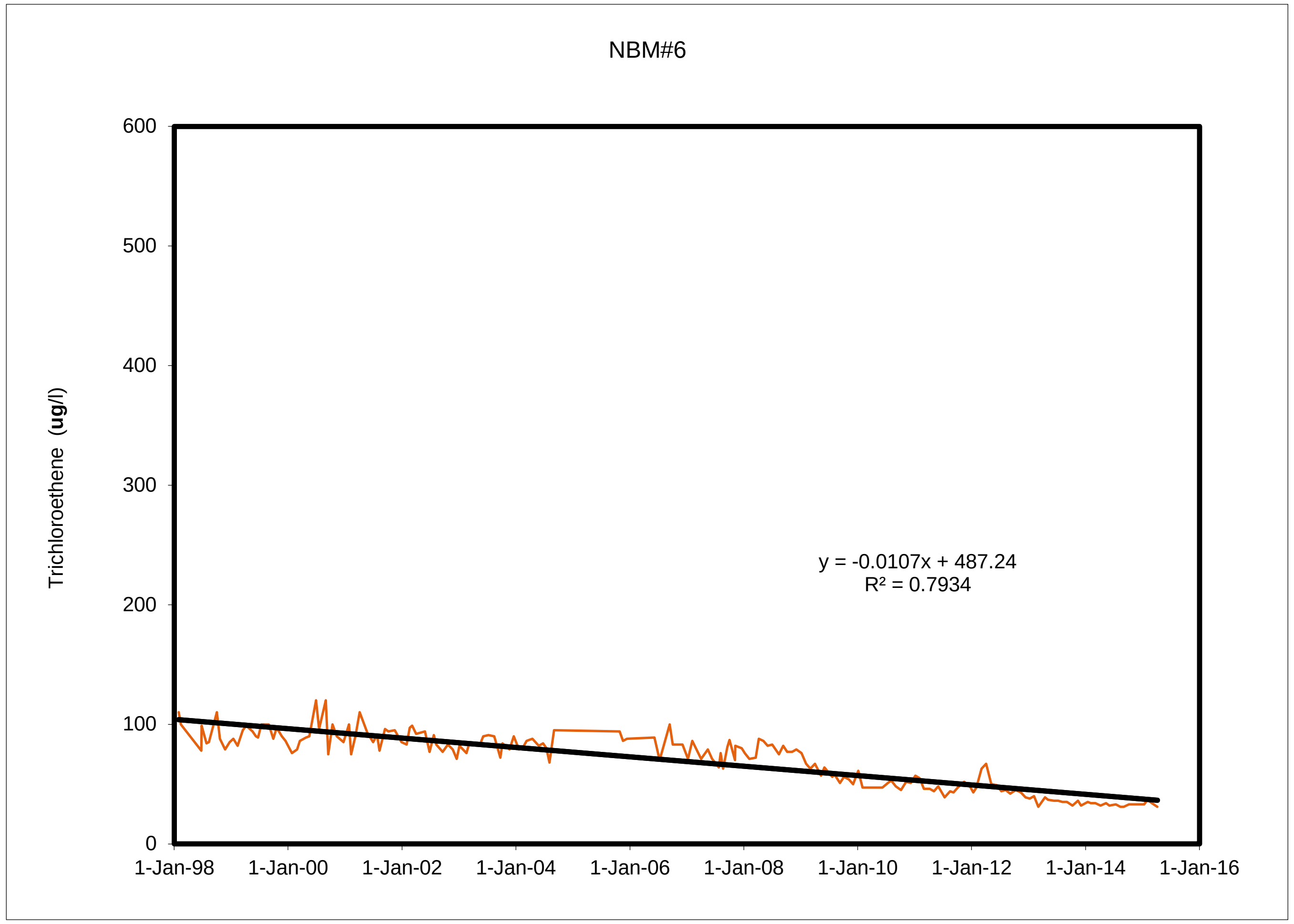



**Figure D.2.3-2**
**New Brighton Municipal Wells: Regression Analysis Since 1998: Trichloroethene**

FY 2018 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, MN



# APPENDIX E

## Well Inventory Update – FY 2018

## 1.0 PURPOSE

The purpose of well inventory is to identify wells that have been impacted or could potentially be impacted by contaminants from the New Brighton/Arden Hills Superfund Site.

## 2.0 BACKGROUND

Developing and maintaining the well inventory is a process that was initiated in 1991, with the work efforts documented in several update reports since that time. Beginning in FY 1999, the update reporting was incorporated into the Annual Performance Reports.

The well inventory "study area," as defined by the Minnesota Pollution Control Agency, is shown on Figure E-1, and coincides with the Minnesota Department of Health (MDH) Special Well Construction Area.

The aquifers of concern are defined by the 5 μg/L trichloroethene contour for the Unit 3 and Unit 4 aquifers, and the 1 μg/L cis-1,2-dichloroethene contour for the Unit 1 aquifer at the north end of OU2.

The "area of concern" for the Unit 3 and Unit 4 aquifers is created by adding a quarter mile buffer area outside the 5 μg/L trichloroethene contour. The area of concern for the Unit 3 and Unit 4 aquifers is shown on Figure E-2.

The area of concern for the Unit 1 aquifer on the north side of OU2 is delineated by city streets. The area of concern for the Unit 1 aquifer is shown on Figure E-3.

Wells within the study area are categorized based on location, depth/aquifer, and use. Well categories for the well inventory are described in Table E-1.

## 3.0 PROGRAM REQUIREMENTS

The well inventory program requirements have evolved over time, with changes documented through the update reports. A flowchart that describes the annual requirements for maintaining the well inventory database is shown on Figure E-4. Requirements are summarized below.

Near the beginning of each fiscal year, a database of study area wells is acquired from the MDH. This MDH database query is limited to study area wells that were constructed, sealed, or disclosed in the previous fiscal year. The MDH database consists of three lists:

- Constructed Wells (generated through drillers submitting Well and Boring Records);
- Sealed Wells (generated through drillers submitting Well Sealing Records); and
- Disclosed Wells (made known through property transfer).

With the new MDH information, the well inventory database is updated by recategorizing wells, as necessary, and by adding any new wells that are within the study area. Any new wells found in Categories 1a, 1b, 1c, 2a, 2b, 2c, or 4a are targeted for sampling in that fiscal year; however, an attempt to reclassify any new category 4a wells will be made prior to sampling. Wells that are not sampled due to non-responsive well owners are targeted for sampling in the next major sampling event.

Category 4 wells are those with an unknown depth or unknown location, or both. Ideally, there should be no wells in Category 4. Each year, an attempt is made to reclassify Category 4 wells into one of the other categories. This is accomplished through phone calls, letters, and/or site visits to obtain additional information. Any wells which are re-classified as Category 1a, 1b, 1c, 2a, 2b, or 2c are targeted for sampling in that fiscal year.

"Major" well inventory sampling events occur every four years and are shown in Appendix A.1. The major sampling events are scheduled to coincide with the biennial sampling events for performance purposes as delineated in the APR. For each major event, all wells in Categories 1a, 1b, 1c, 2a, 2b, 2c, and 4a are targeted for sampling. After every sampling event, each well owner is mailed a copy of their testing results. Wells that are not sampled due to non-responsive well owners are targeted for sampling in the next major sampling event.

For each sampling event, if any well has a detection which exceeds the applicable New Brighton/Arden Hills Superfund Site groundwater cleanup level for that contaminant (or an additivity of 1.0, similar to the MDH Hazard Index calculation), the well is evaluated using the flow chart presented in Figure E-4 to determine the timing of additional sampling. Wells that are used for drinking water are sampled again within one month of data validation. Wells that are not used for drinking water, but have possible contact exposure risks, are sampled the next fiscal year. If a cleanup level exceedance is confirmed (two consecutive events), and the contaminant concentrations in the well are proportional to contaminant concentrations of the New Brighton/Arden Hills Superfund Site OU1 plume, the Army offers to abandon the well and/or provide an alternate water supply.

The annual reporting requirements for the New Brighton/Arden Hills Superfund Site well inventory will include:

- A list of any wells found or reclassified.
- Analytical results and a summary of sampling efforts from that fiscal year.
- Recommendations for participation in the Well Abandonment/Alternate Water Supply Program.
- An updated well inventory database that lists wells by well category.
- An updated database listing water quality of wells.

## 4.0 FY 2018 UPDATE

The updated MDH database was provided to Arcadis on January 10, 2019. MDH generates the database from specific Township, Range, and Section data. This comprehensive database was screened to extract the lists of wells that were constructed, disclosed, or sealed between October 1, 2016 and September 30, 2018. Further investigative efforts were primarily focused on determining each well's location (inside or outside the study area and/or area of concern), status (active, inactive, or sealed), and water use (supply/non-supply).

Newly constructed active and inactive wells, and wells of unknown status that were determined to be located within the study area, are presented in Table E-2. Thirty-eight wells were identified within the study area, all of them classified as environmental or monitoring wells. All wells were classified into Category 6.

Disclosed wells that were identified as being in use, inactive, sealed, or of unknown status and that were determined to be located within the study area are identified in Table E-3. Disclosed wells that were located within the area of concern and that the MDH identified as having a change in status from active or inactive to sealed were further investigated for confirmation of their sealed status. Any wells that were already in the well inventory database that the MDH identified as having a change in status from active or inactive to sealed are shown in Table E-3 with strikeouts through the previous well category entry. There were 173 wells disclosed during FY18 that are located within the study area. Of the 173 wells disclosed within the study area, 1 well was categorized as 1d which was inoperable/unused, 34 wells were supply wells within the Study area but outside of the area of concern (Category 3), 4 wells were categorized as 4b (unknown location),12 wells were listed as monitoring wells and assigned to Category 6, 14 wells were assigned to Category 7a (documented as sealed/abandoned), 108 wells were categorized as 7b (undocumented as sealed or improperly abandoned).

Sealed wells were found by reviewing the MDH sealed well list. Wells identified as sealed are shown in Table E-4. Wells identified as sealed in the MDH database updates were assigned to Category 7a.

FY 2018 was not a “major” well inventory sampling event, which occur every four years and which target the wells in Categories 1a, 1b, 1c, 2a, 2b, 2c, and 4a. The next major well inventory sampling event will occur in 2020.

Information contained in Tables E-2 through E-4 has been updated in the well inventory database (Filename “Well Inventory Main Database FY 2018”, an Excel file included on this CD).

# WELL INVENTORY DATABASE

The Well Inventory Database is located on
this CD in the following Microsoft Excel file:

Well Inventory Main Database FY 2018.xls

**Table E-1**
**Well Inventory Category Descriptions**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

| Category | Subcategory | Explanation |
|---|---|---|
| 1 | | Water supply wells screened in an aquifer of concern, inside the area of concern. Wells are divided into the following subcategories: |
| | 1a | Drinking water well |
| | 1b | Nondrinking but possible contact water |
| | 1c | Nondrinking, noncontact water |
| | 1d | Well is inoperable or has not been used for several years |
| | 1e | Well for which the owner has refused (or has been unresponsive to) an Army offer for abandonment, or for which the water use has been deemed acceptable |
| 2 | | Water supply wells in an area of concern, inside the buffer lines, but outside the area of concern, screened in an aquifer of concern. Wells are divided into the following subcategories: |
| | 2a | Drinking water well |
| | 2b | Nondrinking but possible contact water |
| | 2c | Nondrinking, noncontact water |
| | 2d | Well is inoperable or has not been used for several years |
| 3 | | Water supply wells within the Study Area that are either outside the area of concern, or are within the area of concern but are not screened in an aquifer of concern. |
| 4 | | Water supply wells with missing information, divided into the following subcategories: |
| | 4a | Unknown depth or aquifer, but located in the area of concern. |
| | 4b | Unknown location, but potentially located within the Study Area. Wells with both an unknown depth and an unknown location are included in 4b. |
| 5 | | Wells that are in the study area, but that have been field checked and not located. No further action is recommended for these wells. |
| 6 | | Nonsupply wells (primarily monitoring wells). |
| 7 | | Sealed or abandoned wells. Wells are divided into the following subcategories: |
| | 7a | Documented as sealed/abandoned |
| | 7b | Undocumented as sealed, or improperly abandoned |

**Table E-2**
**Constructed Wells**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

PIKA ARCADIS a joint venture

| Unique Number | Category | Last Name or Business Name | Street | City | Use | Depth | Date Drilled | Well in Database? |
|---|---|---|---|---|---|---|---|---|
| 808877 | 6 | Wall Development Cos. | 501 30th Avenue SE | Minneapolis | Environmental Well | 36 | 5/24/2018 | Y |
| 808878 | 6 | Wall Development Cos. | 501 30th Avenue SE | Minneapolis | Environmental Well | 41 | 1/26/2018 | Y |
| 808879 | 6 | Wall Development Cos. | 501 30th Avenue SE | Minneapolis | Environmental Well | 26 | 5/23/2018 | Y |
| 808880 | 6 | Wall Development Cos. | 501 30th Avenue SE | Minneapolis | Environmental Well | 46 | 5/8/2018 | Y |
| 817743 | 6 | Fridley HRA | 400 71st Avenue NE | Fridley | Monitoring | 8 | 12/1/2016 | Y |
| 817744 | 6 | Fridley HRA | 400 71st Avenue NE | Fridley | Monitoring | 10.5 | 12/2/2016 | Y |
| 817745 | 6 | Fridley HRA | 400 71st Avenue NE | Fridley | Monitoring | 20.5 | 12/1/2016 | Y |
| 817746 | 6 | Fridley HRA | 400 71st Avenue NE | Fridley | Monitoring | 8 | 12/1/2016 | Y |
| 817747 | 6 | Fridley HRA | 400 71st Avenue NE | Fridley | Monitoring | 8 | 12/2/2016 | Y |
| 821414 | 6 | Tomas | 2501 Lowry Avenue Ne | St. Anthony | Environmental Well | 20 | 3/27/2017 | Y |
| 821415 | 6 | Tomas | 2501 Lowry Avenue Ne | St. Anthony | Environmental Well | 25 | 3/27/2017 | Y |
| 821416 | 6 | Tomas | 2501 Lowry Avenue Ne | St. Anthony | Environmental Well | 40 | 3/27/2017 | Y |
| 821417 | 6 | Tomas | 2501 Lowry Avenue Ne | St. Anthony | Environmental Well | 25 | 6/26/2017 | Y |
| 824850 | 6 | Twin City Metalseal and Powder Coating | 825 11th Avenue SE | Minneapolis | Environmental Well | 27 | 5/10/2018 | Y |
| 828032 | 6 | US Army Enivronmental Command | 4761 Hamline Avenue N | Arden Hills | Environmental Well | 231 | 7/11/2017 | Y |
| 828033 | 6 | US Army Enivronmental Command | 4761 Hamline Avenue N | Arden Hills | Environmental Well | 296 | 7/14/2017 | Y |
| 828034 | 6 | US Army Enivronmental Command | 4761 Hamline Avenue N | Arden Hills | Environmental Well | 201 | 7/20/2017 | Y |
| 828128 | 6 | Tomas | 2501 Lowry Avenue Ne | St. Anthony | Environmental Well | 25 | 6/26/2017 | Y |
| 828129 | 6 | Tomas | 2401 Lowry Avenue NE | St. Anthony | Environmental Well | | 9/25/2017 | Y |
| 828130 | 6 | Tomas | 2401 Lowry Avenue NE | St. Anthony | Environmental Well | 28 | 9/25/2017 | Y |
| 828131 | 6 | Tomas | 2401 Lowry Avenue NE | St. Anthony | Environmental Well | 30 | 9/25/2017 | Y |
| 828132 | 6 | Tomas | 2401 Lowry Avenue NE | St. Anthony | Environmental Well | 32 | 9/25/2017 | Y |
| 830770 | 6 | Ramsey County | 1661 Highway 96 W | Arden Hills | Environmental Well | | 5/9/2018 | Y |
| 830771 | 6 | Ramsey County | 1661 Highway 96 W | Arden Hills | Environmental Well | | 5/24/2018 | Y |
| 830772 | 6 | Ramsey County | 1661 Highway 96 W | Arden Hills | Environmental Well | | 5/23/2018 | Y |
| 831551 | 6 | Twin City Metalseal and Powder Coating | 825 11th Avenue SE | Minneapolis | Environmental Well | 27 | 5/9/2018 | Y |
| 831552 | 6 | Twin City Metalseal and Powder Coating | 825 11th Avenue SE | Minneapolis | Environmental Well | 31 | 5/10/2018 | Y |
| 832386 | 6 | Twin City Die Casting Co. | 1070 33rd Avenue SE | Lauderdale | Environmental Well | 30 | 5/24/2018 | Y |
| 832387 | 6 | Twin City Die Casting Co. | 1070 33rd Avenue SE | Lauderdale | Environmental Well | 27 | 5/9/2018 | Y |
| 832388 | 6 | Twin City Die Casting Co. | 1070 33rd Avenue SE | Lauderdale | Environmental Well | 28 | 5/10/2018 | Y |
| 832389 | 6 | Twin City Die Casting Co. | 1070 33rd Avenue SE | Lauderdale | Environmental Well | 57 | 1/25/2018 | Y |
| 832390 | 6 | Twin City Die Casting Co. | 1070 33rd Avenue SE | Lauderdale | Environmental Well | 30 | 5/25/2018 | Y |
| 832516 | 6 | MPCA | 2600 Winter Street NE | Minneapolis | Environmental Well | 28 | 5/8/2018 | Y |

**Table E-2**
**Constructed Wells**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

PIKA ARCADIS a joint venture

| Unique Number | Category | Last Name or Business Name | Street | City | Use | Depth | Date Drilled | Well in Database? |
|---|---|---|---|---|---|---|---|---|
| 832517 | 6 | MPCA | 2600 Winter Street NE | Minneapolis | Environmental Well | 34 | 5/25/2018 | Y |
| 832518 | 6 | MPCA | 2600 Winter Street NE | Minneapolis | Environmental Well | 36 | 5/11/2018 | Y |
| 832519 | 6 | MPCA | 2600 Winter Street NE | Minneapolis | Environmental Well | 66 | 1/25/2018 | Y |
| 832520 | 6 | MPCA | 2600 Winter Street NE | Minneapolis | Environmental Well | 35 | 5/14/2018 | Y |
| 832521 | 6 | MPCA | 2600 Winter Street NE | Minneapolis | Environmental Well | 56 | 5/7/2018 | Y |

**Table E-3**
**Wells Disclosed through Property Transfer**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

PIKA ARCADIS a joint venture

| Unique Number | Category | Last Name or Business Name | Street | City | Status | Date Sealed | Depth | Date Drilled |
|---|---|---|---|---|---|---|---|---|
| 127537 | 7a | Midwest Asphalt | 1385 Nothwest Parkway | New Brighton | Monitoring | 12/5/2007 | NA | NA |
| 133237 | 3 | Gerald Griebie TRST | 1698 Terrace Drive | Shoreview | In Use | NA | 115 | 28334 |
| 135390 | 3 | Alay | 5550 Schutta Road | Shoreview | In Use | NA | 125 | 28570 |
| 188009 | 7a | Baker | 1715 Hillview Road | Shoreview | | 4/25/1987 | NA | NA |
| 191942 | 7a | Midwest Asphalt | 591 Devine Drive | New Brighton | Monitoring | 6/28/2007 | NA | NA |
| 200068 | 7a | Hammes Partners II, LP | 1831 County Road C W | Roseville | Water Supply | 10/1/1991 | NA | NA |
| 206779 | 3 | Casper | 3963 Glenview Avenue | Arden Hills | In Use | NA | 195 | 22270 |
| 233846 | 3 | Yesil | 1401 County Road E W | Arden Hills | Not In Use | NA | 92 | NA |
| 234277 | 3 | No Owner Found | New Brighton | New Brighton | No Status Reported | NA | 17 | 7/25/1980 |
| 234296 | 7a | City of New Brighton | New Brighton | New Brighton | Monitoring | 12/11/2007 | NA | NA |
| 234297 | 7a | Alliant Techsystems | 450 14th Street NW | New Brighton | Monitoring | 8/18/2008 | NA | NA |
| 257443 | 7a | Midwest Asphalt | 575 Devine Drive | New Brighton | Monitoring | 6/28/2007 | NA | NA |
| 277736 | 3 | B Michael Cox Development, LLC | 890 Mississippi Street | Fridley | Not In Use | NA | NA | NA |
| 277826 | 7b | Journye Home MN | 3246 New Brighton Road | Arden Hills | Water Supply | NA | NA | NA |
| 277898 | 7a | Nguyen | 2551 Wheeler Avenue N | Roseville | Water Supply | 10/28/2016 | NA | NA |
| 409596 | 7a | Midwest Asphalt | 575 Devine Drive | New Brighton | Monitoring | 6/28/2007 | NA | NA |
| 409597 | 7a | Midwest Asphalt | 591 Devine Drive | New Brighton | Monitoring | 6/28/2007 | NA | NA |
| 409598 | 7a | City of New Brighton | 540 Devine Drive | New Brighton | Monitoring | 12/5/2007 | NA | NA |
| 426810 | 3 | Honeywell TCAAP | New Brighton | New Brighton | No Status Reported | NA | 113 | 4/29/1986 |
| 541657 | 7a | Hammes Partners II, LP | 1835 County Road C W | Roseville | Monitoring | 8/20/1997 | NA | NA |
| 717791 | 6 | Nusz | 2847 Central Avenue NE | Minneapolis | No Status Reported | NA | 196 | 11/15/2005 |
| 717792 | 6 | Nusz | 2847 Central Avenue NE | Minneapolis | No Status Reported | NA | 85 | 11/11/2005 |
| 717793 | 6 | Nusz | 2847 Central Avenue NE | Minneapolis | No Status Reported | NA | 43 | 11/9/2005 |
| 757552 | 7a | City of New Brighton | New Brighton | New Brighton | Monitoring | NA | NA | NA |
| 764188 | 6 | 2407 University Investment, LLC | 2407 University Avenue SE | Minneapolis | In Use | NA | 28 | 8/14/2008 |
| 764189 | 6 | 2407 University Investment, LLC | 2407 University Avenue SE | Minneapolis | In Use | NA | 27 | 8/15/2008 |
| 764190 | 6 | 2407 University Investment, LLC | 2407 University Avenue SE | Minneapolis | In Use | NA | 28 | 8/14/2008 |
| 764191 | 6 | 2407 University Investment, LLC | 2407 University Avenue SE | Minneapolis | In Use | NA | 27 | 8/15/2008 |
| 764192 | 6 | 2407 University Investment, LLC | 2407 University Avenue SE | Minneapolis | In Use | NA | 27 | 8/15/2008 |
| 764193 | 7b | 2407 University Investment, LLC | 2407 University Avenue SE | Minneapolis | Monitoring | NA | NA | NA |
| 787876 | 6 | 2407 University Investment, LLC | 2407 University Avenue SE | Minneapolis | In Use | NA | 30 | 10/11/2011 |
| 787877 | 6 | 2407 University Investment, LLC | 2407 University Avenue SE | Minneapolis | In Use | NA | 30 | 10/11/2011 |
| 787878 | 6 | 2407 University Investment, LLC | 2407 University Avenue SE | Minneapolis | In Use | NA | 30 | 10/11/2011 |
| 787879 | 6 | 2407 University Investment, LLC | 2407 University Avenue SE | Minneapolis | In Use | NA | 30 | 10/11/2011 |
| 797083 | ~~6~~ 7b | 807 Broadway Revival, LLC | 807 Broadway Street NE | Minneapolis | Monitoring | 10/21/2014 | 24 | NA |
| 797084 | ~~6~~ 7b | 807 Broadway Revival, LLC | 1112 Quincy Street NE | Minneapolis | Monitoring | 10/21/2014 | 25 | NA |
| H000019287 | 7b | Erickson | 2505 County Road H | Mounds view | Sealed | NA | NA | NA |
| H000034644 | 7b | Hammes Partners II, LP | 1835 County Road C W | Roseville | Sealed | NA | NA | NA |
| H000035785 | 7b | Wolters | 1927 Glenpaul Avenue | Arden Hills | Sealed | NA | NA | NA |
| H000073723 | 7b | Leary | 338 New Brighton Road | New Brighton | Sealed | NA | NA | NA |
| H000073961 | 7b | Garner | 1666 Ridgewood Lane N | Roseville | Sealed | NA | NA | NA |
| H000091222 | 7b | Ellsworth | 2972 16th Street NW | New Brighton | Sealed | NA | NA | NA |

**Table E-3**
**Wells Disclosed through Property Transfer**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

PIKA ARCADIS a joint venture

| Unique Number | Category | Last Name or Business Name | Street | City | Status | Date Sealed | Depth | Date Drilled |
|---|---|---|---|---|---|---|---|---|
| H000111185 | 7b | Nusz | 2847 Central Avenue NE | Minneapolis | Sealed | NA | NA | NA |
| H000133395 | 7b | Tracy Homes, LLC | 1923 Summer Street | Falcon Heights | Sealed | NA | NA | NA |
| H000164293 | 7b | Tieney | 1955 Edgewater Avenue | Arden Hills | Sealed | NA | NA | NA |
| H000168109 | 7b | Neff | 1760 Shorewood Curve | Roseville | Sealed | NA | NA | NA |
| H000182476 | 7b | Abouhadir | 840 Mississippi Street NE | Fridley | Sealed | NA | NA | NA |
| H000206497 | 7b | Zinnecker | 4420 Hamline Avenue N | Arden Hills | Sealed | NA | NA | NA |
| H000213718 | 7b | Cramond | 5323 Clifton Drive | Mounds View | Sealed | NA | NA | NA |
| H000245554 | 7b | Haskin | 1655 Oak Avenue | Arden Hills | Sealed | NA | NA | NA |
| H000266223 | 7b | No Owner Found | New Brighton | New Brighton | Sealed | NA | NA | NA |
| H000266224 | 7b | No Owner Found | New Brighton | New Brighton | Sealed | NA | NA | NA |
| H000266225 | 7b | No Owner Found | New Brighton | New Brighton | Sealed | NA | NA | NA |
| H000266226 | 7b | No Owner Found | New Brighton | New Brighton | Sealed | NA | NA | NA |
| H000266227 | 7b | No Owner Found | 540 Devine Drive | New Brighton | Sealed | NA | NA | NA |
| H000266229 | 7b | No Owner Found | 510 14th Street NW | New Brighton | Sealed | NA | NA | NA |
| H000266230 | 7b | No Owner Found | New Brighton | New Brighton | Sealed | NA | NA | NA |
| H000268012 | 7b | Nguyen | 2530 Silver Lake Road NW | New Brighton | Sealed | NA | NA | NA |
| H000268766 | 7b | No Owner Found | New Brighton | New Brighton | Sealed | NA | NA | NA |
| H000268794 | 7b | No Owner Found | New Brighton | New Brighton | Sealed | NA | NA | NA |
| H000273505 | 7b | No Owner Found | 1385 Nothwest Parkway | New Brighton | Sealed | NA | NA | NA |
| H000273549 | 7b | No Owner Found | 510 14th Street NW | New Brighton | Sealed | NA | NA | NA |
| H000285660 | 7b | Gutierrez | 1915  Glenpaul Avenue | Arden Hills | Sealed | NA | NA | NA |
| H000312294 | 7b | Moore | 1974 Summer Street | Falcon Heights | Sealed | NA | NA | NA |
| H000315144 | 7b | Hunt | 7531 Tempo Terrace NE | Fridley | Sealed | NA | NA | NA |
| H000318902 | 7b | Szatrowski | 1875 Ryan Avenue W | Roseville | Sealed | NA | NA | NA |
| H000318917 | 7b | Pierce | 2599 Wheller Street N | Roseville | Sealed | NA | NA | NA |
| H000319676 | 7b | Robles | 4528 Fourth Street NE | Columbia Heights | Sealed | NA | NA | NA |
| H000319802 | 7b | Kulzer | 4408 Hamline Avenue | Arden Hills | Sealed | NA | NA | NA |
| H000322966 | 7b | Sparr | 1975 Autumn Street | Falcon Heights | Sealed | NA | NA | NA |
| H000323113 | 7b | Maple Ridge Construction, Inc | 2544 Beacon Street | Roseville | Sealed | NA | NA | NA |
| H000325459 | 7b | Martin | 4908 Jefferson Street NE | Columbia Heights | Sealed | NA | NA | NA |
| H000333899 | 7b | Kelley | 4439 2½ Street NE | Columbia Heights | Sealed | NA | NA | NA |
| H000337183 | 7b | Journey Home MN | 3246 New Brighton Road | Arden Hills | Sealed | NA | NA | NA |
| H000337195 | 7b | Buus | 1592Lois Drive | Shoreview | Sealed | NA | NA | NA |
| H000339448 | 7b | Hornstra | 2816 Highway 88 | St. Anthony | Sealed | NA | NA | NA |
| H000340447 | 7b | Carvalhodealmeida | 20 Mid Oaks Lane | Roseville | Sealed | NA | NA | NA |
| H000340953 | 7b | Faust | 760 Eighth Avenue NW | New Brighton | Sealed | NA | NA | NA |
| H000342443 | 7b | Stevens | 1624 Osborne Road NE | Fridley | Sealed | NA | NA | NA |
| H000344717 | 7b | Liu | 6361 Able Street NE | Fridley | Sealed | NA | NA | NA |
| H000345131 | 7b | Abouhadir | 840 Mississippi Street NE | Fridley | Sealed | NA | NA | NA |
| H000346763 | 7b | Neuburger | 2143 Midlothian Road | Roseville | Sealed | NA | NA | NA |
| H000349499 | 7b | Smith | 1831 Tatum Street | Falcon Heights | Sealed | NA | NA | NA |
| H000351838 | 7b | Stevens | 3090 Wilder Street N | Roseville | Sealed | NA | NA | NA |

**Table E-3**
**Wells Disclosed through Property Transfer**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

PIKA ARCADIS a joint venture

| Unique Number | Category | Last Name or Business Name | Street | City | Status | Date Sealed | Depth | Date Drilled |
|---|---|---|---|---|---|---|---|---|
| H000351838 | 7b | No Owner Found | 3090 Wilder Street N | Roseville | Sealed | NA | NA | NA |
| UNK0437667 | 3 | Imholte | 5290 Pinewood Court | Mounds view | Not In Use | NA | NA | NA |
| UNK0538006 | 7b | Al Maliki | 7301 Van Buren Street NE | Fridley | Sealed | NA | NA | NA |
| UNK0538250 | 7b | Phan | 1730 Hillview Road | Shoreview | Sealed | NA | NA | NA |
| UNK0538258 | 7b | Lindberg | 6524 Anoka Street NE | Fridley | Sealed | NA | NA | NA |
| UNK0538349 | 3 | Wegner | 1735 Lois Drive | Shoreview | In Use | NA | NA | NA |
| UNK0538593 | 7b | Sanchezquevedo | 7365 Spring Lake Road | Mounds View | Sealed | NA | NA | NA |
| UNK0538594 | 7b | Sanchezquevedo | 7365 Spring Lake Road | Mounds View | Sealed | NA | NA | NA |
| UNK0538595 | 7b | Sanchezquevedo | 7365 Spring Lake Road | Mounds View | Sealed | NA | NA | NA |
| UNK0539205 | 3 | Barnsley | 5541 Fairview Avenue N | Shoreview | In Use | NA | NA | NA |
| UNK0539665 | 3 | Hubers | 2936 Old Highway 8 | Roseville | In Use | NA | NA | NA |
| UNK0540012 | 3 | Energy Park Holdings, LLC | 2091 Energy Park Drive | St. Paul | In Use | NA | NA | NA |
| UNK0540711 | 7b | Kavaloski | 2917  Troseth Road | Roseville | Sealed | NA | NA | NA |
| UNK0540753 | 7b | Miner | 2243  Thorndale Avenue | New Brighton | Sealed | NA | NA | NA |
| UNK0540756 | 7b | Macrina | 1665 Rose Place | Roseville | Sealed | NA | NA | NA |
| UNK0540948 | 3 | Watson | 2210 Bronson Drive | Mounds View | Not In Use | NA | NA | NA |
| UNK0541007 | 7b | Perez | 7460 Able Street NE | Fridley | Sealed | NA | NA | NA |
| UNK0541070 | 7b | Forsythe | 2705  27th Avenue NE | St. Anthony | Sealed | NA | NA | NA |
| UNK0541265 | 3 | Roeser | 2030 Fairview Avenue N | Roseville | In Use | NA | 165 | 1973 |
| UNK0541294 | 7b | Forte | 2591 Charlotte Street | Roseville | Sealed | NA | NA | NA |
| UNK0541687 | 3 | Schneider | 2237 N Cleveland Avenue | Roseville | Not In Use | NA | NA | NA |
| UNK0542032 | 7b | Aker | 4765  Main Street NE | Fridley | Sealed | NA | NA | NA |
| UNK0542132 | 7b | Samplson | 1711 St. Marys Street | Falcon Heights | Sealed | NA | NA | NA |
| UNK0542587 | 7b | Kelley | 4439  2 ½ Avenue NE | Columbia Heights | Sealed | NA | NA | NA |
| UNK0542625 | 3 | Little Red Hen Properties, Inc. | 1683 Lois Drive | Shoreview | In Use | NA | NA | NA |
| UNK0542641 | 7b | Maloney | 1922 Autumn Street | Falcon Heights | Sealed | NA | NA | NA |
| UNK0543296 | 7b | McDonough | 7425 Pleasant View Drive | Mounds View | Sealed | NA | NA | NA |
| UNK0543331 | 3 | Odegard | 2605 Wheeler Street N | Roseville | Not In Use | NA | NA | NA |
| UNK0544567 | 3 | Smith | 118 New Brighton Road | New Brighton | Not In Use | NA | NA | NA |
| UNK0544921 | 3 | Olson | 3011 Shorewood Lane | Roseville | Not In Use | NA | NA | NA |
| UNK0544996 | 3 | Persuitti | 3150 Shorewood Drive | Arden Hills | Not In Use | NA | NA | NA |
| UNK0545452 | 3 | Marken | 1370 Rice Creek Road Ne | Fridley | Not In Use | NA | NA | NA |
| UNK0546162 | 7b | Woolsey | 1791 Longview Drive | New Brighton | Sealed | NA | NA | NA |
| UNK0546639 | 3 | Kruta | 1870 Beckman Avenue | Arden Hills | In Use | NA | NA | NA |
| UNK0546639 | 3 | VanKampen | 1870 Beckman Avenue | Arden Hills | In Use | NA | NA | NA |
| UNK0547700 | 7b | Christensen | 6161 Sunrise Drive NE | Fridley | Sealed | NA | NA | NA |
| UNK0547746 | 7b | Oase | 1683 Lois Drive | Shoreview | Sealed | NA | NA | NA |
| UNK0547924 | 7b | Darrel D. | 2516 27th Avenue NE | St. Anthony | Sealed | NA | NA | NA |
| UNK0548540 | 7b | Viken | 1985 Glenpaul Avenue | Arden Hills | Sealed | NA | NA | NA |
| UNK0548830 | 7b | Swenson | 4030 Valentine Court | Arden Hills | Sealed | NA | NA | NA |
| UNK0548840 | 3 | Taylor | 1803 Venus Avenue | Arden Hills | Not In Use | NA | NA | NA |
| UNK0549486 | 7b | Stier | 2009 Beacon Street | Roseville | Sealed | NA | NA | NA |

PIKA ARCADIS a joint venture

| Unique Number | Category | Last Name or Business Name | Street | City | Status | Date Sealed | Depth | Date Drilled |
|---|---|---|---|---|---|---|---|---|
| UNK0549524 | 3 | Kottke | 1661 Lake Valentine Road | Arden Hills | In Use | NA | NA | NA |
| UNK0549551 | 7b | Lavine | 4370 Snelling Avenue N | Arden Hills | Sealed | NA | NA | NA |
| UNK0549946 | 7b | Buzzel | 1385 Skywood Lane NE | Fridley | Sealed | NA | NA | NA |
| UNK0550118 | 7b | Stiff | 1742 Tatum Street | Falcon Heights | Sealed | NA | NA | NA |
| UNK0550212 | 3 | Howe | 1770 Hillview Road | Shoreview | In Use | NA | NA | NA |
| UNK0550328 | 7b | Reiter | 1636 Lois Drive | Shoreview | Sealed | NA | NA | NA |
| UNK0550329 | 7b | Reiter | 1636 Lois Drive | Shoreview | Sealed | NA | NA | NA |
| UNK0550651 | 3 | Howell | 2276 Highway 36 W | Roseville | In Use | NA | NA | NA |
| UNK0550974 | 7b | Durhman | 3628 Snelling Avenue N | Arden Hills | Sealed | NA | NA | NA |
| UNK0551951 | 3 | Cornerstone Private Asset Trust Co., LLC | 6663 Lucia Lane | Fridley | In Use | NA | NA | NA |
| UNK0551958 | 3 | Gast | 3083 Shorewood Lane | Roseville | In Use | NA | NA | NA |
| UNK0551963 | 3 | Cornerstone Private Asset Trust Co., LLC | 6663 Lucia Lane | Fridley | In Use | NA | NA | NA |
| UNK0552090 | 7b | Gibbs | 2167 Rosewood Lane N | Roseville | Sealed | NA | NA | NA |
| UNK0552174 | 7b | Mesa Investments, LLC | 2005 Longview Drive | New Brighton | Sealed | NA | NA | NA |
| UNK0552175 | 7b | Mesa Investments, LLC | 2005 Longview Drive | New Brighton | Sealed | NA | NA | NA |
| UNK0552193 | 7b | Lundquist | 1657 Millwood Avenue | Roseville | Sealed | NA | NA | NA |
| UNK0552479 | 7a | Lohmann | 1646 Gardena Avenue NE | Fridley | Sealed | 11/16/2007 | 157 | NA |
| UNK0552638 | 3 | Buie | 5580 Aldine Street | Shoreview | Not In Use | NA | NA | NA |
| UNK0552922 | 3 | Buie | 5580 Aldine Street | Shoreview | Not In Use | NA | NA | NA |
| UNK0553071 | 1d | Belden River Properties, LLC | 2504 27th Avenue NE | St. Anthony | Not In Use | NA | NA | NA |
| UNK0553097 | 7b | Mejia | 1770 Oakcrest Avenue | Roseville | Sealed | NA | NA | NA |
| UNK0553184 | 3 | Lemmons | 1841 Gramsie Road | Arden Hills | In Use | NA | NA | NA |
| UNK0553240 | 7b | Holmes | 1921 Grant Road | Arden Hills | Sealed | NA | NA | NA |
| UNK0553272 | 7b | Matala | 3623 Pascal Avenue | Arden Hills | Sealed | NA | NA | NA |
| UNK0553463 | 7b | Vondall | 525 66th Avenue NE | Fridley | Sealed | NA | NA | NA |
| UNK0553687 | 7b | Regents of the University of Minnesota | 650 25th Avenue SE | Minneapolis | Sealed | NA | NA | NA |
| UNK0553795 | 7b | Ball | 6725 Channel Road NE | Fridley | Sealed | NA | NA | NA |
| UNK0553876 | 7b | Riley | 4544 Second Street | Fridley | Sealed | NA | NA | NA |
| UNK0553884 | 7b | May | 1836 Gramsie Road | Arden Hills | Sealed | NA | NA | NA |
| UNK0554873 | 7b | Sroga | 2565 Charlotte Street | Roseville | Sealed | NA | NA | NA |
| UNK0554930 | 7b | Kimberly Wells, MN | 1376 Mississippi Street NE | Fridley | Sealed | NA | NA | NA |
| UNK0555078 | 4b | No Owner Found | New Brighton | New Brighton | No Status Reported | NA | NA | NA |
| UNK0555079 | 4b | No Owner Found | New Brighton | New Brighton | No Status Reported | NA | NA | NA |
| UNK0555080 | 4b | No Owner Found | New Brighton | New Brighton | No Status Reported | NA | NA | NA |
| UNK0555081 | 4b | No Owner Found | New Brighton | New Brighton | No Status Reported | NA | NA | NA |
| UNK0555105 | 7b | Thomas L. Frattalone, MN | 1203 W County Road E | Arden Hills | Sealed | NA | NA | NA |
| UNK0555458 | 7b | Holbrook | 1863 Glenpaul Avenue | Arden Hills | Sealed | NA | NA | NA |
| UNK0556005 | 3 | Anderson | 4419 Old Highway 10 | Arden Hills | In Use | NA | NA | NA |
| UNK0556143 | 7b | Vandegrift | 2243 Rainbow Avenue | New Brighton | Sealed | NA | NA | NA |
| UNK0556457 | 7b | Collette | 1644 Oak Avenue | Arden Hills | Sealed | NA | NA | NA |

**Table E-3**
**Wells Disclosed through Property Transfer**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

| Unique Number | Category | Last Name or Business Name | Street | City | Status | Date Sealed | Depth | Date Drilled |
|---|---|---|---|---|---|---|---|---|
| UNK0556492 | 7b | VanKampen | 1870 Beckman Avenue | Arden Hills | Sealed | NA | NA | NA |
| UNK0557942 | 7b | Greiner | 1086 27th Avenue NW | New Brighton | Sealed | NA | NA | NA |
| UNK0558000 | 7b | Symons | 1770 Hillview Road | Shoreview | Sealed | NA | NA | NA |
| UNK0558231 | 7b | Weber | 575 Ninth Avenue NW | New Brighton | Sealed | NA | NA | NA |
| UNK0558235 | 7b | Lamoreux | 2463 Ridge Lane | Mounds view | Sealed | NA | NA | NA |
| UNK0558236 | 7b | Fontaine | 2288 County Road 10 | Mounds view | Sealed | NA | NA | NA |
| UNK0559221 | 7b | Mark | 1701 Fairview Avenue N | Falcon Heights | Sealed | NA | NA | NA |

**Table E-4**
**Sealed Wells**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

PIKA ARCADIS a joint venture

| Unique Number | Category | Last Name or Business Name | Street | City | Use | Date Sealed |
|---|---|---|---|---|---|---|
| 82922 | 7a | MN DOT | | Arden Hills | Environmental Well | 2/5/2018 |
| 277898 | 7a | Plummer | 2551 Wheeler Avenue N | Roseville | Water Supply | 10/28/2016 |
| 277902 | 7a | Podlasek | 4410 N Snelling Avenue | Arden Hills | Water Supply | 1/30/2017 |
| 278949 | 7a | Kavaloski | 2917 Troseth Road | Roseville | Water Supply | 2/15/2018 |
| 493585 | 7a | City of Mounds View | 2466 Bronson Drive | Mounds View | Monitoring | 5/5/2017 |
| 493586 | 7a | City of Mounds View | 2466 Bronson Drive | Mounds View | Monitoring | 5/15/2017 |
| 493587 | 7a | City of Mounds View | 2466 Bronson Drive | Mounds View | Monitoring | 5/5/2017 |
| 493588 | 7a | City of Mounds View | 2466 Bronson Drive | Mounds View | Monitoring | 5/5/2017 |
| 780901 | 7a | City of St. Paul | Raymond Avenue | St. Paul | Monitoring | 10/18/2016 |
| 780903 | 7a | City of St. Paul | Raymond Avenue | St. Paul | Monitoring | 10/18/2016 |
| 796623 | 7a | Brenntag Great Lakes, LLC | 2130 Energy Park Drive | St. Paul | Env. Boring | 3/16/2018 |
| 796624 | 7a | Brenntag Great Lakes, LLC | 2130 Energy Park Drive | St. Paul | Environmental Well | 3/16/2018 |
| 796625 | 7a | Brenntag Great Lakes, LLC | 2130 Energy Park Drive | St. Paul | Environmental Well | 3/16/2018 |
| 796626 | 7a | Brenntag Great Lakes, LLC | 2130 Energy Park Drive | St. Paul | Environmental Well | 3/16/2018 |
| 804277 | 7a | MPCA | Fridley | Fridley | Environmental Well | 10/31/2017 |
| 804278 | 7a | MPCA | Fridley | Fridley | Environmental Well | 10/23/2017 |
| 805467 | 7a | Metropolitan Council | Fridley | Fridley | Other | 6/6/2017 |
| 817711 | 7a | MN DOT | New Brighton | New Brighton | Environmental Well | 10/30/2017 |
| 817712 | 7a | MN DOT | New Brighton | New Brighton | Environmental Well | 10/30/2017 |
| 817713 | 7a | MN DOT | New Brighton | New Brighton | Environmental Well | 10/30/2017 |
| 817714 | 7a | MN DOT | New Brighton | New Brighton | Environmental Well | 10/30/2017 |
| 817715 | 7a | MN DOT | New Brighton | New Brighton | Environmental Well | 10/30/2017 |
| 817743 | 7a | City of Fridley | 400 71st Avenue NE | Fridley | Monitoring | 5/15/2017 |
| 817744 | 7a | City of Fridley | 400 71st Avenue NE | Fridley | Monitoring | 5/15/2017 |
| 817745 | 7a | City of Fridley | 400 71st Avenue NE | Fridley | Monitoring | 5/15/2017 |
| 817746 | 7a | City of Fridley | 400 71st Avenue NE | Fridley | Monitoring | 5/15/2017 |
| 817747 | 7a | City of Fridley | 400 71st Avenue NE | Fridley | Monitoring | 5/15/2017 |
| 828032 | 7a | US Army Environmental Command | 4761 Hamline Avenue N | Arden Hills | Env. Boring | 7/11/2017 |
| 828033 | 7a | US Army Environmental Command | 4761 Hamline Avenue N | Arden Hills | Env. Boring | 7/14/2017 |
| 828034 | 7a | US Army Environmental Command | 4761 Hamline Avenue N | Arden Hills | Env. Boring | 7/20/2017 |
| H000297255 | 7a | Sand Companies, Inc. | Roseville | Roseville | Environmental Well | 2/15/2018 |
| H000297264 | 7a | No Owner Found | 4889 Old Highway 8 | Mounds View | Environmental Well | 3/16/2018 |
| H000297709 | 7a | Wall Development Comp., LLC | 518 Malcolm Avenue SE | Minneapolis | Env. Boring | 2/27/2017 |
| H000297718 | 7a | Korean United Methodist Church | 701 EIGHTH Avenue NW | New Brighton | Environmental Well | 10/12/2017 |
| H000320547 | 7a | United Properties Dev., LLC | 3300 University Avenue SE | Minneapolis | Env. Boring | 11/29/2016 |
| H000325415 | 7a | Bremer Bank | 4061 Lexington Avenue | Shoreview | | 8/31/2017 |
| H000328474 | 7a | D and A Development, LLP | 4825 Mustang Circle | Mounds View | Other | 12/8/2016 |
| H000331898 | 7a | St. Paul Regional Water Services | Little Canada | Little Canada | Monitoring | 1/26/2017 |
| H000335498 | 7a | Javelin | 3757 Lexington Avenue N | Arden Hills | | 4/16/2018 |
| H000337185 | 7a | Nelson | 346 Third Avenue SE | New Brighton | Water Supply | 10/26/2016 |
| H000337195 | 7a | Welch | 1592 Lois Drive | Shoreview | Water Supply | 11/28/2016 |
| H000338146 | 7a | Phan | 1730 Hillview Road | Shoreview | Water Supply | 10/4/2016 |
| H000339448 | 7a | Palkowski | 2816 Highway 88 | St. Anthony | Water Supply | 10/10/2016 |
| H000339465 | 7a | Sylvester | 1957 Creek Road | New Brighton | Water Supply | 11/17/2016 |
| H000339872 | 7a | Pape | 1805 Lois Drive | Shoreview | Water Supply | 5/31/2017 |

**Table E-4**
**Sealed Wells**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

| Unique Number | Category | Last Name or Business Name | Street | City | Use | Date Sealed |
|---|---|---|---|---|---|---|
| H000340447 | 7a | schauffert | 20 Mid Oaks Lane | Roseville | Water Supply | 5/22/2017 |
| H000340742 | 7a | Hawkeye Hotels, Inc. | 3920 Northwoods Drive | Arden Hills | Environmental Well | 7/21/2017 |
| H000340994 | 7a | Broadway Holdings, LLC | 3501 Broadway Street | Minneapolis | Other | 10/12/2016 |
| H000341024 | 7a | Midwest Climbing | 518 Malcolm Avenue SE | Minneapolis | Monitoring | 11/25/2016 |
| H000341812 | 7a | MN DOT | New Brighton | New Brighton | Monitoring | 12/20/2016 |
| H000341814 | 7a | City of New Brighton | New Brighton | New Brighton | Monitoring | 12/19/2016 |
| H000342170 | 7a | WEST | 3076 Shorewood Lane | Roseville | Water Supply | 11/6/2017 |
| H000342171 | 7a | Eino Lammi Estate | 7365 Spring Lake Road | Mounds View | Water Supply | 10/13/2016 |
| H000342172 | 7a | Eino Lammi Estate | 7365 Spring Lake Road | Mounds View | Water Supply | 10/13/2016 |
| H000342173 | 7a | Eino Lammi Estate | 7365 Spring Lake Road | Mounds View | Water Supply | 10/13/2016 |
| H000342194 | 7a | Boyer | 345 Second Avenue SE | New Brighton | Water Supply | 6/16/2017 |
| H000342385 | 7a | MPCA | 2112 Broadway Street NE | Minneapolis | Monitoring | 12/7/2016 |
| H000342416 | 7a | MPCA | 2200 Old Highway 8 | New Brighton | Monitoring | 3/2/2017 |
| H000342443 | 7a | McClain | 1624 Osborne Road NE | Fridley | Water Supply | 1/19/2017 |
| H000343524 | 7a | City of Arden Hills | Arden Hills | Arden Hills | Env. Boring | 8/23/2017 |
| H000343527 | 7a | City of St. Anthony | St. Anthony | St. Anthony | Environmental Well | 9/18/2017 |
| H000343579 | 7a | Hunters Rock | 2855 Anthony Lane S | St. Anthony | Environmental Well | 7/2/2018 |
| H000343883 | 7a | Wulff | 4337 Old Highway 10 | Arden Hills | Water Supply | 5/8/2017 |
| H000343970 | 7a | American Consulting Services | 2108 University Avenue | St. Paul | Monitoring | 1/24/2017 |
| H000344429 | 7a | DJK, INC. | 1814 Central Avenue NE | Minneapolis | Monitoring | 11/14/2016 |
| H000344464 | 7a | Hennepin Investors, LLC | 950 E Hennepin Avenue | Minneapolis | Monitoring | 4/4/2017 |
| H000344484 | 7a | Vincent | 700 24th Avenue SE | Minneapolis | Monitoring | 2/8/2017 |
| H000344491 | 7a | Schlieper | 1991 Eldridge Avenue W | Roseville | Water Supply | 2/28/2017 |
| H000344594 | 7a | R and D Systems | 614 McKinley PlaceNE | Minneapolis | Other | 12/27/2017 |
| H000344604 | 7a | Janzen | 455 37th Avenue NE | Columbia Heights | Monitoring | 2/16/2017 |
| H000344636 | 7a | Goring | 4500 Central Avenue | Columbia Heights | Monitoring | 1/18/2017 |
| H000344717 | 7a | Towey | 6361 Able Street NE | Fridley | Water Supply | 1/19/2017 |
| H000345131 | 7a | Melcher | 840 Mississippi Street NE | Fridley | Water Supply | 4/11/2017 |
| H000345145 | 7a | Ellefson | 1918 Grant Road | Arden Hills | Water Supply | 6/13/2017 |
| H000345430 | 7a | Micom Corp. | 475 Old Highway 8 NW | New Brighton | Monitoring | 2/21/2017 |
| H000345434 | 7a | Central Plaza Associates | 4500 Central Avenue NE | Columbia Heights | Monitoring | 2/28/2017 |
| H000345448 | 7a | Realterm Nat, Ben Andreycak | 50 14th Street NW | New Brighton | Monitoring | 4/10/2017 |
| H000345869 | 7a | Loerzel | 1770 Oakcrest Avenue | Roseville | Water Supply | 9/21/2017 |
| H000345881 | 7a | Lane | 1459 15th Terrace NW | New Brighton | Water Supply | 4/25/2017 |
| H000346185 | 7a | Twin Cities Die Casting | 1070 33RD Avenue SE | Lauderdale | Environmental Well | 9/27/2017 |
| H000346186 | 7a | Fulton Family Partnership | 2550 Wabash Avenue | St. Paul | Environmental Well | 10/16/2017 |
| H000346221 | 7a | Bona Brothers | 5311 University Avenue NE | Fridley | Monitoring | 4/24/2017 |
| H000346337 | 7a | Leasing | 2195 County Road C2 W | Roseville | Monitoring | 3/17/2017 |
| H000346346 | 7a | Goers | 125 Lowry Avenue NE | Minneapolis | Monitoring | 3/30/2017 |
| H000346406 | 7a | Lavigne | 10121 Palm Street NW | Coon Rapids | Water Supply | 5/3/2017 |
| H000346591 | 7a | API Group, Inc. | New Brighton | New Brighton | Environmental Well | 2/6/2018 |
| H000346674 | 7a | Wash on Central | 7699 Highway 65 N | Fridley | Env. Boring | 3/29/2017 |
| H000346687 | 7a | City of Minneapolis | Minneapolis | Minneapolis | Env. Boring | 4/27/2017 |
| H000346697 | 7a | Mulcahy | 3391 Labore Road | Vadnais Heights | Environmental Well | 5/7/2017 |
| H000346763 | 7a | Makintyre | 2143 Midlothian Road | Roseville | Water Supply | 5/11/2017 |

**Table E-4**
**Sealed Wells**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

PIKA ARCADIS a joint venture

| Unique Number | Category | Last Name or Business Name | Street | City | Use | Date Sealed |
|---|---|---|---|---|---|---|
| H000346772 | 7a | Lovelace | 1683 Lois Drive | Shoreview | Water Supply | 6/7/2017 |
| H000346834 | 7a | Dickson | 2187 Rosewood Lane N | Roseville | Water Supply | 3/29/2017 |
| H000346864 | 7a | Bass | 3150 Shorewood Drive | Arden Hills | Water Supply | 5/8/2017 |
| H000347035 | 7a | Tyson Trucking | 185 Fifth Avenue SW | New Brighton | Monitoring | 7/25/2017 |
| H000347056 | 7a | Smith | 932 County Road C2 | Roseville | Water Supply | 7/17/2017 |
| H000347060 | 7a | Trudell | 1911 Fairview Avenue N | Falcon Heights | Water Supply | 9/12/2017 |
| H000347338 | 7a | Olson | 3027 Shorewood Lane | Roseville | Water Supply | 8/30/2017 |
| H000347835 | 7a | Freemont | 1985 Glen Paul Avenue | Arden Hills | Water Supply | 7/24/2017 |
| H000348166 | 7a | City of Mounds View | 2466 Bronson Drive | Mounds View | Monitoring | 6/13/2017 |
| H000348173 | 7a | Hawkins, Inc. | 3100 E Hennepin Avenue | Minneapolis | Monitoring | 6/22/2017 |
| H000348184 | 7a | Sor Real Estate, LLC | 1905 Lake Valentine Road | New Brighton | Monitoring | 7/12/2017 |
| H000348610 | 7a | Pulte Group | Arden Hills | Arden Hills | | 7/26/2017 |
| H000348649 | 7a | Lindsey | 3900 Bethel Drive | Arden Hills | | 9/7/2017 |
| H000348901 | 7a | Evanson | 3191 Lake Johanna Boulevard | Arden Hills | Water Supply | 10/19/2017 |
| H000348909 | 7a | Gupta | 1681 Ridgewood Lane N | Roseville | Water Supply | 8/14/2017 |
| H000349023 | 7a | Cassidy | 1833 Gramsie Road | Arden Hills | Water Supply | 11/15/2017 |
| H000349499 | 7a | Smith | 1831 Tatum Street | Falcon Heights | Water Supply | 3/15/2018 |
| H000349602 | 7a | Portillos Restaurant | Roseville Mall Drive | Roseville | | 8/22/2017 |
| H000349628 | 7a | Prospect Foundry | 1225 Winter Street NE | Minneapolis | Environmental Well | 11/14/2017 |
| H000349813 | 7a | Bethel University | 3900 Bethel Drive | Arden Hills | Environmental Well | 10/13/2017 |
| H000349854 | 7a | CRESA Minneapolis | Kasota Avenue | St. Paul | Env. Boring | 11/9/2017 |
| H000349881 | 7a | Midland Hills Golf Course | 1985 Lake Street | Roseville | Environmental Well | 8/7/2017 |
| H000349894 | 7a | City of Minneapolis; Sewer & Water | | Minneapolis | Environmental Well | 8/22/2017 |
| H000349966 | 7a | Meritex Highcrest DC III, LLC | 2470 Highcrest Road | Roseville | Environmental Well | 9/14/2017 |
| H000350058 | 7a | Tomas | 2401 Lowry Avenue NE | St. Anthony | Environmental Well | 8/18/2017 |
| H000350063 | 7a | BNSF Railway Co. | 640 Malcom Avenue SE | St. Paul | Environmental Well | 9/19/2017 |
| H000350087 | 7a | Fridley Public Schools | 6000 W Moore Lake Drive NE | Fridley | Environmental Well | 11/30/2017 |
| H000350212 | 7a | City of Mounds View | 2466 Bronson Drive | Mounds View | Monitoring | 8/4/2017 |
| H000350233 | 7a | Herbert W. Tousley Fourth | 2300 Wycliff Street | St. Paul | Environmental Well | 8/17/2017 |
| H000350263 | 7a | Gurak | 1567 Oak Avenue | Arden Hills | Water Supply | 8/23/2017 |
| H000350267 | 7a | Ward | 1320 69th Avenue NE | Fridley | Water Supply | 8/22/2017 |
| H000350692 | 7a | Vik | 6725 Channel Road | Fridley | Water Supply | 12/27/2017 |
| H000350699 | 7a | Linke | 1691 Oakwood Drive | Shoreview | Water Supply | 4/11/2018 |
| H000351389 | 7a | Univar USA Inc. | 2313 Wycliff Street | St. Paul | Environmental Well | 11/2/2017 |
| H000351478 | 7a | Mim | 2631 NE Sixth Street | Minneapolis | Environmental Well | 12/8/2017 |
| H000351487 | 7a | Mim | 829 Marshall Street NE | Minneapolis | Environmental Well | 5/7/2018 |
| H000351495 | 7a | Mim | 3805 Second Street NE | Columbia Heights | Environmental Well | 5/2/2018 |
| H000351524 | 7a | Schill | 5062 Greenwood Drive | Mounds View | Water Supply | 8/8/2018 |
| H000351740 | 7a | Franke | 7635 Groveland Road | Mounds View | Water Supply | 9/11/2017 |
| H000351809 | 7a | Leopold | 1644 Oak Avenue | Arden Hills | Water Supply | 4/5/2018 |
| H000351838 | 7a | Boettner | 3090 Wilder Street N | Roseville | Water Supply | 5/30/2018 |
| H000352224 | 7a | Buzzeli | 4853 University Avenue NE | Columbia Heights | Water Supply | 12/13/2017 |
| H000352225 | 7a | Coldwell Banker Burnet | 1921 Grant Road | Arden Hills | Water Supply | 12/20/2017 |
| H000352226 | 7a | Johnson | 1646 Gardena Avenue NE | Fridley | Water Supply | 11/16/2017 |
| H000352245 | 7a | Diedrich | 2545 Herschel Street | Roseville | Water Supply | 11/20/2017 |

Table E-4
Sealed Wells
FY 2018 Annual Report
Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota

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| Unique Number | Category | Last Name or Business Name | Street | City | Use | Date Sealed |
|---|---|---|---|---|---|---|
| H000352551 | 7a | Clevelander, LLC | 2785 Fairview Avenue N | Roseville | Environmental Well | 9/22/2017 |
| H000352587 | 7a | The Javelin Group | 2285 Hampden Avenue W | St. Paul | Environmental Well | 2/16/2018 |
| H000352592 | 7a | Reiling | 3058 Old Highway 8 | Roseville | Environmental Well | 4/23/2018 |
| H000352843 | 7a | Smith | 2005 Longview Drive | New Brighton | Water Supply | 11/20/2017 |
| H000352844 | 7a | Smith | 2005 Longview Drive | New Brighton | Water Supply | 11/20/2017 |
| H000352845 | 7a | Fox | 1782 Terrace Drive | Shoreview | Water Supply | 11/30/2017 |
| H000352963 | 7a | City of New Brighton | New Brighton | New Brighton | Environmental Well | 1/19/2018 |
| H000352976 | 7a | City of Roseville | Roseville | Roseville | Environmental Well | 12/8/2017 |
| H000352977 | 7a | City of Roseville | Roseville | Roseville | Environmental Well | 12/8/2017 |
| H000353013 | 7a | Mounds View Public Schools | 2101 14th Street NW | New Brighton | Environmental Well | 3/8/2018 |
| H000353028 | 7a | McGough Construction Co., Inc. | 2785 Fairview Avenue N | Roseville | Environmental Well | 1/18/2018 |
| H000353553 | 7a | Sullivan | 2931 Partridge Road | Roseville | Environmental Well | 10/17/2017 |
| H000353554 | 7a | Irilbeck | 4920 Central Avenue NE | Columbia Heights | Environmental Well | 10/18/2017 |
| H000353619 | 7a | Nellis | 651 11th Avenue NW | New Brighton | Water Supply | 5/18/2018 |
| H000353721 | 7a | MPCA | 5000 Central Avenue NE | Columbia Heights | Environmental Well | 2/22/2018 |
| H000353730 | 7a | MN DOT | St. Paul | St. Paul | Environmental Well | 11/16/2017 |
| H000353731 | 7a | MN DOT | St. Paul | St. Paul | Environmental Well | 11/15/2017 |
| H000353737 | 7a | MN DOT | St. Paul | St. Paul | Environmental Well | 11/15/2017 |
| H000353738 | 7a | MN DOT | St. Paul | St. Paul | Environmental Well | 11/15/2017 |
| H000353833 | 7a | Kunz | 2280 County Road I | Mounds View | Other | 6/6/2018 |
| H000353834 | 7a | Kunz | 2280 County Road I | Mounds View | Environmental Well | 7/10/2018 |
| H000354088 | 7a | Salad | 3836 Stinson Boulevard | Columbia Heights | Environmental Well | 11/17/2017 |
| H000354233 | 7a | ISD 623 | 1744 County Road B W | Roseville | Environmental Well | 2/14/2018 |
| H000354245 | 7a | ISD 623 | 1910 County Road B W | Roseville | Environmental Well | 2/8/2018 |
| H000354376 | 7a | Ramsey County | 1661 Highway 96 | Arden Hills | Env. Boring | 5/8/2018 |
| H000354377 | 7a | Ramsey County | 1661 Highway 96 | Arden Hills | Env. Boring | 5/2/2018 |
| H000354380 | 7a | ISD 621 | 5100 Edgewood Drive N | Mounds View | Environmental Well | 5/2/2018 |
| H000354398 | 7a | ISD 621 | 1900 Lake Valentine Road | Arden Hills | Env. Boring | 5/23/2018 |
| H000354470 | 7a | Land M Holding Co., LLP | 2250 University Avenue W | St. Paul | | 7/31/2018 |
| H000354700 | 7a | MN Relocation | 5085 Red Oak Drive | Mounds View | Water Supply | 3/13/2018 |
| H000354724 | 7a | CRESA Minneapolis | 2575 Kasota Avenue | St. Paul | Environmental Well | 12/20/2017 |
| H000354750 | 7a | Wentworth | 1799 Stanbridge Avenue | Roseville | Water Supply | 8/28/2018 |
| H000354895 | 7a | Village Auto Works | 2760 Fairview Avenue N | Roseville | Environmental Well | 1/23/2018 |
| H000354907 | 7a | PS Midwest Hunting Valley, INC. | Hunting Valley Road | St. Paul | Environmental Well | 3/19/2018 |
| H000354908 | 7a | PS Midwest Hunting Valley, INC. | Hunting Valley Road | St. Paul | Environmental Well | 3/21/2018 |
| H000354909 | 7a | MN DOT | Roseville | Roseville | Environmental Well | 4/26/2018 |
| H000354910 | 7a | MN DOT | Roseville | Roseville | Environmental Well | 4/26/2018 |
| H000354911 | 7a | MN DOT | Arden Hills | Arden Hills | Environmental Well | 4/26/2018 |
| H000354912 | 7a | MN DOT | New Brighton | New Brighton | Environmental Well | 4/27/2018 |
| H000354913 | 7a | MN DOT | New Brighton | New Brighton | Environmental Well | 3/21/2018 |
| H000354914 | 7a | MN DOT | New Brighton | New Brighton | Environmental Well | 3/21/2018 |
| H000355080 | 7a | Homepride, INC. | 4544 Second Street NE | Fridley | Water Supply | 1/31/2018 |
| H000355100 | 7a | How | 1770 Hillview Road | Shoreview | Water Supply | 5/21/2018 |
| H000355301 | 7a | B31 Transfer Road LLC | 2109 University Avenue | St. Paul | Environmental Well | 12/7/2017 |
| H000355302 | 7a | Space Center | 2501 Rosegate | Roseville | Environmental Well | 2/12/2018 |

**Table E-4**
**Sealed Wells**
**FY 2018 Annual Report**
**Twin Cities Army Ammunitions Plant**
**Arden Hills, Minnesota**

PIKA ARCADIS
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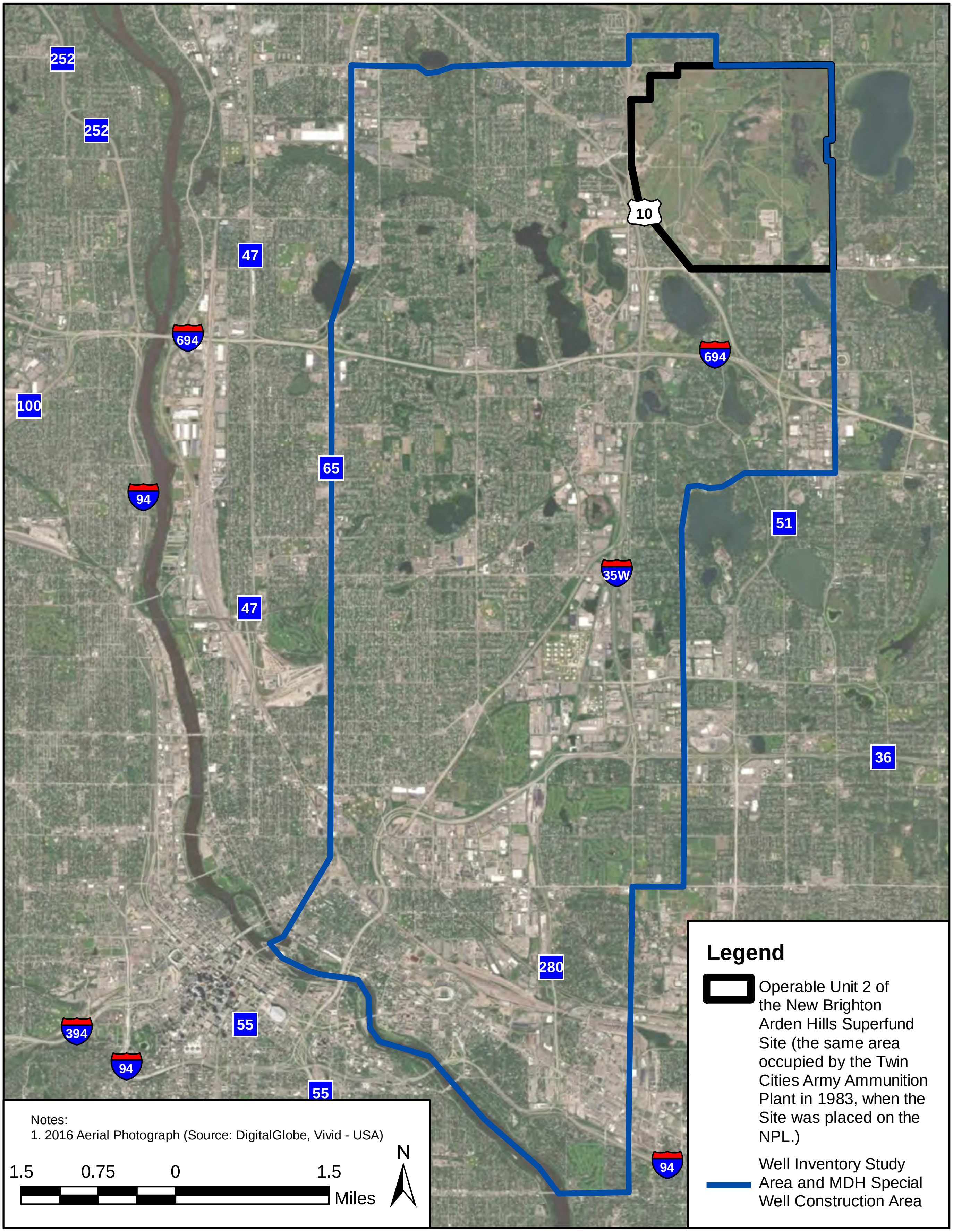
| Unique Number | Category | Last Name or Business Name | Street | City | Use | Date Sealed |
|---|---|---|---|---|---|---|
| H000355306 | 7a | Hoff Machinery | 7645 Baker Street NE | Fridley | Environmental Well | 3/2/2018 |
| H000355311 | 7a | TCDC | 1070 33rd Avenue SE | Lauderdale | Other | 4/19/2018 |
| H000355312 | 7a | Tetra Tech | 2975 Partridge Road | Roseville | Environmental Well | 4/24/2018 |
| H000355334 | 7a | Alden | 1086 27th Avenue NW | New Brighton | Water Supply | 5/23/2018 |
| H000355340 | 7a | Taylor | 1803 Venus Avenue | Arden Hills | Water Supply | 7/13/2018 |
| H000355379 | 7a | Rysgaard | 1937 Eustis Street | Lauderdale | Water Supply | 5/22/2018 |
| H000355387 | 7a | Perkins | 3655 Hamline Avenue | Arden Hills | Water Supply | 6/28/2018 |
| H000355390 | 7a | Olson | 3011 Shorewood Lane | Roseville | Water Supply | 7/19/2018 |
| H000355391 | 7a | Olson | 1732 Millwood Avenue | Roseville | Water Supply | 7/19/2018 |
| H000355396 | 7a | Johnson | 5607 Fairview Avenue | Shoreview | Water Supply | 8/16/2018 |
| H000355400 | 7a | Tchobanoff | 3955 Glenview Avenue | Arden Hills | Water Supply | 9/6/2018 |
| H000355596 | 7a | Hakomaki | 2222 Marion Road | Roseville | Water Supply | 6/14/2018 |
| H000355869 | 7a | Ashlin | 5925 Fifth Street NE | Fridley | Water Supply | 6/28/2018 |
| H000355905 | 7a | Nelson | 2205 County Road H | New Brighton | | 5/8/2018 |
| H000355933 | 7a | City of St. Paul Public Works | St. Paul | St. Paul | Environmental Well | 3/22/2018 |
| H000355940 | 7a | MN Commercial Railway CO. | | | Environmental Well | 3/15/2018 |
| H000355971 | 7a | West Real Estate | 3015 Centre Point Drive | Roseville | Environmental Well | 4/25/2018 |
| H000356015 | 7a | Ramsey County Public Works | Roseville | Roseville | | 6/21/2018 |
| H000356019 | 7a | City of New Brighton | New Brighton | New Brighton | Environmental Well | 6/1/2018 |
| H000356943 | 7a | Northpond Partners | 558 Vandalia Street | St. Paul | Environmental Well | 8/29/2018 |
| H000357164 | 7a | NE HYDE, LLC | 2125 E Hennepin Avenue | Minneapolis | Environmental Well | 8/27/2018 |
| H000357192 | 7a | L and M Holdings Co., LLP | 2250 University Avenue W | St. Paul | Env. Boring | 7/31/2018 |
| H000357962 | 7a | Gervais | 5079 Greenwood Drive | Mounds View | Water Supply | 8/15/2018 |
| H000358017 | 7a | Bona Brothers Minnoco | 5311 University Avenue NE | Fridley | Environmental Well | 6/12/2018 |
| H000358021 | 7a | 700 Emerald, LLC | 700 Emerald Street SE | St. Paul | Environmental Well | 6/26/2018 |
| H000358031 | 7a | Olson | 1847 Beckman Avenue | Arden Hills | Water Supply | 7/18/2018 |
| H000358796 | 7a | Mim | 642 Moroe Street NE | Minneapolis | Environmental Well | 8/14/2018 |
| H000358851 | 7a | Twin Properties Group, LLC | 427 Harrison Street NE | Minneapolis | Environmental Well | 6/28/2018 |
| H000359074 | 7a | Gable | 1701 Fairview Avenue N | Falcon Heights | Water Supply | 7/13/2018 |
| H000359082 | 7a | Reiher | 1965 Autumn Street | Falcon Heights | Water Supply | 7/26/2018 |
| H000359252 | 7a | Bursack | 515 12th Avenue NW | New Brighton | Water Supply | 8/8/2018 |
| H000359820 | 7a | IDS 621 | 1800 Fifth Street NW | New Brighton | | 8/8/2018 |
| H000359837 | 7a | Senior Housing Partners | 1910 County Road D W | Roseville | Environmental Well | 8/22/2018 |
| H000360667 | 7a | MN Solvents Chemical Corp. | 2340 Rose Place W | Roseville | Environmental Well | 9/5/2018 |
| H000360782 | 7a | Iron Point Partners, LLC | Prior Avenue | Roseville | Environmental Well | 5/30/2018 |
| H000360783 | 7a | Civil Site Group, INC. | 675 37th Avenue NE | Columbia Heights | Environmental Well | 5/30/2018 |
| H000362427 | 7a | Rose Marie Will, Laurence Will, Trustee | 2285 Rainbow Avenue | New Brighton | Water Supply | 9/24/2018 |
| H000362726 | 7a | Ryan Companies US, INC. | 2814 Cleveland Avenue N | Roseville | Environmental Well | 9/27/2018 |
| | | | | | | |




ANNUAL PERFORMANCE REPORT

Well Inventory Study Area

PIKA ARCADIS a joint venture

FY 2018

Figure E-1

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2019-01\Figure_E-1_Well Inventory Study Area_FY2018.mxd
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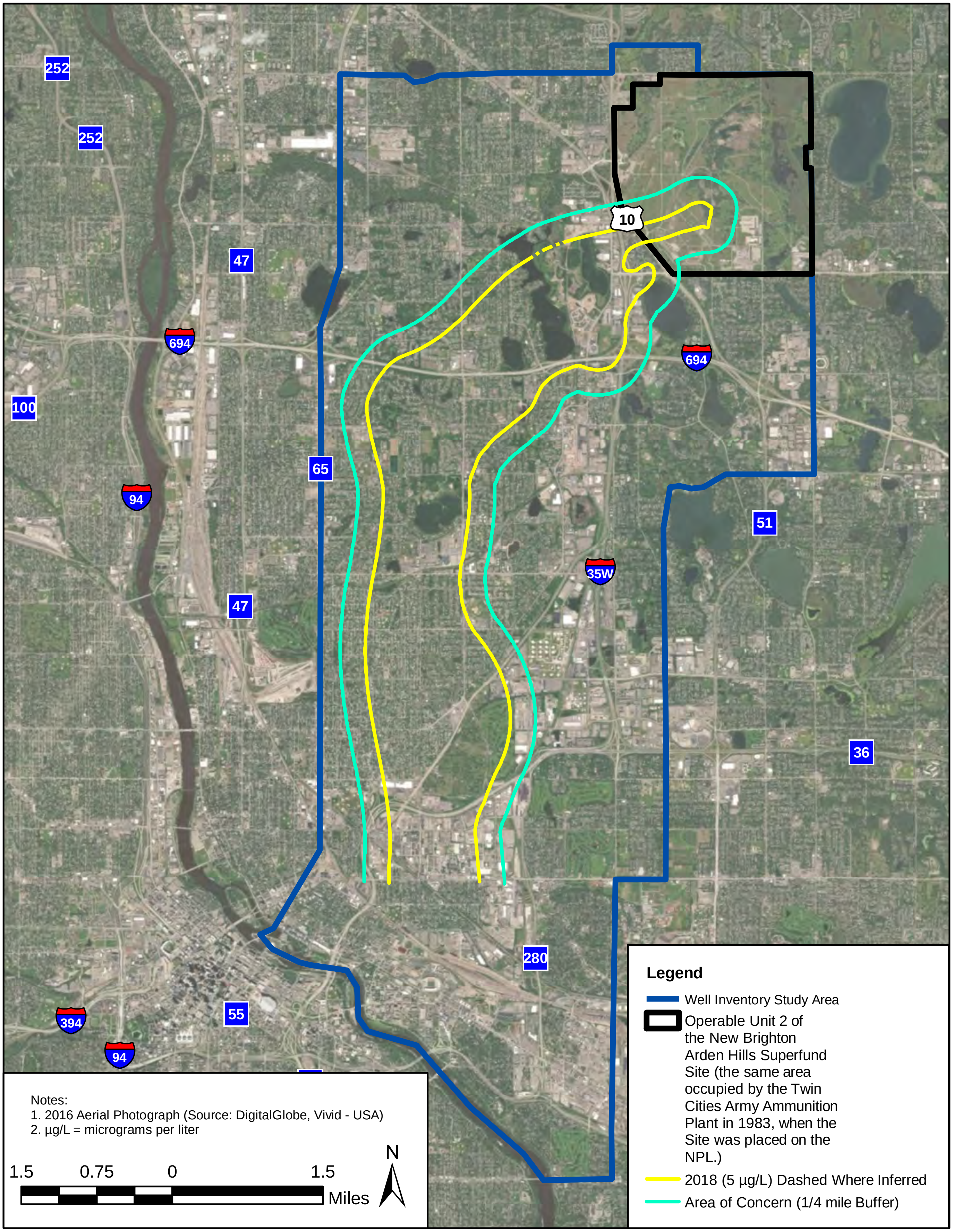


ANNUAL PERFORMANCE REPORT

Areas of Concern (Upper Unit 4)

PIKA ARCADIS a joint venture

FY 2018

Figure E-2

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2019-01\Figure_E-2_Areas of Concern (Unit 3 and Unit 4)_FY2018.mxd
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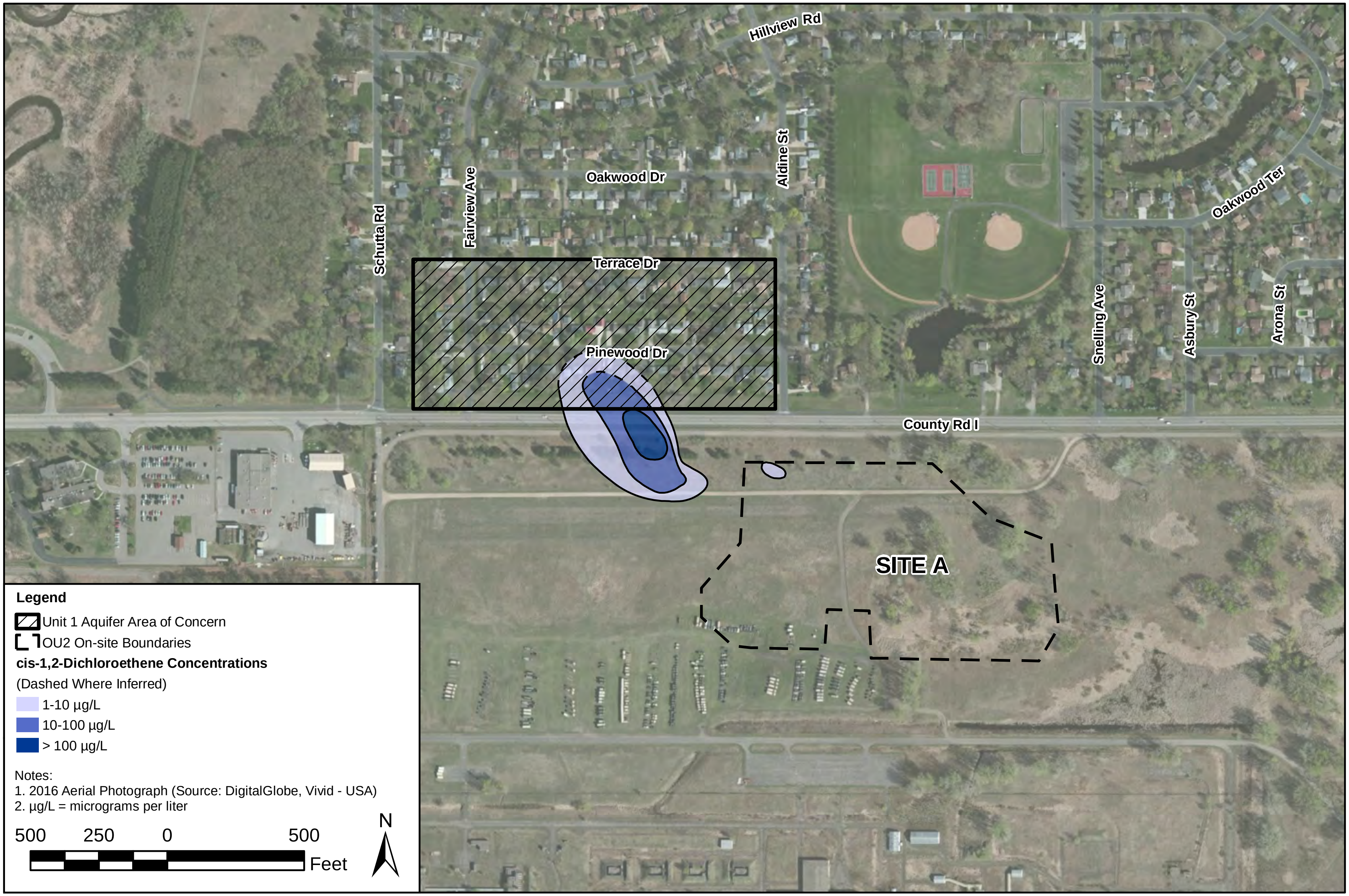



ANNUAL PERFORMANCE REPORT

Area of Concern (Unit 1)

PIKA ARCADIS a joint venture

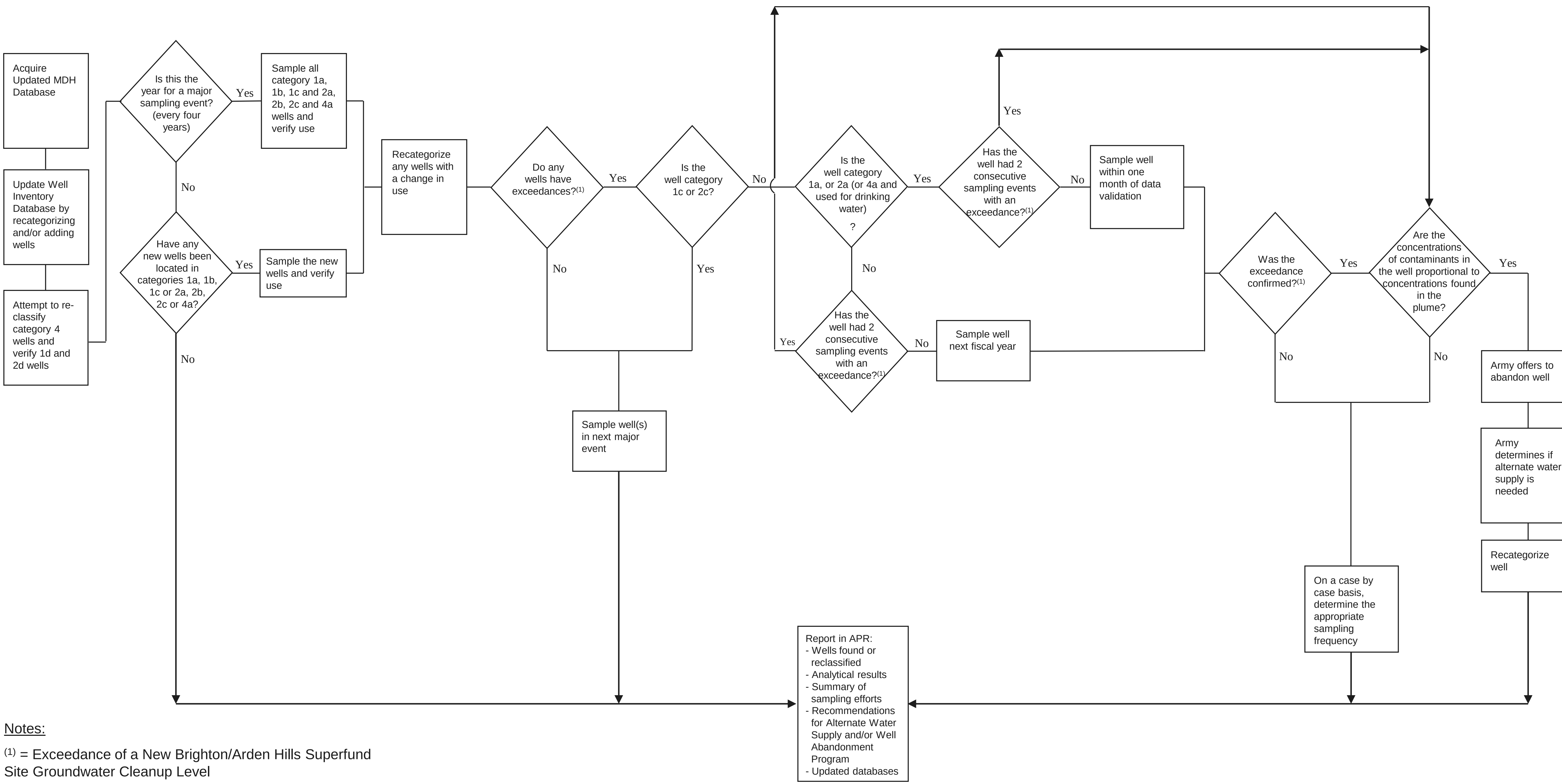
FY 2018

Figure E-3

Path: Z:\GISProjects_ENV\TCAAP_Arden_Hills_MN\MXD\2019-01\Figure_E-3_Areas of Concern (Unit 1)_FY2018.mxd
Date: 1/30/2019 Time: 12:10:59 PM User: kgpeters

**Figure E-4**
**Annual Requirements for Maintaining Well Inventory Database**

Twin Cities Army Ammunitions Plant
Arden Hills, Minnesota




Notes:

(1) = Exceedance of a New Brighton/Arden Hills Superfund Site Groundwater Cleanup Level

Figure generated by Wenck Associates, Inc.

# APPENDIX F

## Annual Site Inspection Checklist for Land Use Controls

# ANNUAL SITE INSPECTION CHECKLIST FOR LAND USE CONTROLS

Operable Unit 2, New Brighton/Arden Hills Superfund Site

Date: 7/30/2018

Inspected by: Nick Smith, Mary Lee, Katy Grant

Period Covered: From prior annual inspection (8/10/2017) 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 | 129-15 | Outdoor Firing Range |
| Property owner: | BRAC | N.G. | Reserve | R.C. | N.G. | BRAC | N.G. | N.G. | N.G. | N.G. | 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 | 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 | 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 | 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 | 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 |
| 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 | 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

*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 deficiencies and completed or planned actions to address such deficiencies are described in the attached Explanation of Deficiency(ies).*

Nicholas Smith, U.S. Army Environmental Command

Description of Deficiency(ies) attached? ☐ Yes ☐ No (none were identified)

# APPENDIX G

## Site K and TGRS Operational Data

**Appendix G.1**

**Inspection and Maintenance Activities**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

**October 2017**

| | |
|---|---|
| 10/3/2017 | The system cycled between inspections.<br>Down time: None. |
| 10/4/2017 | Increased the influent flow rate and decreased the effluent flow rate.<br>Down time: None. |
| 10/7/2017 | Increased the influent flow rate and decreased the effluent flow rate.<br>Down time: None. |
| 10/11/2017 | Increased the influent flow rate.<br>Down time: None. |
| 10/17/2017 | Increased the influent flow rate and decreased the effluent flow rate.<br>Down time: None. |
| 10/19/2017 | The system cycled between inspections.<br>Down time: None. |
| 10/26/2017 | Increased the influent flow rate and decreased the effluent flow rate.<br>Down time: None. |
| 10/27/2017 | The system cycled between inspections.<br>Down time: None. |
| 10/28-29/2017 | The system cycled between the inspections. Decreased the influent flow rate and increased the effluent flow rate each day.<br>Down time: None. |
| 10/30/2017 | The system cycled between inspections.<br>Down time: None. |
| 10/31/2017 | The system cycled between inspections. Decreased the influent flow rate.<br>Down time: None. |

**November 2017**

| | |
|---|---|
| 11/3/2017 | Increased the influent flow rate slightly.<br>Down time: None. |
| 11/4/2017 | Increased the influent flow rate slightly.<br>Down time: None. |
| 11/6/2017 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |

**Appendix G.1**

**Inspection and Maintenance Activities**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 11/7/2017 | The system was off upon arrival and the "Air Stripper High/High Water Level" light was lit. Reset the PLC and restarted the system. The system restarted normally. Reset the influent and effluent flow rates.<br>Down time: 21.5 hours. |
| 11/8/2017 | Increased the influent flow rate slightly.<br>Down time: None. |
| 11/9/2017 | Increased the influent flow rate slightly.<br>Down time: None. |
| 11/11/2017 | Increased the influent flow rate slightly.<br>Down time: None. |
| 11/12/2017 | Decreased the influent flow rate slightly.<br>Down time: None. |
| 11/14/2017 | Decreased the influent flow rate and increased the effluent flow rate slightly.<br>Down time: None. |
| 11/17/2017 | There was a site wide power outage which ceased power to the treatment system. Xcel Energy was contacted and they repaired the problem. Turned the treatment system back on and observed normal operation. The power outage blew the heater core in the building heater. Contacted Preferred Electric and they repaired the heater.<br>Down time: 10 hours. |
| 11/19/2017 | Increased the influent flow rate slightly.<br>Down time: None. |
| 11/20/2017 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 11/22/2017 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 11/23/2017 | No inspection was performed due to the Thanksgiving Day holiday. Meter readings were estimated.<br>Down time: None. |
| 11/26/2017 | Increased the influent flow rate slightly.<br>Down time: None. |
| 11/27/2017 | Increased the influent flow rate slightly. |

**Appendix G.1**

**Inspection and Maintenance Activities**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| | Down time: None. |
| 11/28/2017 | Decreased the influent flow rate and increased the effluent flow rate slightly.<br>Down time: None. |
| 11/29/2017 | Increased the influent flow rate and decreased the effluent flow rate slightly.<br>Down time: None. |
| 11/30/2017 | The system was off during the inspection due to normal system cycling.<br>Down time: None.<br>Down time: None. |

**December 2017**

| | |
|---|---|
| 12/1/2017 | The system was off upon arrival and the "Low Air Flow" light was lit. Reset the PLC and restarted the system. The system restarted normally. Reset the influent and effluent flow rates.<br>Down time: None. |
| 12/3/2017 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 12/4/2017 | Increased the influent flow rate.<br>Down time: None. |
| 12/5/2017 | Decreased the influent flow rate.<br>Down time: None. |
| 12/6/2017 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 12/7/2017 | Increased the influent flow rate and decreased the effluent flow rate.<br>Down time: None. |
| 12/10/2017 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 12/20/2017 | Increased the influent flow rate and decreased the effluent flow rate.<br>Down time: None. |
| 12/25/2017 | Christmas Day. The inspection was not performed. Meter readings were estimated.<br>Down time: None. |
| 12/26/2017 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |

**Appendix G.1**

**Inspection and Maintenance Activities**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

**January 2018**

| | |
|---|---|
| 1/4/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 1/5/2018 | Increased the influent flow rate slightly and decreased the effluent flow rate slightly.<br>Down time: None. |
| 1/7/2018 | Decreased the influent flow rate slightly and increased the effluent flow rate.<br>Down time: None. |
| 1/8/2018 | Increased the influent flow rate slightly.<br>Down time: None. |
| 1/10/2018 | Decreased the influent flow rate slightly.<br>Down time: None. |
| 1/16/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 1/18/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 1/19/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 1/20/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 1/22/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 1/23/2018 | Increased the influent flow rate slightly.<br>Down time: None. |
| 1/24/2018 | Increased the influent flow rate slightly and decreased the effluent flow rate slightly.<br>Down time: None. |
| 1/25/2018 | Decreased the influent flow rate slightly and increased the effluent flow rate.<br>Down time: None. |
| 1/26/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |

**Appendix G.1**

**Inspection and Maintenance Activities**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 1/27/2018 | Increased the influent flow rate slightly.<br>Down time: None. |
| 1/29/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 1/31/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| **February 2018** | |
| 2/2/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 2/4/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 2/6/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 2/7/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 2/8/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 2/9/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 2/10/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 2/13/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 2/15/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 2/16/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 2/17/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 2/18/2018 | The system was off during the inspection due to normal system cycling. |

**Appendix G.1**

**Inspection and Maintenance Activities**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| | Down time: None. |
| 2/20/2018 | The system was off during the inspection due to normal system cycling. Down time: None. |
| 2/21/2018 | The system was off during the inspection due to normal system cycling. Down time: None. |
| 2/22/2018 | The system was off during the inspection due to normal system cycling. Down time: None. |
| 2/23/2018 | The system was off during the inspection due to normal system cycling. Down time: None. |
| 2/24/2018 | The system was off during the inspection due to normal system cycling. Down time: None. |
| 2/25/2018 | The system was off during the inspection due to normal system cycling. Down time: None. |
| 2/26/2018 | The system was off during the inspection due to normal system cycling. Down time: None. |
| 2/28/2018 | The system was off during the inspection due to normal system cycling. Down time: None. |
| **March 2018** | |
| 3/1/2018 | The system was off during the inspection due to normal system cycling. Down time: None. |
| 3/2/2018 | The system was off during the inspection due to normal system cycling. Down time: None. |
| 3/4/2018 | The system was off during the inspection due to normal system cycling. Down time: None. |
| 3/6/2018 | The system was off during the inspection due to normal system cycling. Down time: None. |
| 3/7/2018 | The system was off during the inspection due to normal system cycling. Down time: None. |
| 3/8/2018 | The system was off during the inspection due to normal system cycling. Down time: None. |

**Appendix G.1**

**Inspection and Maintenance Activities**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 3/10/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 3/15/2018 | The system was off during the inspection due to normal system cycling.<br>Down time: None. |
| 3/25/2018 | The inspection was not performed. Meter readings were estimated.<br>Down time: None. |
| **April 2018** | |
| 4/14/2018 | Increased the influent flow rate slightly.<br>Down time: None. |
| 4/15/2018 | The inspection was not performed. Meter readings were estimated.<br>Down time: None. |
| 4/16/2018 | Increased the influent flow rate slightly.<br>Down time: None. |
| 4/17/2018 | Increased the influent flow rate slightly.<br>Down time: None. |
| 4/21/2018 | Increased the influent flow rate slightly.<br>Down time: None. |
| 4/27/2018 | Increased the influent flow rate slightly.<br>Down time: None. |
| 4/28/2018 | Increased the influent flow rate slightly.<br>Down time: None. |
| 4/30/2018 | Increased the influent flow rate slightly.<br>Down time: None. |
| **May 2018** | |
| 5/1/2018 | Turned the building heater off and turned on the building vent fan.<br>Down time: None. |
| 5/4/2018 | Increased the influent flow rate and decreased the effluent flow rate slightly.<br>Down time: None. |
| 5/9/2018 | Preferred Electric performed the annual electrical inspection.<br>Down time: None. |

**Appendix G.1**

**Inspection and Maintenance Activities**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 5/10/2018 | The high/high water level light was on. Reset the PLC and the pump restarted normally. Exercised the influent and effluent flow control valves and reset the influent and effluent flow rates. Possibly the electrician bumped the influent flow control valve which increased the flow rate causing the high/high water level alarm.<br>Down time: 21 hours. |
| 5/11/2018 | Turned the treatment system off and replaced the tower packing. Cleaned the inside of the treatment system and the building.<br>Down time: 5.5 hours. |
| 5/12/2018 | Increased the influent flow rate.<br>Down time: None. |
| 5/14/2018 | Increased the influent flow rate.<br>Down time: None. |
| 5/15/2018 | Increased the influent flow rate slightly.<br>Down time: None. |
| 5/16/2018 | Increased the influent flow rate slightly.<br>Down time: None. |
| 5/17/2018 | Increased the influent flow rate.<br>Down time: None. |
| 5/19/2018 | Increased the influent flow rate.<br>Down time: None. |
| 5/20/2018 | Increased the influent flow rate.<br>Down time: None. |
| 5/24/2018 | Increased the influent flow rate.<br>Down time: None. |
| 5/26/2018 | The inspection was not performed due to Memorial Day. Meter readings were estimated.<br>Down time: None. |

**June 2018**

| | |
|---|---|
| 6/4/2018 | Increased the influent flow rate and decreased the effluent flow rate slightly.<br>Down time: None. |
| 6/5/2018 | Decreased the influent flow rate. |

**Appendix G.1**

**Inspection and Maintenance Activities**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

Down time: None.

6/9/2018 Increased the influent flow rate.
Down time: None.

6/12/2018 Increased the influent flow rate slightly.
Down time: None.

6/13/2018 Increased the influent flow rate slightly.
Down time: None.

6/16/2018 Increased the influent flow rate.
Down time: None.

6/23/2018 Increased the influent flow rate.
Down time: None.

6/25/2018 Increased the influent flow rate.
Down time: None.

6/29/2018 Increased the influent flow rate.
Down time: None.

**July 2018**

7/4/2018 Independence Day holiday. The daily inspection was not performed. Meter readings were estimated.
Down time: None.

7/5/2018 Increased the influent flow rate.
Down time: None.

7/8/2018 Increased the influent flow rate.
Down time: None.

7/9/2018 Decreased the influent flow rate.
Down time: None.

7/11/2018 Increased the influent flow rate.
Down time: None.

7/13/2018 The system was off. Troubleshooting indicated a blown sump pump motor. Replaced the sump pump with a new one from inventory. Restarted the system, reset the flow rates and the system ran normally.

**Appendix G.1**

**Inspection and Maintenance Activities**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 7/22/2018 | Increased the influent flow rate.<br>Down time: None. |
| 7/23/2018 | Increased the influent flow rate.<br>Down time: None. |
| 7/24/2018 | Increased the influent flow rate.<br>Down time: None. |
| 7/25/2018 | Increased the influent flow rate.<br>Down time: None. |
| 7/29/2018 | Increased the influent flow rate.<br>Down time: None. |
| 7/29/2018 | Increased the influent flow rate.<br>Down time: None. |
| **August 2018** | |
| 8/1/2018 | The sump pump was sucking air indicating the pump was not at the bottom of the manhole. Lowered the pump to the full extent of the length of the power wire and repositioned the floats. Restarted the pump and reset the influent and effluent flow rates. Observed normal operation.<br>Down time: 1 hour. |
| 8/2/2018 | The sump pump was again sucking air. Added (spliced) wire to the power wire to be able to lower the pump to the bottom of the manhole. Also, cleaned out the bottom of the manhole and repositioned the floats. Restarted the pump and reset the influent and effluent flow rates. Observed normal operation.<br>Down time: 8 hours. |
| 8/3/2018 | Increased the influent flow rate.<br>Down time: None. |
| 8/4/2018 | Increased the influent flow rate.<br>Down time: None. |
| 8/5/2018 | Increased the influent flow rate.<br>Down time: None. |
| 8/8/2018 | Increased the influent flow rate.<br>Down time: None. |
| 8/12/2018 | Increased the influent flow rate. |

**Appendix G.1**

**Inspection and Maintenance Activities**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| | Down time: None. |
| 8/18/2018 | Increased the influent flow rate.<br>Down time: None. |
| 8/21/2018 | The system was off and the flow meter low water flow rate light was on. Reset and restarted the system. Exercised the influent and effluent flow control valves and reset the influent and effluent flow rates. Observed normal operation.<br>Down time: 11.5 hours. |
| 8/22/2018 | Increased the influent flow rate and decreased the effluent flow rate slightly. Also installed a new thermometer in the building.<br>Down time: None. |
| 8/25/2018 | Increased the influent flow rate.<br>Down time: None. |
| 8/27/2018 | Cleaned the sump site glass. Increased the influent flow rate.<br>Down time: None. |
| 8/28/2018 | Increased the influent flow rate.<br>Down time: None. |
| 8/29/2018 | Increased the influent flow rate.<br>Down time: None. |
| 8/30/2018 | The system was off and the flow meter low water flow rate light was on. Unable to start the system in auto. Started the system in hand and then quickly switched the system to auto. The system ran normally.<br>Down time: 19.5 hours. |
| 8/31/2018 | To troubleshoot the system not starting in auto because of the low water flow rate, used the display keypad to reset the water low flow alarm set point from 5 seconds to 10 seconds. Started the system in auto and the system started normally.<br>Down time: None. |

**September 2018**

| | |
|---|---|
| 9/2/2018 | Increased the influent flow rate.<br>Down time: None. |
| 9/3/2018 | Labor Day holiday. The daily inspection was not performed. Meter reading estimated.<br>Down time: None. |

**Appendix G.1**

**Inspection and Maintenance Activities**
**Fiscal Year 2018**
**Site K, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 9/4/2018 | The system was down upon arrival due to normal system cycling.<br>Down time: None. |
| 9/5/2018 | The system was down upon arrival and the "high/high water level" light was on. Reset the PLC and restarted the system. Exercised the influent and effluent flow control valves and reset their flow rates. Normal operation observed.<br>Down time: 9.5 hours. |
| 9/6/2018 | Increased the influent flow rate.<br>Down time: None. |
| 9/8/2018 | Increased the influent flow rate.<br>Down time: None. |
| 9/13/2018 | Increased the influent flow rate.<br>Down time: None. |
| 9/19/2018 | Increased the influent flow rate.<br>Down time: None. |
| 9/25/2018 | Increased the influent flow rate.<br>Down time: None. |
| 9/30/2018 | Increased the influent flow rate.<br>Down time: None. |

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

**October 2017**

| | |
|---|---|
| 10/2-3/2017 | Pumphouse B9; Each day, the light was flashing on the well field panel. Reset the PLC and the light relit normally. At the pumphouse, the pump was running normally. There is a contractor working in the vicinity of the B5 pumphouse.<br>Down time: 31.5 hours. |
| 10/7-12/2017 | Pumphouse SC2; The RPZ was leaking. Attempted to stop the leak but the leak continued. Turned the pump and breaker to off and closed the gate valve. Jayhawk Mechanical repaired the RPZ. Turned the pump on but the flow rate would not register on the water meter. Removed and cleaned the water meter. The meter shows flow now but only at 2 gallons per minute. Daily meter readings were estimated to reflect 2 gallons per minute.<br>Down time: 122.5 hours. |
| 10/17/2017 | Pumphouse B5; Received a phone call that a communication line was hit about 20 feet west of the pumphouse. Upon inspection, the conduit was broken and 4 blue data cables were visible through the break. A hand hole vault will have to be installed to protect the break. Since pumphouses B9 and B10 continue to operate in "Auto", likely the cables were not damaged. There was starter chatter in the B9 control cabinet. Disconnected the data cable between B9 and B10 and the chatter ceased.<br>Down time: None. |
| 10/18/2017 | Treatment System; Replaced the airflow pressure gauge on the blower inlet for tower 3.<br>Down time: None. |
| 10/18/2017 | Pumphouse B4; The RPZ was leaking. Turned the pump off and relieved pressure to the RPZ. Restarted the pump and observed normal operation.<br>Down time: None. |
| 10/26-31/2017 | Pumphouse SC2; The pump can no longer overcome the forcemain back pressure. Turned the pump off and contacted Thein Well to jet the well screen and replace the pump and motor. Thein Well continued to work on the well when the month ended.<br>Down time: 141.5 hours. |
| 10/27/2017 | Treatment System; The flow meter for pump 4 no longer totals correctly. Removed the flow meter from Pump 4 and switched it with the flow meter from Pump 3. Observed normal operation.<br>Down time: None. |
| 10/27/2017 | Treatment System; The ECV for pump 4 would not close on command. Installed a new solenoid valve in the control piping. Cycled the valve three times and observed normal operation.<br>Down time: None. |

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 10/30/2017 | Pumphouse B6; The heater no longer provides heat. Opened the breaker to the heater and installed a temporary electric heater in the pumphouse to provide heat.<br>Down time: None. |
| **November 2017** | |
| 11/2/2017 | Pumphouse SC2; The pump and motor Thein Well installed did not meet performance specifications. Thein Well installed a new pump and motor. Following installation, turned the pump on and observed normal operation.<br>Down time: 43 hours. |
| 11/5/2017 | Daylight savings time; Adjusted the spreadsheet accordingly to reflect the addition of one hour.<br>Down time: None. |
| 11/13/2017 | Pumphouses B3, B4 and B8; Turned the pumphouses off to repair the water distribution systems at the tops of Towers 3 and 4. Following the repairs, turned the pumps on and observed normal operation.<br>Down time: 20.5 hours at each well. |
| 11/15-16/2017 | Pumphouse B13; The flow rate was below the target flow rate. Pulled the lift system, jetted the well screen and replaced the pump and motor with new. Turned the pump on and observed normal operation.<br>Down time: 24 hours. |
| 11/16/2017 | Pumphouse SC1; During the daily inspection, the pump was off. At B11, the control switch was in the "Off" position. Turned the switch to "Auto" and inspected SC1. At SC1, the pump was operating normally.<br>Down time: 22 hours. |
| 11/17-18/2017 | Pumphouses B1, B13, B3, B4, B5, B6, B8, B9, SC1, SC2, SC5; Call from Time Communication that the TGRS was down. At the site, there was a power outage that ceased power to the entire site. Contacted Xcel Energy and they found a blown fuse in the power pole across County Road 10 from Scherer Brothers Lumber. They installed a new fuse and power was restored power. However, the power outage blew the two electric heaters in the treatment center and the electric heater in pumphouse SC1. It also shorted the electrical wire in the conduit between the breaker box and Pump 3 in the treatment center. Contacted Preferred Electric and they repaired the heaters and also replaced the electrical wire to Pump 3. Also, Blower 3 in the treatment center would not start. Replaced a blown fuse and restarted Blower 3. Blower 3 restarted normally.<br>Down time: B1 for 8 hours; B13, B4, B6 and B8 for 6.5 hours; B9, SC1 and SC5 for 7.5 hours; B3 and B5 for 4 hours; SC2 for 3 hours. |

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 11/18/2017 | Pumphouse B8; The RPZ was leaking. Contacted Jayhawk Mechanical and they repaired the RPZ backflow preventer.<br>Down time: 14 hours. |
| 11/19-22/2017 | Pumphouse B6; The RPZ backflow preventer was leaking. Contacted Jayhawk Mechanical and they repaired the RPZ backflow preventer. Restarted the pump and observed normal operation.<br>Down time: 73.5 hours. |
| 11/20/2017 | Pumphouses B9 and B10; Call from McCrossan that they hit a communication cable near pumphouse B10. The wires were severed and stretched. Contacted Preferred Electric and they assessed the damage to prepare an estimate for repairs.<br>Down time: None. |
| 11/23-24/2017 | Pumphouse B1; The motor starter was tripped each day. Reset the starter and the turned the pump on. Observed normal operation each day.<br>Down time: 30.5 hours. |
| 11/27-30/2017 | Pumphouse B1; The motor starter was tripped. Contacted Preferred Electric. Troubleshooting showed a blown submersible pump motor. Contacted Thein Well and they replaced the pump and motor. Started the pump and observed normal operation.<br>Down time: 95.5 hours. |

**December 2017**

| | |
|---|---|
| 12/1-2/2017 | Pumphouse B1; The motor starter was tripped. Contacted Preferred Electric. Troubleshooting indicated a blown submersible pump motor. Contacted Thein Well and they replaced the pump and motor. Started the pump and observed normal operation.<br>Down time: 23.5 hours. |
| 12/3/2017 | Pumphouses B5 and B8; Increased the ECV back pressure to slow the flow rate.<br>Down time: None. |
| 12/6/2017 | Pumphouse B8; Increased the ECV back pressure to slow the flow rate.<br>Down time: None. |
| 12/18/2017 | Pumphouse B1; Turned the pump off to conduct testing on the pump to determine why the pump is not producing at design capacity. Following testing, turned the pump on and observed normal operation.<br>Down time: 4.5 hours. |
| 12/25/2017 | Christmas Day; The inspection was not performed. Meter readings were estimated.<br>Down time: None. |

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 12/30-31/2017 | Pumphouse SC2; The RPZ was leaking at a fast rate. Turned the pump off and contacted Jayhawk Mechanical for repairs. They were not able to respond until the beginning of next week.<br>Down time: None. |
| **January 2018** | |
| 1/1/2018 | The daily inspection was not performed due to the New Year's Day holiday. Meter readings were estimated.<br>Down time: None. |
| 1/1-4 /2018 | Pumphouse SC2; The RPZ was leaking. Turned the pump off and contacted Jayhawk Mechanical. They repaired the RPZ. Restarted the pump and observed normal operation.<br>Down time: 93.5 hours. |
| 1/2/2018 | Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light relit normally. At the pumphouse, the pump was running normally.<br>Down time: 11.5 hours. |
| 1/8/2018 | Pumphouse B5, The light was flashing on the wellfield panel. Reset the PLC and the light relit normally. At the pumphouse, the pump was running normally.<br>Down time: 14 hours. |
| 1/11/2018 | Pumphouse SC2; The flow meter was totaling too quickly. Removed and replaced the flow meter with one from inventory. Observed normal operation.<br>Down time: None. |
| 1/12/2018 | Pumphouse SC1; The building temperature was about 35 degrees on arrival. Cycled the thermostat and the heater came on normally. Checked the building after completion of the daily inspection. The building was warm and the heater was working normally.<br>Down time: None. |
| 1/15/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel. Reset the PLC and the lights relit normally. At the pumphouses, the pumps were running normally.<br>Down time: 16 hours at B5 and 20 hours at B6. |
| 1/16/2018 | Pumphouse B5; The light was flashing on the well field panel. Drove to the pumphouse and found the "Low Level" light was on. Troubleshooting indicated a blown water level control board. Changed out the water level control board with one from inventory and restarted the pump. The pump restarted normally however the ECV no longer held pressure. Changed out the pilot, exercised the control valves flushed the control piping and reset the pilot. Observed normal operation.<br>Down time: 13.5 hours. |

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

**February 2018**

2/9/2018 Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was working normally.
Down time: 8 hours.

2/13/2018 Pumphouses B3 and B4; The lights were flashing on the well field panel. Reset the PLC and the lights came on steady. At the pumphouses, the pumps were running normally.
Down time: 18 hours at B3 and 19 hours at B4.

2/14/2018 Pumphouse B6; The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was running normally.
Down time: 1.5 hours.

2/15/2018 Pumphouse B6; The light was flashing on the PLC. Turned the pumphouses off and turned the PLC to off. Allowed the PLC to remain off for 5 minutes and then restarted the PLC. The well field and treatment system restarted normally. Performed the daily inspection and the TGRS was operating normally.
Down time: 6 hours.

2/15/2018 Pumphouse B8; The pump was off and the I/O adapter light was flashing on the control card. Reset the I/O adapter card and restarted the pump. The pump restarted normally.
Down time: None.

2/19/2018 Pumphouses SC1, SC2 and SC5; The lights were out on the well field panel. At the pumphouses, the pumps were off and the lights were dim. A fuse was found to be open on a power pole near the old Lind electrical sub-station. Contacted Xcel Energy and they responded. They installed a new fuse. Restarted the pumps and observed normal operation.
Down time: None. Xcel Energy responded right away.

2/19/2018 Pumphouse B4; The RPZ was leaking. Turned the pump off and closed the ECV. Started the pump and opened the ECV slowly. The RPZ did not leak and normal operation was observed.
Down time: None.

2/20/2018 Pumphouses SC1, SC2 and SC5; The lights were off on the well field panel. At the pumphouses, the pumps were off and the lights were dim. The same fuse was found to be open on the power pole near the old Lind electrical sub-station. Contacted Xcel Energy again and they responded. They thoroughly inspected the power lines and found a location near SC4 where the wind could possibly blow a loose power line into the power pole. They repaired the wire and installed new fuses at a number of locations. Restarted the pumps and observed normal operation.
Down time: 19 hours at SC1, 18.5 hours at SC2 and 16.5 hours at SC5.

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 2/21/2018 | Pumphouse SC2; The ECV had substantial iron bacteria build-up which was blocking flow. Removed the ECV and installed a flow meter in its place. Turned the pump on and the pump restarted normally. The flow rate increased approximately 40%.<br><br>Down time: 19.5 hours. |

**March 2018**

| | |
|---|---|
| 3/6/2018 | Treatment System and Well Field; There was a snow storm last night. DK Concrete was on site and plowed snow.<br>Down time: None. |
| 3/6/2018 | Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light relit normally. At the pumphouse, the ECV was wide open. Replaced the strainer screen, flushed the control piping and exercised the control valves on the control piping. Reset the pilot pressure and the valve operated normally.<br>Down time: 25.5 hours. |
| 3/7/2018 | Pumphouse B5; The light was flashing again on the well field panel. Turned the TGRS off and performed the daily inspection. Upon return the treatment system, restarted the TGRS. Observed normal operation. The limit switch was not triggered at B5. Lowered the doughnut on the valve stem. Closed the ECV and the pump turned off normally. Restarted the pump and the pump started normally.<br>Down time: 15 hours. |
| 3/12/2018 | Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was running normally.<br>Down time: 12 hours. |
| 3/13/2018 | Pumphouse B6; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was running normally.<br>Down time: 2 hours. |
| 3/19/2018 | Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was running normally.<br>Down time: 11.5 hours. |
| 3/20/2018 | Pumphouse B6; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was running normally.<br>Down time: 16.5 hours. |
| 3/21/2018 | Pumphouse B6; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was running normally.<br>Down time: 4.5 hours. |

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 3/22/2018 | Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was running normally. Down time: 13 hours. |
| 3/24-27/2018 | Pumphouses B1, B13 and B6; The lights were flashing on the well field panel. Reset the PLC and the light for B6 came back on steady. However the lights for B1 and B13 turned off. At pumphouse B6, the pump was operating normally. At pumphouses B1 and B13, the pumps were rapidly turning on and off. Turned the controls at B1 from AUTO to HAND and the pump ran normally. Turned the controls at B13 from AUTO to HAND and the pump continued to rapidly turn on and off. Troubleshooting indicated a bad I/O adapter card at B13. Replaced the I/O adapter card with one from inventory and the B13 pump restarted normally. Switched the controls at B1 from HAND to AUTO and the pump operated normally. Down time: 10.5 hours at B1, 26 hours at B6 hours and 78 hours at B13. |
| 3/28/2018 | Pumphouse B9; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was operating normally. Down time: 8.5 hours. |
| 3/29/2018 | Pumphouse B9; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was operating normally. Down time: 21.5 hours. |
| 3/30/2018 | Pumphouse B9; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was operating normally. Down time: 23.5 hours. |
| **April 2018** | |
| 4/5/2018 | Pumphouse B6; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was operating normally. Down time: 20 hours. |
| 4/9/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel. Reset the PLC and the lights came back on steady. At the pumphouses, the pumps were operating normally. Down time: 18 hours at B5 and 22.5 hours at B6. |
| 4/12/2018 | Pumphouse B6; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was operating normally. Down time: None. |
| 4/11/2018 | Pumphouses B1, B13, B3 and B4; The cold water flow meters required maintenance. Removed them, cleaned them with acid and reinstalled them. Observed normal operation of each flow meter following the work. Down time: 2.5 hours at B1. |

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 4/12/2018 | Pumphouses B5, B6, SC2 and SC5; The cold water flow meters required maintenance. Removed them, cleaned them with acid and reinstalled them. Observed normal operation of each flow meter following the work.<br>Down time: 2.5 hours at B5, 3.5 hours at B6, 3 hours at SC2 and 4 hours at SC5. |
| 4/14-16/2018 | Pumphouse B5; Each day the light was flashing on the well field panel. Reset the PLC each day and the light came back on steady. At the pumphouse, the pump was operating normally.<br>Down time: 61.5 hours. |
| 4/15/2018 | Treatment system and well field; The inspection was not performed due to a snow storm. Meter readings were estimated.<br>Down time: None. |
| 4/16/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel. Reset the PLC and the lights came back on steady. At the pumphouses, the pumps were operating normally.<br>Down time: 23.5 hours at B5 and 6.5 hours at B6. |
| 4/17/2018 | Pumphouse B4; Performed troubleshooting to determine the reason for B5/B6 intermittent operation. Turned B4 off to swap out communication modules.<br>Down time: 3 hours. |
| 4/18/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel. Reset the PLC and the lights came back on steady. At the pumphouses, the pumps were operating normally.<br>Down time: 2.5 hours at B5 and 2 hours at B6. |
| 4/18-24/2018 | Pumphouse B13; Each day the light was flashing on the well field panel. Reset the PLC each day and the light would stay on steady. At the pumphouse, the pump would be operating normally. The next day the light would be flashing on the well field panel again. Changed out the I/O adapter module in B13 and restarted the B13 pump. The pump restarted normally.<br>Down time: 101.5 hours. |
| 4/19/2018 | Treatment System; ECV 4 would not close on command. Turned off pumphouses B9 and B6 to minimize well field cycling. Rebuilt the pilot and replaced the solenoid valve. Following the work, turned Pump 4 on and actuated ECV 4. ECV 4 did not close properly. Additional troubleshooting necessary.<br>Down time: 2 hours at B6 and 2 hours at B9. |
| 4/27-30/2018 | Pumphouse B13; Each day the light was flashing on the well field. Reset the PLC each day and each day the light came back on steady. At the pumphouse the pump was operating normally. Additional troubleshooting necessary.<br>Down time: 76 hours. |

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

4/28-29/2018 Pumphouse SC5; The flow rate slowed overnight. Removed and cleaned the strainer screen and reset the pilot. Restarted the pump and observed normal operation.
Down time: 9 hours.

**May 2018**

5/1-4/2018 Pumphouse B13; Each day the light was flashing on the well field. Reset the PLC each day and each day the light came back on steady. At the pumphouse the pump was operating normally. Troubleshooting eventually revealed a bad I/O adapter card at pumphouse B1. Replaced the I/O adapter card at B1 and restarted pump in B13. The pump restarted and observed normal operation.
Down time: 55 hours.

5/1/2018 Treatment System; ECV 4 will not close on command. Installed a new seal kit in the pilot and replaced the solenoid body but the valve did not close. Likely a new 10-inch valve seal kit will need to be installed for the valve to close. Scheduled the installation.

Down time: None.

5/2/2018 Pumphouse B1; The RPZ was venting out the overflow. Closed the ECV, turned the pump off and exercised the RPZ blow off valves. Turned the pump back on and the RPZ no longer leaked. Observed normal operation.
Down time: None.

5/3/2018 Pumphouse B4; In an effort to troubleshoot the B13 communication issue, turned the pump in B4 off and swapped communication cards with pumphouses B1 and B13. Following the troubleshooting work, turned B4 on and observed normal operation.

Down time: 2 hours.

5/4/2018 Pumphouse SC5; The RPZ was venting out the overflow. Closed the ECV, turned the pump off and exercised the RPZ blow off valves. Turned the pump back on and the RPZ leaked. Contacted Jayhawk Mechanical and they repaired the leak. Turned the pump back on and observed normal operation.
Down time: 4 hours.

5/5-7/2018 Pumphouses SC1, SC2 and SC5; A storm knocked out power to the wells and a fuse is open on the power pole near the old Lind electrical substation. Contacted Xcel Energy and they replaced the fuse and worked on other areas of the power line. Turned the pumps back on and observed normal operation.
Down time: 36.5 hours at each pumphouse.

5/8/2018 Pumphouse Roads; Contracted JL Weber to repair the snow melt erosion ruts to the site roads.
Down time: None.

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

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|---|---|
| 5/8-9/2018 | Treatment System and Well Field; Preferred Electric performed the annual electrical inspection.<br>Down time: None. |
| 5/10/2018 | Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical performed the annual RPZ electrical inspection.<br>Down time: None. |
| 5/10/2018 | Pumphouse B9; Following the electrical inspection at B9, the electrician forgot to turn the pump back on. The pump was turned back on the following day during the daily inspection when the oversight was noticed.<br>Down time: 25 hours. |
| 5/14/2018 | Pumphouse SC5; The flow rate slowed overnight due to build-up of manganese in the ECV control piping. Flushed the control piping and cleaned and replaced the strainer screen. Reset the pilot to operating flow rate and pressure and observed normal operation.<br>Down time: 1.5 hours. |
| 5/15/2018 | Pumphouses B4, B5, B6, B8 and B9; The lights were not lit on the well field panel. Upon inspection, there was a blown fuse holder on the power pole near pumphouse B5. Contacted Xcel Energy and they repaired the fuse holder. Turned the pumps on and observed normal operation.<br>Down time: 20 hours at B4, B5, B6 and B9; 17.5 hours at B8. |
| 5/15/2018 | Pumphouses B3 and B5; Increased their flow rates to maximum.<br>Down time: None. |
| 5/25/2018 | Pumphouse B5; The light was flashing on the well field panel. There was a storm last night that possibly knocked out communication between the pumphouse and the PLC in Building 116. At the pumphouse, reset the starter and turned the switch to Auto. The pump turned on and normal operation was observed.<br>Down time: 20.5 hours. |
| 5/28/2018 | Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was operating normally.<br>Down time: 19.5 hours. |
| 5/29/2018 | Treatment System and Well Field; Call from Time Communications - "TGRS Fail". At the Site, found the power was out to the treatment system. Found a fusible link open on a power pole west of Building 116. Contacted Xcel Energy and they responded. They replaced the fuse and found a dead raccoon near the power pole which was likely the cause of the power outage.<br>Down time: 1.5 hours at B4 and B9; 2 hours at B1; 2.5 hours at B13 and SC5; 14.5 hours at B6 and 20 hours at B5. |

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 5/30/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel; At the pumphouses, the low level lights were on. Cycled power to the control panels and turned the pumps on to Auto. The pumps restarted normally.<br>Down time: 9 hours at B6 and 19.5 hours at B5. |

**June 2018**

| | |
|---|---|
| 6/1/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel. At the pumphouses, the low level lights were on. Installed a new output card in the B6 control panel. Restarted the pumps and observed normal operation.<br>Down time: 18.5 hours at B5 and 14.5 hours at B6 |
| 6/5/2018 | Pumphouse B1; The starter was chattering. Turned the pump and control panel off, opened the 480 volt disconnect and removed the output card. Reinstalled the same output card, closed the disconnect and turned the control panel back on. Turned the switch to auto and the pump restarted normally.<br>Down time: None. |
| 6/7/2018 | Pumphouse B9; The flow meter stopped totaling. Replaced the flow meter with a new one from inventory. Restarted the pump and observed normal operation. Meter reading was estimated for the day.<br>Down time: None. |
| 6/8/2018 | Treatment System; ECV 4 no longer closes. Turned the pumps in B5 and B9 to off to stop the well field from cycling with only Pump 3 in the treatment system operating. Replaced the valve seals in ECV 4. Turned Pump 4 on and cycled ECV 4. Observed normal operation. Turned the pumps in B5 and B9 back on for normal operation.<br><br>Down time: 7 hours at B5 and 7.5 hours at B9. |
| 6/15/2018 | Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was operating normally.<br>Down time: 14 hours. |
| 6/16/2018 | Pumphouse B5; The light was flashing on the well field panel. At the pumphouse, the low level light was on. Installed a new output card and restarted the pump. The pump restarted normally.<br>Down time: 21 hours. |
| 6/18/2018 | Pumphouse B5; The light was flashing on the well field panel. At the pumphouse, cycled power to the control panel and then turned the pump to auto. The pump started and normal operation was observed.<br>Down time: 21 hours. |
| 6/27-30/2018 | Pumphouse SC2; The flow meter was no longer totaling and the pump was not producing pressure. Turned the pump off. Likely the pump inlet is packed with iron bacteria. |

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| | Down time: 98.5 hours. |
| 6/29/2018 | Pumphouse B5; The light was flashing on the well field panel. At the pumphouse, the low level light was on. Cycled power to the control panel and turned the pump to auto. The pump started normally.<br>Down time: 18 hours. |
| **July 2018** | |
| 7/4/2018 | The daily inspection was not performed due to the Independence Day holiday. Meter readings were estimated.<br>Down time: None. |
| 7/8/2018 | Treatment System - The auto dialer backup battery was low. Replaced the auto dialer battery.<br>Down time: None. |
| 7/8/2018 | Pumphouses B3 and B4 - The lights were flashing on the well field panel. Reset the PLC but the lights continued flashing. At the pumphouses, the pumps would not run in auto. Turned the pumps on in hand and observed normal operation. Additional troubleshooting necessary.<br>Down time: 15.5 hours at B3 and 21 hours at B4. |
| 7/10/2018 | Pumphouse B5 - The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was operating normally.<br>Down time: 20.5 hours. |
| 7/11/2018 | Pumphouse B5 - The light was flashing on the well field panel. Reset the PLC but the light continued flashing. At the pumphouse, the pump would not run in auto. Turned the pump on in hand and observed normal operation. Additional troubleshooting necessary.<br>Down time: 14 hours. |
| 7/11-14/2018 | Pumphouse B1 - Turned the pump off to redevelop the well and install a larger capacity pump. Following the work, turned the pump on and the pump started normally.<br>Down time: 69 hours. |
| 7/13/2018 | Pumphouse B13 - The light was flashing on the well field panel. At the pumphouse, the starter would chatter when the pump was turned on in auto. Replaced the output card and restarted the pump. Observed normal operation.<br>Down time: 1 hour. |
| 7/13/2018 | Pumphouse SC5 - The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was running normally.<br>Down time: 1.5 hours. |

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

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|---|---|
| 7/13/2018 | Pumphouse B5 - The starter would chatter when the pump was turned on in auto. Turned the pump off to perform troubleshooting work. Installed new input, output and I/O adapter cards in the chassis and restarted the pump in auto. Observed normal operation.<br>Down time: 3.5 hours. |
| 7/13-14/2018 | Pumphouse B4 - Performed troubleshooting on the control system. Restarted the pump in auto and the pump restarted normally. The following day, the light was flashing on the well field panel. Turned the pump back on in hand. Additional troubleshooting necessary.<br>Down time: 16 hours. |
| 7/16-20/2018 | Pumphouse B5 - Turned the pump off to redevelop the well and install a larger capacity pump. Following the work, turned the pump on and the pump restarted normally.<br>Down time: 95.5 hours. |
| 7/25/2018 | Pumphouse B4 - Contracted Egan Company to performed troubleshooting on the control system. Restarted the pump in auto and the pump restarted normally. The following day, the light was flashing on the well field panel. Turned the pump back on in hand. Additional troubleshooting necessary.<br>Down time: 21.5 hours. |
| 7/26/2018 | Pumphouse B5 - The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was operating normally.<br>Down time: 20 hours. |
| 7/26-27/2018 | Pumphouse B4 - The RPZ was leaking out the vent pipe. Attempted to stop the leak but to no avail. Turned the pump off. The following day, restarted the pump and the RPZ did not leak. Observed normal operation.<br>Down time: 18.5 hours. |
| 7/28/2018 | Pumphouse B9 - The ECV would not close. Turned the pump off to remove portions of the ECV control piping and remove sand build-up. Following the work, restarted the pump and observed normal operation.<br>Down time: 1.5 hours. |
| 7/30/2018 | Pumphouse B1 - The light was flashing on the well field panel. Reset the PLC and the light relit normally. At the pumphouse, the pump was operating normally.<br>Down time: 5.5 hours. |
| 7/31/2018 | Pumphouse B5 - The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was operating normally.<br>Down time: 12.5 hours. |

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

7/31/2018 Pumphouses B13, B4, B6, B9, SC1 and SC5 - Turned the TGRS to perform troubleshooting on the PLC controls due to the B3, B4, B5 communication issues with the PLC. Found a bad common ground terminal on the B1 through B6 data line protector. Replaced the data line protector and restarted the TGRS. The communication issues continued and additional troubleshooting necessary.

Down time: 3 hours at B13, B9, SC1 and SC5. B4 and B6 had 1.5 hours of down time.

**August 2018**

8/1/2018 Pumphouse B3 and B4. B4 is in Hand and B3 is in Auto. Reset chassis jumpers in an attempt to troubleshoot the problem. Restarted the pumps but chatter and eventual shut down at B4 occurred. Also, swapped out control cards from B8/B11 but that had no effect either. Additional troubleshooting necessary. B4 in Hand and B3 in Auto.

Down time: None.

8/2/2018 Pumphouse B3. The light was flashing on the well field panel. At the pumphouse the low level light was on and the pump was off. Turned the control to hand and the pump restarted normally.

Down time: 17.5 hours.

8/2/2018 Pumphouse B4. Changed out the LCS 10 water level control board, the data line protector, the ECV operating solenoid valve and the control chassis. Attempted to restart the pump in Auto but starter chatter and eventual shutdown occurred. Additional troubleshooting necessary.

Down time: 3 hours.

8/3/2018 Pumphouse B1. Preferred Electric installed 120 volt line surge protector in control panel.

Down time: None.

8/4/2018 Pumphouses B1, B13, B5 and SC1. The lights were flashing on the well field panel. There was a thunderstorm last night which most likely caused the wells to turn off. Reset the well field panel and except for SC1, the lights came back on steady. At pumphouse SC1 the operating light on the control panel was off. Reset the control panel but the light remained off. It shares controls with B11. At B11, the active light on the I/O adapter card was off. Cycled power to the control cards and the light came back on steady. Returned to SC1 and reset the controls. SC1 restarted normally. At B1, B13 and B5 the pumps were operating normally.

Down time: 6.5 hours at B1, 17 hours at B13, 15 hours at B5 and 17.5 hours at SC1.

8/5/2018 Pumphouses B4, B6 and B9. The lights were flashing on the well field panel. At the pumphouses, cycled power to the control panels and reset the starters. Turned the pumps on in Auto and observed normal operation.

Down time: 10 hours at B4 and B9. 9 hours at B6.

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

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|---|---|
| 8/7/2018 | Pumphouse B5. The light was flashing on the well field panel. At the pumphouse, cycled power to the controls and reset the starter. Restarted the pump in auto but starter chatter occurred. Turned the pump on in hand. Normal operation observed.<br>Down time: 12 hours. |
| 8/7/2018 | Pumphouses B1-B6. The wells are pumping in hand because they will only temporarily work in auto. Additional troubleshooting is necessary.<br>Down time: None. |
| 8/8-9/2018 | Pumphouses B1-B6. Inspected communication line hand holes south of the treatment center. Some of the communication wires were found to be damaged. Possibly damaged by an animal. Scheduled additional troubleshooting.<br>Down time: None. |
| 8/10-13/2018 | Pumphouses B1-B6. The wells would not run in Auto and were switched to operating in hand. Turned B13 off rather than risk lowering the pumping water level to the pump intake. Rang out and identified communication lines south of building 116. Temporarily spliced lines together and B1-B6 pumps all worked in Auto. Normal operation observed.<br>Down time: 3 hours each at B1, B4, B9, SC1 and SC5. 73.5 hours at B13. |
| 8/16/2018 | Pumphouses B1-B6. Turned the pumps off so Preferred Electric could professionally splice the communication wires in the hand hole south of Building 116. Following the work, turned the pumps on in Auto and all pumps operated normally.<br><br>Down time: 1.5 hours at B1 and 1.5 hours at B4. |
| 8/18-19/2018 | Pumphouses B4, B5, B6, B8 and B9. There was no power to the pumphouses and a portion of the electrical wiring on the transformers on the power pole behind B5 was damaged. Contacted Xcel Energy and they responded and repaired the problem. Turned the pumps on for normal service and normal operation was observed.<br><br>Down time: 13.5 hours at B4 and B9, 2 hours at B5, 10 hours at B6 and 3 hours at B8. |
| 8/25/2018 | Pumphouse B5. The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was running normally.<br>Down time: 26.5 hours. |
| 8/25/2018 | Pumphouse SC5. The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was running normally.<br>Down time: 5 hours. |

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

8/30/2018 Pumphouses B5 and B9. The gland packing around the pump shafts for Pumps 3 and 4 in the treatment center was leaking. Turned pumps B5 and B9 off to negate well field cycling. Removed and replaced the gland packing and tightened the packing followers. Turned the pumps back on and turned the pumps in B5 and B9 back on. Observed normal operation.

Down time: 5 hours at B9.

**September 2018**

9/3/2018 Labor Day holiday. No inspection was performed. Meter readings were estimated.
Down time: None.

9/5-6/2018 Pumphouse B9. The pump would not run in Auto without starter chatter and eventual pump shutdown. Turned the pump on in hand and scheduled further troubleshooting.

Down time: 19 hours.

9/8-11/2018 Pumphouse SC1. The meter stopped totaling. Removed the flow meter, cleaned it with acid and replaced the flow meter. Turned the pump on and the meter totaled normally. Meter readings were estimated.

Down time: 19 hours.

9/13/2018 Pumphouse B9. The pump would not run in Auto without starter chatter and eventual pump shutdown. Traced communication wire from the treatment center south and inspected the wire in the hand holes. Located a potential bad splice and respliced the wire. Also, turned the TGRS off and replaced the B9/B10 scanner module and replaced the I/O adapter in the pumphouse control panel. Turned the pump on in Auto and observed normal operation.

Down time: 1.5 hours.

9/13/2018 Pumphouse SC5. The RPZ was venting out the overflow. Turned the pump off, flushed piping and exercised valves. Turned the pump on and opened and closed the ECV to actuate RPZ spring valve. The RPZ stopped leaking and normal operation was observed.

Down time: None.

9/13-14/2018 Pumphouse B4. The RPZ was leaking out the overflow. Exercised valves and flushed piping. Opened and closed the ECV several times but the RPZ continued to vent. Turned the pump off and scheduled Jayhawk Mechanical for maintenance.

Down time: 23 hours.

9/14/2018 Pumphouse SC5. The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was running normally.

Down time: 8 hours.

**Appendix G.2**

**Maintenance Activities**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 9/17/2018 | Pumphouse SC1. The pump was not running. Located a blown fuse on the power pole near B11. Contacted Xcel Energy and they repaired the problem. Turned SC1 on and observed normal operation.<br>Down time: 20 hours. |
| 9/21/2018 | Pumphouse B9. The light was flashing on the well field panel. Reset the PLC and the light went out. At the pumphouse, the pump was off. Cycled power to the pump and control system and restarted the pump. Significant chatter from the starter and then the pump turned off. Turned the pump on in hand. Additional troubleshooting necessary.<br>Down time: |
| 9/22-26/2018 | Pumphouses B 4, B5, B6, B8, B9. The pumps are off. Located an open fusible link on the power pole adjacent to pumphouse B5. Contacted Xcel Energy. They found that one of the three legs inside the CT cabinet had corroded and failed. Contacted Preferred Electric and they installed new wiring in the CT cabinet. Xcel Energy returned to the site, connected the new wires and energized the lines. Turned the pumps on and observed normal operation.<br>Down time: 126 hours at B6 and B9, 127 hours at B4, 124 hours at B5 and 125 hours at B8. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

**Pumphouse B1**

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|---|---|
| 11/17-18/2017 | Pumphouses B1, B13, B3, B4, B5, B6, B8, B9, SC1, SC2, SC5; Call from Time Communication that the TGRS was down. At the site, there was a power outage that ceased power to the entire site. Contacted Xcel Energy and they found a blown fuse in the power pole across County Road 10 from Scherer Brothers Lumber. They installed a new fuse and power was restored power. However, the power outage blew the two electric heaters in the treatment center and the electric heater in pumphouse SC1. It also shorted the electrical wire in the conduit between the breaker box and Pump 3 in the treatment center. Contacted Preferred Electric and they repaired the heaters and also replaced the electrical wire to Pump 3. Also, Blower 3 in the treatment center would not start. Replaced a blown fuse and restarted Blower 3. Blower 3 restarted normally.<br><br>Down time: B1 for 8 hours; B13, B4, B6 and B8 for 6.5 hours; B9, SC1 and SC5 for 7.5 hours; B3 and B5 for 4 hours; SC2 for 3 hours. |
| 11/23-24/2017 | Pumphouse B1; The motor starter was tripped each day. Reset the starter and the turned the pump on. Observed normal operation each day.<br>Down time: 30.5 hours. |
| 11/27-30/2017 | Pumphouse B1; The motor starter was tripped. Contacted Preferred Electric. Troubleshooting showed a blown submersible pump motor. Contacted Thein Well and they replaced the pump and motor. Started the pump and observed normal operation.<br><br>Down time: 95.5 hours. |
| 12/1-2/2017 | Pumphouse B1; The motor starter was tripped. Contacted Preferred Electric. Troubleshooting indicated a blown submersible pump motor. Contacted Thein Well and they replaced the pump and motor. Started the pump and observed normal operation.<br>Down time: 23.5 hours. |
| 12/18/2017 | Pumphouse B1; Turned the pump off to conduct testing on the pump to determine why the pump is not producing at design capacity. Following testing, turned the pump on and observed normal operation.<br>Down time: 4.5 hours. |
| 3/24-27/2018 | Pumphouses B1, B13 and B6; The lights were flashing on the well field panel. Reset the PLC and the light for B6 came back on steady. However the lights for B1 and B13 turned off. At pumphouse B6, the pump was operating normally. At pumphouses B1 and B13, the pumps were rapidly turning on and off. Turned the controls at B1 from AUTO to HAND and the pump ran normally. Turned the controls at B13 from AUTO to HAND and the pump continued to rapidly turn on and off. Troubleshooting indicated a bad I/O adapter card at B13. Replaced the I/O adapter card with one from inventory and the B13 pump restarted normally. Switched the controls at B1 from HAND to AUTO and the pump operated normally.<br><br>Down time: 10.5 hours at B1, 26 hours at B6 hours and 78 hours at B13. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 4/11/2018 | Pumphouses B1, B13, B3 and B4; The cold water flow meters required maintenance. Removed them, cleaned them with acid and reinstalled them. Observed normal operation of each flow meter following the work.<br>Down time: 2.5 hours at B1. |
| 5/2/2018 | Pumphouse B1; The RPZ was venting out the overflow. Closed the ECV, turned the pump off and exercised the RPZ blow off valves. Turned the pump back on and the RPZ no longer leaked. Observed normal operation.<br>Down time: None. |
| 5/10/2018 | Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical performed the annual RPZ electrical inspection.<br>Down time: None. |
| 6/5/2018 | Pumphouse B1; The starter was chattering. Turned the pump and control panel off, opened the 480 volt disconnect and removed the output card. Reinstalled the same output card, closed the disconnect and turned the control panel back on. Turned the switch to auto and the pump restarted normally.<br>Down time: None. |
| 7/11-14/2018 | Pumphouse B1 - Turned the pump off to redevelop the well and install a larger capacity pump. Following the work, turned the pump on and the pump started normally.<br>Down time: 69 hours. |
| 7/30/2018 | Pumphouse B1 - The light was flashing on the well field panel. Reset the PLC and the light relit normally. At the pumphouse, the pump was operating normally.<br>Down time: 5.5 hours. |
| 8/3/2018 | Pumphouse B1. Preferred Electric installed 120 volt line surge protector in control panel.<br>Down time: None. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

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|---|---|
| 8/4/2018 | Pumphouses B1, B13, B5 and SC1. The lights were flashing on the well field panel. There was a thunderstorm last night which most likely caused the wells to turn off. Reset the well field panel and except for SC1, the lights came back on steady. At pumphouse SC1 the operating light on the control panel was off. Reset the control panel but the light remained off. It shares controls with B11. At B11, the active light on the I/O adapter card was off. Cycled power to the control cards and the light came back on steady. Returned to SC1 and reset the controls. SC1 restarted normally. At B1, B13 and B5 the pumps were operating normally.<br>Down time: 6.5 hours at B1, 17 hours at B13, 15 hours at B5 and 17.5 hours at SC1. |
| 8/7/2018 | Pumphouses B1-B6. The wells are pumping in hand because they will only temporarily work in auto. Additional troubleshooting is necessary.<br>Down time: None. |
| 8/8-9/2018 | Pumphouses B1-B6. Inspected communication line hand holes south of the treatment center. Some of the communication wires were found to be damaged. Possibly damaged by an animal. Scheduled additional troubleshooting.<br>Down time: None. |
| 8/10-13/2018 | Pumphouses B1-B6. The wells would not run in Auto and were switched to operating in hand. Turned B13 off rather than risk lowering the pumping water level to the pump intake. Ran out and identified communication lines south of building 116. Temporarily spliced lines together and B1-B6 pumps all worked in Auto. Normal operation observed.<br>Down time: 3 hours each at B1, B4, B9, SC1 and SC5. 73.5 hours at B13. |
| 8/16/2018 | Pumphouses B1-B6. Turned the pumps off so Preferred Electric could professionally splice the communication wires in the hand hole south of Building 116. Following the work, turned the pumps on in Auto and all pumps operated normally.<br>Down time: 1.5 hours at B1 and 1.5 hours at B4. |

**Pumphouse B3**

| | |
|---|---|
| 11/13/2017 | Pumphouses B3, B4 and B8; Turned the pumphouses off to repair the water distribution systems at the tops of Towers 3 and 4. Following the repairs, turned the pumps on and observed normal operation.<br>Down time: 20.5 hours at each well. |
| 2/13/2018 | Pumphouses B3 and B4; The lights were flashing on the well field panel. Reset the PLC and the lights came on steady. At the pumphouses, the pumps were running normally.<br>Down time: 18 hours at B3 and 19 hours at B4. |
| 5/15/2018 | Pumphouses B3 and B5; Increased their flow rates to maximum.<br>Down time: None. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 7/8/2018 | Pumphouses B3 and B4 - The lights were flashing on the well field panel. Reset the PLC but the lights continued flashing. At the pumphouses, the pumps would not run in auto. Turned the pumps on in hand and observed normal operation. Additional troubleshooting necessary.<br>Down time: 15.5 hours at B3 and 21 hours at B4. |
| 8/1/2018 | Pumphouse B3 and B4. B4 is in Hand and B3 is in Auto. Reset chasis jumpers in an attempt to troubleshoot the problem. Restarted the pumps but chatter and eventual shut down at B4 occurred. Also, swapped out control cards from B8/B11 but that had no effect either. Additional troubleshooting necessary. B4 in Hand and B3 in Auto.<br>Down time: None. |
| 8/2/2018 | Pumphouse B3. The light was flashing on the well field panel. At the pumphouse the low level light was on and the pump was off. Turned the control to hand and the pump restarted normally.<br>Down time: 17.5 hours. |

**Pumphouse B4**

| | |
|---|---|
| 10/18/2017 | Pumphouse B4; The RPZ was leaking. Turned the pump off and relieved pressure to the RPZ. Restarted the pump and observed normal operation.<br>Down time: None. |
| 11/13/2017 | Pumphouses B3, B4 and B8; Turned the pumphouses off to repair the water distribution systems at the tops of Towers 3 and 4. Following the repairs, turned the pumps on and observed normal operation.<br>Down time: 20.5 hours at each well. |
| 11/17-18/2017 | Pumphouses B1, B13, B3, B4, B5, B6, B8, B9, SC1, SC2, SC5; Call from Time Communication that the TGRS was down. At the site, there was a power outage that ceased power to the entire site. Contacted Xcel Energy and they found a blown fuse in the power pole across County Road 10 from Scherer Brothers Lumber. They installed a new fuse and power was restored power. However, the power outage blew the two electric heaters in the treatment center and the electric heater in pumphouse SC1. It also shorted the electrical wire in the conduit between the breaker box and Pump 3 in the treatment center. Contacted Preferred Electric and they repaired the heaters and also replaced the electrical wire to Pump 3. Also, Blower 3 in the treatment center would not start. Replaced a blown fuse and restarted Blower 3. Blower 3 restarted normally.<br>Down time: B1 for 8 hours; B13, B4, B6 and B8 for 6.5 hours; B9, SC1 and SC5 for 7.5 hours; B3 and B5 for 4 hours; SC2 for 3 hours. |
| 2/13/2018 | Pumphouses B3 and B4; The lights were flashing on the well field panel. Reset the PLC and the lights came on steady. At the pumphouses, the pumps were running normally. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

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|---|---|
| | Down time: 18 hours at B3 and 19 hours at B4. |
| 2/19/2018 | Pumphouse B4; The RPZ was leaking. Turned the pump off and closed the ECV. Started the pump and opened the ECV slowly. The RPZ did not leak and normal operation was observed.<br>Down time: None. |
| 4/11/2018 | Pumphouses B1, B13, B3 and B4; The cold water flow meters required maintenance. Removed them, cleaned them with acid and reinstalled them. Observed normal operation of each flow meter following the work.<br>Down time: 2.5 hours at B1. |
| 4/17/2018 | Pumphouse B4; Performed troubleshooting to determine the reason for B5/B6 intermittent operation. Turned B4 off to swap out communication modules.<br>Down time: 3 hours. |
| 5/3/2018 | Pumphouse B4; In an effort to troubleshoot the B13 communication issue, turned the pump in B4 off and swapped communication cards with pumphouses B1 and B13. Following the troubleshooting work, turned B4 on and observed normal operation.<br><br>Down time: 2 hours. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 5/10/2018 | Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical performed the annual RPZ electrical inspection.<br>Down time: None. |
| 5/15/2018 | Pumphouses B4, B5, B6, B8 and B9; The lights were not lit on the well field panel. Upon inspection, there was a blown fuse holder on the power pole near pumphouse B5. Contacted Xcel Energy and they repaired the fuse holder. Turned the pumps on and observed normal operation.<br>Down time: 20 hours at B4, B5, B6 and B9; 17.5 hours at B8. |
| 7/8/2018 | Pumphouses B3 and B4 - The lights were flashing on the well field panel. Reset the PLC but the lights continued flashing. At the pumphouses, the pumps would not run in auto. Turned the pumps on in hand and observed normal operation. Additional troubleshooting necessary.<br>Down time: 15.5 hours at B3 and 21 hours at B4. |
| 7/13-14/2018 | Pumphouse B4 - Performed troubleshooting on the control system. Restarted the pump in auto and the pump restarted normally. The following day, the light was flashing on the well field panel. Turned the pump back on in hand. Additional troubleshooting necessary.<br>Down time: 16 hours. |
| 7/25/2018 | Pumphouse B4 - Contracted Egan Company to performed troubleshooting on the control system. Restarted the pump in auto and the pump restarted normally. The following day, the light was flashing on the well field panel. Turned the pump back on in hand. Additional troubleshooting necessary.<br>Down time: 21.5 hours. |
| 7/26-27/2018 | Pumphouse B4 - The RPZ was leaking out the vent pipe. Attempted to stop the leak but to no avail. Turned the pump off. The following day, restarted the pump and the RPZ did not leak. Observed normal operation.<br>Down time: 18.5 hours. |
| 8/1/2018 | Pumphouse B3 and B4. B4 is in Hand and B3 is in Auto. Reset chasis jumpers in an attempt to troubleshoot the problem. Restarted the pumps but chatter and eventual shut down at B4 occurred. Also, swapped out control cards from B8/B11 but that had no effect either. Additional troubleshooting necessary. B4 in Hand and B3 in Auto.<br>Down time: None. |
| 8/2/2018 | Pumphouse B4. Changed out the LCS 10 water level control board, the data line protector, the ECV operating solenoid valve and the control chasis. Attempted to restart the pump in Auto but starter chatter and eventual shutdown occurred. Additional troubleshooting necessary.<br>Down time: 3 hours. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

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|---|---|
| 8/5/2018 | Pumphouses B4, B6 and B9. The lights were flashing on the well field panel. At the pumphouses, cycled power to the control panels and reset the starters. Turned the pumps on in Auto and observed normal operation.<br>Down time: 10 hours at B4 and B9. 9 hours at B6. |
| 8/7/2018 | Pumphouses B1-B6. The wells are pumping in hand because they will only temporarily work in auto. Additional troubleshooting is necessary.<br>Down time: None. |
| 8/8-9/2018 | Pumphouses B1-B6. Inspected communication line hand holes south of the treatment center. Some of the communication wires were found to be damaged. Possibly damaged by an animal. Scheduled additional troubleshooting.<br>Down time: None. |
| 8/10-13/2018 | Pumphouses B1-B6. The wells would not run in Auto and were switched to operating in hand. Turned B13 off rather than risk lowering the pumping water level to the pump intake. Ran out and identified communication lines south of building 116. Temporarily spliced lines together and B1-B6 pumps all worked in Auto. Normal operation observed.<br>Down time: 3 hours each at B1, B4, B9, SC1 and SC5. 73.5 hours at B13. |
| 8/16/2018 | Pumphouses B1-B6. Turned the pumps off so Preferred Electric could professionally splice the communication wires in the hand hole south of Building 116. Following the work, turned the pumps on in Auto and all pumps operated normally.<br>Down time: 1.5 hours at B1 and 1.5 hours at B4. |
| 8/18-19/2018 | Pumphouses B4, B5, B6, B8 and B9. There was no power to the pumphouses and a portion of the electrical wiring on the transformers on the power pole behind B5 was damaged. Contacted Xcel Energy and they responded and repaired the problem. Turned the pumps on for normal service and normal operation was observed.<br>Down time: 13.5 hours at B4 and B9, 2 hours at B5, 10 hours at B6 and 3 hours at B8. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

9/13-14/2018 Pumphouse B4. The RPZ was leaking out the overflow. Exercised valves and flushed piping. Opened and closed the ECV several times but the RPZ continued to vent. Turned the pump off and scheduled Jayhawk Mechanical for maintenance.

Down time: 23 hours.

9/22-26/2018 Pumphouses B 4, B5, B6, B8, B9. The pumps are off. Located an open fusible link on the power pole adjacent to pumphouse B5. Contacted Xcel Energy. They found that one of the three legs inside the CT cabinet had corroded and failed. Contacted Preferred Electric and they installed new wiring in the CT cabinet. Xcel Energy returned to the site, connected the new wires and energized the lines. Turned the pumps on and observed normal operation.

Down time: 126 hours at B6 and B9, 127 hours at B4, 124 hours at B5 and 125 hours at B8.

**Pumphouse B5**

10/17/2017 Pumphouse B5; Received a phone call that a communication line was hit about 20 feet west of the pumphouse. Upon inspection, the conduit was broken and 4 blue data cables were visible through the break. A hand hole vault will have to be installed to protect the break. Since pumphouses B9 and B10 continue to operate in "Auto", likely the cables were not damaged. There was starter chatter in the B9 control cabinet. Disconnected the data cable between B9 and B10 and the chatter ceased.

Down time: None.

11/17-18/2017 Pumphouses B1, B13, B3, B4, B5, B6, B8, B9, SC1, SC2, SC5; Call from Time Communication that the TGRS was down. At the site, there was a power outage that ceased power to the entire site. Contacted Xcel Energy and they found a blown fuse in the power pole across County Road 10 from Scherer Brothers Lumber. They installed a new fuse and power was restored power. However, the power outage blew the two electric heaters in the treatment center and the electric heater in pumphouse SC1. It also shorted the electrical wire in the conduit between the breaker box and Pump 3 in the treatment center. Contacted Preferred Electric and they repaired the heaters and also replaced the electrical wire to Pump 3. Also, Blower 3 in the treatment center would not start. Replaced a blown fuse and restarted Blower 3. Blower 3 restarted normally.

Down time: B1 for 8 hours; B13, B4, B6 and B8 for 6.5 hours; B9, SC1 and SC5 for 7.5

12/3/2017 Pumphouses B5 and B8; Increased the ECV back pressure to slow the flow rate.
Down time: None.

1/2/2018 Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light relit normally. At the pumphouse, the pump was running normally.
Down time: 11.5 hours.

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 1/8/2018 | Pumphouse B5, The light was flashing on the wellfield panel. Reset the PLC and the light relit normally. At the pumphouse, the pump was running normally.<br>Down time: 14 hours. |
| 1/15/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel. Reset the PLC and the lights relit normally. At the pumphouses, the pumps were running normally.<br>Down time: 16 hours at B5 and 20 hours at B6. |
| 1/16/2018 | Pumphouse B5; The light was flashing on the well field panel. Drove to the pumphouse and found the "Low Level" light was on. Troubleshooting indicated a blown water level control board. Changed out the water level control board with one from inventory and restarted the pump. The pump restarted normally however the ECV no longer held pressure. Changed out the pilot, exercised the control valves flushed the control piping and reset the pilot. Observed normal operation.<br>Down time: 13.5 hours. |
| 2/9/2018 | Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was working normally.<br>Down time: 8 hours. |
| 3/6/2018 | Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light relit normally. At the pumphouse, the ECV was wide open. Replaced the strainer screen, flushed the control piping and exercised the control valves on the control piping. Reset the pilot pressure and the valve operated normally.<br>Down time: 25.5 hours. |
| 3/7/2018 | Pumphouse B5; The light was flashing again on the well field panel. Turned the TGRS off and performed the daily inspection. Upon return the treatment system, restarted the TGRS. Observed normal operation. The limit switch was not triggered at B5. Lowered the doughnut on the valve stem. Closed the ECV and the pump turned off normally. Restarted the pump and the pump started normally.<br>Down time: 15 hours. |
| 3/12/2018 | Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was running normally.<br>Down time: 12 hours. |
| 3/19/2018 | Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was running normally.<br>Down time: 11.5 hours. |
| 3/22/2018 | Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was running normally.<br>Down time: 13 hours. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 4/9/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel. Reset the PLC and the lights came back on steady. At the pumphouses, the pumps were operating normally.<br>Down time: 18 hours at B5 and 22.5 hours at B6. |
| 4/12/2018 | Pumphouses B5, B6, SC2 and SC5; The cold water flow meters required maintenance. Removed them, cleaned them with acid and reinstalled them. Observed normal operation of each flow meter following the work.<br>Down time: 2.5 hours at B5, 3.5 hours at B6, 3 hours at SC2 and 4 hours at SC5. |
| 4/14-16/2018 | Pumphouse B5; Each day the light was flashing on the well field panel. Reset the PLC each day and the light came back on steady. At the pumphouse, the pump was operating normally.<br>Down time: 61.5 hours. |
| 4/16/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel. Reset the PLC and the lights came back on steady. At the pumphouses, the pumps were operating normally.<br>Down time: 23.5 hours at B5 and 6.5 hours at B6. |
| 4/18/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel. Reset the PLC and the lights came back on steady. At the pumphouses, the pumps were operating normally.<br>Down time: 2.5 hours at B5 and 2 hours at B6. |
| 5/25/2018 | Pumphouse B5; The light was flashing on the well field panel. There was a storm last night that possibly knocked out communication between the pumphouse and the PLC in Building 116. At the pumphouse, reset the starter and turned the switch to Auto. The pump turned on and normal operation was observed.<br>Down time: 20.5 hours. |
| 5/28/2018 | Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was operating normally.<br>Down time: 19.5 hours. |
| 5/30/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel; At the pumphouses, the low level lights were on. Cycled power to the control panels and turned the pumps on to Auto. The pumps restarted normally.<br>Down time: 9 hours at B6 and 19.5 hours at B5. |
| 6/1/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel. At the pumphouses, the low level lights were on. Installed a new output card in the B6 control panel. Restarted the pumps and observed normal operation.<br>Down time: 18.5 hours at B5 and 14.5 hours at B6 |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 6/15/2018 | Pumphouse B5; The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was operating normally.<br>Down time: 14 hours. |
| 6/16/2018 | Pumphouse B5; The light was flashing on the well field panel. At the pumphouse, the low level light was on. Installed a new output card and restarted the pump. The pump restarted normally.<br>Down time: 21 hours. |
| 6/18/2018 | Pumphouse B5; The light was flashing on the well field panel. At the pumphouse, cycled power to the control panel and then turned the pump to auto. The pump started and normal operation was observed.<br>Down time: 21 hours. |
| 6/29/2018 | Pumphouse B5; The light was flashing on the well field panel. At the pumphouse, the low level light was on. Cycled power to the control panel and turned the pump to auto. The pump started normally.<br>Down time: 18 hours. |
| 7/10/2018 | Pumphouse B5 - The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was operating normally.<br>Down time: 20.5 hours. |
| 7/11/2018 | Pumphouse B5 - The light was flashing on the well field panel. Reset the PLC but the light continued flashing. At the pumphouse, the pump would not run in auto. Turned the pump on in hand and observed normal operation. Additional troubleshooting necessary.<br>Down time: 14 hours. |
| 7/13/2018 | Pumphouse B5 - The starter would chatter when the pump was turned on in auto. Turned the pump off to perform troubleshooting work. Installed new input, output and I/O adapter cards in the chasis and restarted the pump in auto. Observed normal operation.<br>Down time: 3.5 hours. |
| 7/16-20/2018 | Pumphouse B5 - Turned the pump off to redevelop the well and install a larger capacity pump. Following the work, turned the pump on and the pump restarted normally.<br>Down time: 95.5 hours. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 7/26/2018 | Pumphouse B5 - The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was operating normally.<br>Down time: 20 hours. |
| 7/31/2018 | Pumphouse B5 - The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was operating normally.<br>Down time: 12.5 hours. |
| 8/7/2018 | Pumphouse B5. The light was flashing on the well field panel. At the pumphouse, cycled power to the controls and reset the starter. Restarted the pump in auto but starter chatter occurred. Turned the pump on in hand. Normal operation observed.<br>Down time: 12 hours. |
| 8/25/2018 | Pumphouse B5. The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was running normally.<br>Down time: 26.5 hours. |
| 8/30/2018 | Pumphouses B5 and B9. The gland packing around the pump shafts for Pumps 3 and 4 in the treatment center was leaking. Turned pumps B5 and B9 off to negate well field cycling. Removed and replaced the gland packing and tightened the packing followers. Turned the pumps back on and turned the pumps in B5 and B9 back on. Observed normal operation.<br>Down time: 5 hours at B9. |
| 9/22-26/2018 | Pumphouses B 4, B5, B6, B8, B9. The pumps are off. Located an open fusible link on the power pole adjacent to pumphouse B5. Contacted Xcel Energy. They found that one of the three legs inside the CT cabinet had corroded and failed. Contacted Preferred Electric and they installed new wiring in the CT cabinet. Xcel Energy returned to the site, connected the new wires and energized the lines. Turned the pumps on and observed normal operation.<br>Down time: 126 hours at B6 and B9, 127 hours at B4, 124 hours at B5 and 125 hours at B8. |

**Pumphouse B6**

| | |
|---|---|
| 10/30/2017 | Pumphouse B6; The heater no longer provides heat. Opened the breaker to the heater and installed a temporary electric heater in the pumphouse to provide heat.<br>Down time: None. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 11/19-22/2017 | Pumphouse B6; The RPZ backflow preventer was leaking. Contacted Jayhawk Mechanical and they repaired the RPZ backflow preventer. Restarted the pump and observed normal operation.<br>Down time: 73.5 hours. |
| 2/14/2018 | Pumphouse B6; The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was running normally.<br>Down time: 1.5 hours. |
| 2/15/2018 | Pumphouse B6; The light was flashing on the PLC. Turned the pumphouses off and turned the PLC to off. Allowed the PLC to remain off for 5 minutes and then restarted the PLC. The well field and treatment system restarted normally. Performed the daily inspection and the TGRS was operating normally.<br>Down time: 6 hours. |
| 3/13/2018 | Pumphouse B6; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was running normally.<br>Down time: 2 hours. |
| 3/20/2018 | Pumphouse B6; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was running normally.<br>Down time: 16.5 hours. |
| 3/21/2018 | Pumphouse B6; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was running normally.<br>Down time: 4.5 hours. |
| 4/5/2018 | Pumphouse B6; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was operating normally.<br>Down time: 20 hours. |
| 4/9/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel. Reset the PLC and the lights came back on steady. At the pumphouses, the pumps were operating normally.<br>Down time: 18 hours at B5 and 22.5 hours at B6. |
| 4/12/2018 | Pumphouse B6; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was operating normally.<br>Down time: None. |
| 4/12/2018 | Pumphouses B5, B6, SC2 and SC5; The cold water flow meters required maintenance. Removed them, cleaned them with acid and reinstalled them. Observed normal operation of each flow meter following the work.<br>Down time: 2.5 hours at B5, 3.5 hours at B6, 3 hours at SC2 and 4 hours at SC5. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 4/16/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel. Reset the PLC and the lights came back on steady. At the pumphouses, the pumps were operating normally.<br>Down time: 23.5 hours at B5 and 6.5 hours at B6. |
| 4/18/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel. Reset the PLC and the lights came back on steady. At the pumphouses, the pumps were operating normally.<br>Down time: 2.5 hours at B5 and 2 hours at B6. |
| 5/10/2018 | Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical performed the annual RPZ electrical inspection.<br>Down time: None. |
| 5/15/2018 | Pumphouses B4, B5, B6, B8 and B9; The lights were not lit on the well field panel. Upon inspection, there was a blown fuse holder on the power pole near pumphouse B5. Contacted Xcel Energy and they repaired the fuse holder. Turned the pumps on and observed normal operation.<br>Down time: 20 hours at B4, B5, B6 and B9; 17.5 hours at B8. |
| 5/30/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel; At the pumphouses, the low level lights were on. Cycled power to the control panels and turned the pumps on to Auto. The pumps restarted normally.<br>Down time: 9 hours at B6 and 19.5 hours at B5. |
| 6/1/2018 | Pumphouses B5 and B6; The lights were flashing on the well field panel. At the pumphouses, the low level lights were on. Installed a new output card in the B6 control panel. Restarted the pumps and observed normal operation.<br>Down time: 18.5 hours at B5 and 14.5 hours at B6 |
| 7/31/2018 | Pumphouses B13, B4, B6, B9, SC1 and SC5 - Turned the TGRS to perform troubleshooting on the PLC controls due to the B3, B4, B5 communication issues with the PLC. Found a bad common ground terminal on the B1 through B6 data line protector. Replaced the data line protector and restarted the TGRS. The communication issues continued and additional troubleshooting necessary.<br>Down time: 3 hours at B13, B9, SC1 and SC5. B4 and B6 had 1.5 hours of down time. |
| 8/5/2018 | Pumphouses B4, B6 and B9. The lights were flashing on the well field panel. At the pumphouses, cycled power to the control panels and reset the starters. Turned the pumps on in Auto and observed normal operation.<br>Down time: 10 hours at B4 and B9. 9 hours at B6. |
| 8/7/2018 | Pumphouses B1-B6. The wells are pumping in hand because they will only temporarily work in auto. Additional troubleshooting is necessary.<br>Down time: None. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

8/8-9/2018 Pumphouses B1-B6. Inspected communication line hand holes south of the treatment center. Some of the communication wires were found to be damaged. Possibly damaged by an animal. Scheduled additional troubleshooting.

Down time: None.

8/10-13/2018 Pumphouses B1-B6. The wells would not run in Auto and were switched to operating in hand. Turned B13 off rather than risk lowering the pumping water level to the pump intake. Ran out and identified communication lines south of building 116. Temporarily spliced lines together and B1-B6 pumps all worked in Auto. Normal operation observed.

Down time: 3 hours each at B1, B4, B9, SC1 and SC5. 73.5 hours at B13.

8/16/2018 Pumphouses B1-B6. Turned the pumps off so Preferred Electric could professionally splice the communication wires in the hand hole south of Building 116. Following the work, turned the pumps on in Auto and all pumps operated normally.

Down time: 1.5 hours at B1 and 1.5 hours at B4.

8/18-19/2018 Pumphouses B4, B5, B6, B8 and B9. There was no power to the pumphouses and a portion of the electrical wiring on the transformers on the power pole behind B5 was damaged. Contacted Xcel Energy and they responded and repaired the problem. Turned the pumps on for normal service and normal operation was observed.

Down time: 13.5 hours at B4 and B9, 2 hours at B5, 10 hours at B6 and 3 hours at B8.

9/22-26/2018 Pumphouses B 4, B5, B6, B8, B9. The pumps are off. Located an open fusible link on the power pole adjacent to pumphouse B5. Contacted Xcel Energy. They found that one of the three legs inside the CT cabinet had corroded and failed. Contacted Preferred Electric and they installed new wiring in the CT cabinet. Xcel Energy returned to the site, connected the new wires and energized the lines. Turned the pumps on and observed normal operation.

Down time: 126 hours at B6 and B9, 127 hours at B4, 124 hours at B5 and 125 hours at B8.

**Pumphouse B8**

11/13/2017 Pumphouses B3, B4 and B8; Turned the pumphouses off to repair the water distribution systems at the tops of Towers 3 and 4. Following the repairs, turned the pumps on and observed normal operation.

Down time: 20.5 hours at each well.

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 11/17-18/2017 | Pumphouses B1, B13, B3, B4, B5, B6, B8, B9, SC1, SC2, SC5; Call from Time Communication that the TGRS was down. At the site, there was a power outage that ceased power to the entire site. Contacted Xcel Energy and they found a blown fuse in the power pole across County Road 10 from Scherer Brothers Lumber. They installed a new fuse and power was restored power. However, the power outage blew the two electric heaters in the treatment center and the electric heater in pumphouse SC1. It also shorted the electrical wire in the conduit between the breaker box and Pump 3 in the treatment center. Contacted Preferred Electric and they repaired the heaters and also replaced the electrical wire to Pump 3. Also, Blower 3 in the treatment center would not start. Replaced a blown fuse and restarted Blower 3. Blower 3 restarted normally.<br>Down time: B1 for 8 hours; B13, B4, B6 and B8 for 6.5 hours; B9, SC1 and SC5 for 7.5 hours; B3 and B5 for 4 hours; SC2 for 3 hours. |
| 11/18/2017 | Pumphouse B8; The RPZ was leaking. Contacted Jayhawk Mechanical and they repaired the RPZ backflow preventer.<br>Down time: 14 hours. |
| 12/3/2017 | Pumphouses B5 and B8; Increased the ECV back pressure to slow the flow rate.<br>Down time: None. |
| 12/6/2017 | Pumphouse B8; Increased the ECV back pressure to slow the flow rate.<br>Down time: None. |
| 2/15/2018 | Pumphouse B8; The pump was off and the I/O adapter light was flashing on the control card. Reset the I/O adapter card and restarted the pump. The pump restarted normally.<br>Down time: None. |
| 5/10/2018 | Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical performed the annual RPZ electrical inspection.<br>Down time: None. |
| 5/15/2018 | Pumphouses B4, B5, B6, B8 and B9; The lights were not lit on the well field panel. Upon inspection, there was a blown fuse holder on the power pole near pumphouse B5. Contacted Xcel Energy and they repaired the fuse holder. Turned the pumps on and observed normal operation.<br>Down time: 20 hours at B4, B5, B6 and B9; 17.5 hours at B8. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

9/22-26/2018 Pumphouses B 4, B5, B6, B8, B9. The pumps are off. Located an open fusible link on the power pole adjacent to pumphouse B5. Contacted Xcel Energy. They found that one of the three legs inside the CT cabinet had corroded and failed. Contacted Preferred Electric and they installed new wiring in the CT cabinet. Xcel Energy returned to the site, connected the new wires and energized the lines. Turned the pumps on and observed normal operation.

Down time: 126 hours at B6 and B9, 127 hours at B4, 124 hours at B5 and 125 hours at B8.

**Pumphouse B9**

10/2-3/2017 Pumphouse B9; Each day, the light was flashing on the well field panel. Reset the PLC and the light relit normally. At the pumphouse, the pump was running normally. There is a contractor working in the vicinity of the B5 pumphouse.

Down time: 31.5 hours.

11/17-18/2017 Pumphouses B1, B13, B3, B4, B5, B6, B8, B9, SC1, SC2, SC5; Call from Time Communication that the TGRS was down. At the site, there was a power outage that ceased power to the entire site. Contacted Xcel Energy and they found a blown fuse in the power pole across County Road 10 from Scherer Brothers Lumber. They installed a new fuse and power was restored power. However, the power outage blew the two electric heaters in the treatment center and the electric heater in pumphouse SC1. It also shorted the electrical wire in the conduit between the breaker box and Pump 3 in the treatment center. Contacted Preferred Electric and they repaired the heaters and also replaced the electrical wire to Pump 3. Also, Blower 3 in the treatment center would not start. Replaced a blown fuse and restarted Blower 3. Blower 3 restarted normally.

Down time: B1 for 8 hours; B13, B4, B6 and B8 for 6.5 hours; B9, SC1 and SC5 for 7.5 hours; B3 and B5 for 4 hours; SC2 for 3 hours.

11/20/2017 Pumphouses B9 and B10; Call from McCrossan that they hit a communication cable near pumphouse B10. The wires were severed and stretched. Contacted Preferred Electric and they assessed the damage to prepare an estimate for repairs.

Down time: None.

3/28/2018 Pumphouse B9; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was operating normally.

Down time: 8.5 hours.

3/29/2018 Pumphouse B9; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was operating normally.

Down time: 21.5 hours.

3/30/2018 Pumphouse B9; The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse the pump was operating normally.

Down time: 23.5 hours.

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 5/10/2018 | Pumphouses B1, B3, B4, B5, B6, B8, B9, SC2 and SC5; Jayhawk Mechanical performed the annual RPZ electrical inspection.<br>Down time: None. |
| 5/10/2018 | Pumphouse B9; Following the electrical inspection at B9, the electrician forgot to turn the pump back on. The pump was turned back on the following day during the daily inspection when the oversight was noticed.<br>Down time: 25 hours. |
| 5/15/2018 | Pumphouses B4, B5, B6, B8 and B9; The lights were not lit on the well field panel. Upon inspection, there was a blown fuse holder on the power pole near pumphouse B5. Contacted Xcel Energy and they repaired the fuse holder. Turned the pumps on and observed normal operation.<br>Down time: 20 hours at B4, B5, B6 and B9; 17.5 hours at B8. |
| 6/7/2018 | Pumphouse B9; The flow meter stopped totaling. Replaced the flow meter with a new one from inventory. Restarted the pump and observed normal operation. Meter reading was estimated for the day.<br>Down time: None. |
| 7/28/2018 | Pumphouse B9 - The ECV would not close. Turned the pump off to remove portions of the ECV control piping and remove sand build-up. Following the work, restarted the pump and observed normal operation.<br>Down time: 1.5 hours. |
| 7/31/2018 | Pumphouses B13, B4, B6, B9, SC1 and SC5 - Turned the TGRS to perform troubleshooting on the PLC controls due to the B3, B4, B5 communication issues with the PLC. Found a bad common ground terminal on the B1 through B6 data line protector. Replaced the data line protector and restarted the TGRS. The communication issues continued and additional troubleshooting necessary.<br>Down time: 3 hours at B13, B9, SC1 and SC5. B4 and B6 had 1.5 hours of down time. |
| 8/5/2018 | Pumphouses B4, B6 and B9. The lights were flashing on the well field panel. At the pumphouses, cycled power to the control panels and reset the starters. Turned the pumps on in Auto and observed normal operation.<br>Down time: 10 hours at B4 and B9. 9 hours at B6. |
| 8/10-13/2018 | Pumphouses B1-B6. The wells would not run in Auto and were switched to operating in hand. Turned B13 off rather than risk lowering the pumping water level to the pump intake. Ran  out and identified communication lines south of building 116. Temporarily spliced lines together and B1-B6 pumps all worked in Auto. Normal operation observed.<br>Down time: 3 hours each at B1, B4, B9, SC1 and SC5. 73.5 hours at B13. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 8/18-19/2018 | Pumphouses B4, B5, B6, B8 and B9. There was no power to the pumphouses and a portion of the electrical wiring on the transformers on the power pole behind B5 was damaged. Contacted Xcel Energy and they responded and repaired the problem. Turned the pumps on for normal service and normal operation was observed.<br><br>Down time: 13.5 hours at B4 and B9, 2 hours at B5, 10 hours at B6 and 3 hours at B8. |
| 8/30/2018 | Pumphouses B5 and B9. The gland packing around the pump shafts for Pumps 3 and 4 in the treatment center was leaking. Turned pumps B5 and B9 off to negate well field cycling. Removed and replaced the gland packing and tightened the packing followers. Turned the pumps back on and turned the pumps in B5 and B9 back on. Observed normal operation.<br><br>Down time: 5 hours at B9. |
| 9/5-6/2018 | Pumphouse B9. The pump would not run in Auto without starter chatter and eventual pump shutdown. Turned the pump on in hand and scheduled further troubleshooting.<br><br>Down time: 19 hours. |
| 9/13/2018 | Pumphouse B9. The pump would not run in Auto without starter chatter and eventual pump shutdown. Traced communication wire from the treatment center south and inspected the wire in the hand holes. Located a potential bad splice and respliced the wire. Also, turned the TGRS off and replaced the B9/B10 scanner module and replaced the I/O adapter in the pumphouse control panel. Turned the pump on in Auto and observed normal operation.<br><br>Down time: 1.5 hours. |
| 9/21/2018 | Pumphouse B9. The light was flashing on the well field panel. Reset the PLC and the light went out. At the pumphouse, the pump was off. Cycled power to the pump and control system and restarted the pump. Significant chatter from the starter and then the pump turned off. Turned the pump on in hand. Additional troubleshooting necessary.<br><br>Down time: |
| 9/22-26/2018 | Pumphouses B 4, B5, B6, B8, B9. The pumps are off. Located an open fusible link on the power pole adjacent to pumphouse B5. Contacted Xcel Energy. They found that one of the three legs inside the CT cabinet had corroded and failed. Contacted Preferred Electric and they installed new wiring in the CT cabinet. Xcel Energy returned to the site, connected the new wires and energized the lines. Turned the pumps on and observed normal operation.<br><br>Down time: 126 hours at B6 and B9, 127 hours at B4, 124 hours at B5 and 125 hours at B8. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

**Pumphouse B13**

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|---|---|
| 11/15-16/2017 | Pumphouse B13; The flow rate was below the target flow rate. Pulled the lift system, jetted the well screen and replaced the pump and motor with new. Turned the pump on and observed normal operation.<br>Down time: 24 hours. |
| 4/11/2018 | Pumphouses B1, B13, B3 and B4; The cold water flow meters required maintenance. Removed them, cleaned them with acid and reinstalled them. Observed normal operation of each flow meter following the work.<br>Down time: 2.5 hours at B1. |
| 4/18-24/2018 | Pumphouse B13; Each day the light was flashing on the well field panel. Reset the PLC each day and the light would stay on steady. At the pumphouse, the pump would be operating normally. The next day the light would be flashing on the well field panel again. Changed out the I/O adapter module in B13 and restarted the B13 pump. The pump restarted normally.<br>Down time: 101.5 hours. |
| 4/27-30/2018 | Pumphouse B13; Each day the light was flashing on the well field. Reset the PLC each day and each day the light came back on steady. At the pumphouse the pump was operating normally. Additional troubleshooting necessary.<br>Down time: 76 hours. |
| 5/1-4/2018 | Pumphouse B13; Each day the light was flashing on the well field. Reset the PLC each day and each day the light came back on steady. At the pumphouse the pump was operating normally. Troubleshooting eventually revealed a bad I/O adapter card at pumphouse B1. Replaced the I/O adapter card at B1 and restarted pump in B13. The pump restarted and observed normal operation.<br>Down time: 55 hours. |
| 7/13/2018 | Pumphouse B13 - The light was flashing on the well field panel. At the pumphouse, the starter would chatter when the pump was turned on in auto. Replaced the output card and restarted the pump. Observed normal operation.<br>Down time: 1 hour. |
| 8/4/2018 | Pumphouses B1, B13, B5 and SC1. The lights were flashing on the well field panel. There was a thunderstorm last night which most likely caused the wells to turn off. Reset the well field panel and except for SC1, the lights came back on steady. At pumphouse SC1 the operating light on the control panel was off. Reset the control panel but the light remained off. It shares controls with B11. At B11, the active light on the I/O adapter card was off. Cycled power to the control cards and the light came back on steady. Returned to SC1 and reset the controls. SC1 restarted normally. At B1, B13 and B5 the pumps were operating normally.<br>Down time: 6.5 hours at B1, 17 hours at B13, 15 hours at B5 and 17.5 hours at SC1. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

**Pumphouse SC1**

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|---|---|
| 11/16/2017 | Pumphouse SC1; During the daily inspection, the pump was off. At B11, the control switch was in the "Off" position. Turned the switch to "Auto" and inspected SC1. At SC1, the pump was operating normally.<br>Down time: 22 hours. |
| 11/17-18/2017 | Pumphouses B1, B13, B3, B4, B5, B6, B8, B9, SC1, SC2, SC5; Call from Time Communication that the TGRS was down. At the site, there was a power outage that ceased power to the entire site. Contacted Xcel Energy and they found a blown fuse in the power pole across County Road 10 from Scherer Brothers Lumber. They installed a new fuse and power was restored power. However, the power outage blew the two electric heaters in the treatment center and the electric heater in pumphouse SC1. It also shorted the electrical wire in the conduit between the breaker box and Pump 3 in the treatment center. Contacted Preferred Electric and they repaired the heaters and also replaced the electrical wire to Pump 3. Also, Blower 3 in the treatment center would not start. Replaced a blown fuse and restarted Blower 3. Blower 3 restarted normally.<br>Down time: B1 for 8 hours; B13, B4, B6 and B8 for 6.5 hours; B9, SC1 and SC5 for 7.5 hours; B3 and B5 for 4 hours; SC2 for 3 hours. |
| 1/12/2018 | Pumphouse SC1; The building temperature was about 35 degrees on arrival. Cycled the thermostat and the heater came on normally. Checked the building after completion of the daily inspection. The building was warm and the heater was working normally.<br>Down time: None. |
| 2/19/2018 | Pumphouses SC1, SC2 and SC5; The lights were out on the well field panel. At the pumphouses, the pumps were off and the lights were dim. A fuse was found to be open on a power pole near the old Lind electrical sub-station. Contacted Xcel Energy and they responded. They installed a new fuse. Restarted the pumps and observed normal operation.<br>Down time: None. Xcel Energy responded right away. |
| 2/20/2018 | Pumphouses SC1, SC2 and SC5; The lights were off on the well field panel. At the pumphouses, the pumps were off and the lights were dim. The same fuse was found to be open on the power pole near the old Lind electrical sub-station. Contacted Xcel Energy again and they responded. They thoroughly inspected the power lines and found a location near SC4 where the wind could possibly blow a loose power line into the power pole. They repaired the wire and installed new fuses at a number of locations. Restarted the pumps and observed normal operation.<br>Down time: 19 hours at SC1, 18.5 hours at SC2 and 16.5 hours at SC5. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

5/5-7/2018 Pumphouses SC1, SC2 and SC5; A storm knocked out power to the wells and a fuse is open on the power pole near the old Lind electrical substation. Contacted Xcel Energy and they replaced the fuse and worked on other areas of the power line. Turned the pumps back on and observed normal operation.

Down time: 36.5 hours at each pumphouse.

7/31/2018 Pumphouses B13, B4, B6, B9, SC1 and SC5 - Turned the TGRS to perform troubleshooting on the PLC controls due to the B3, B4, B5 communication issues with the PLC. Found a bad common ground terminal on the B1 through B6 data line protector. Replaced the data line protector and restarted the TGRS. The communication issues continued and additional troubleshooting necessary.

Down time: 3 hours at B13, B9, SC1 and SC5. B4 and B6 had 1.5 hours of down time.

8/4/2018 Pumphouses B1, B13, B5 and SC1. The lights were flashing on the well field panel. There was a thunderstorm last night which most likely caused the wells to turn off. Reset the well field panel and except for SC1, the lights came back on steady. At pumphouse SC1 the operating light on the control panel was off. Reset the control panel but the light remained off. It shares controls with B11. At B11, the active light on the I/O adapter card was off. Cycled power to the control cards and the light came back on steady. Returned to SC1 and reset the controls. SC1 restarted normally. At B1, B13 and B5 the pumps were operating normally.

Down time: 6.5 hours at B1, 17 hours at B13, 15 hours at B5 and 17.5 hours at SC1.

9/8-11/2018 Pumphouse SC1. The meter stopped totaling. Removed the flow meter, cleaned it with acid and replaced the flow meter. Turned the pump on and the meter totaled normally. Meter readings were estimated.

Down time: 19 hours.

9/17/2018 Pumphouse SC1. The pump was not running. Located a blown fuse on the power pole near B11. Contacted Xcel Energy and they repaired the problem. Turned SC1 on and observed normal operation.

Down time: 20 hours.

**Pumphouse SC2**

10/7-12/2017 Pumphouse SC2; The RPZ was leaking. Attempted to stop the leak but the leak continued. Turned the pump and breaker to off and closed the gate valve. Jayhawk Mechanical repaired the RPZ. Turned the pump on but the flow rate would not register on the water meter. Removed and cleaned the water meter. The meter shows flow now but only at 2 gallons per minute. Daily meter readings were estimated to reflect 2 gallons per minute.

Down time: 122.5 hours.

10/26-31/2017 Pumphouse SC2; The pump can no longer overcome the forcemain back pressure. Turned the pump off and contacted Thein Well to jet the well screen and replace the pump and motor. Thein Well continued to work on the well when the month ended.

Down time: 141.5 hours.

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

11/2/2017 Pumphouse SC2; The pump and motor Thein Well installed did not meet performance specifications. Thein Well installed a new pump and motor. Following installation, turned the pump on and observed normal operation.

Down time: 43 hours.

11/17-18/2017 Pumphouses B1, B13, B3, B4, B5, B6, B8, B9, SC1, SC2, SC5; Call from Time Communication that the TGRS was down. At the site, there was a power outage that ceased power to the entire site. Contacted Xcel Energy and they found a blown fuse in the power pole across County Road 10 from Scherer Brothers Lumber. They installed a new fuse and power was restored power. However, the power outage blew the two electric heaters in the treatment center and the electric heater in pumphouse SC1. It also shorted the electrical wire in the conduit between the breaker box and Pump 3 in the treatment center. Contacted Preferred Electric and they repaired the heaters and also replaced the electrical wire to Pump 3. Also, Blower 3 in the treatment center would not start. Replaced a blown fuse and restarted Blower 3. Blower 3 restarted normally.

Down time: B1 for 8 hours; B13, B4, B6 and B8 for 6.5 hours; B9, SC1 and SC5 for 7.5 hours; B3 and B5 for 4 hours; SC2 for 3 hours.

12/30-31/2017 Pumphouse SC2; The RPZ was leaking at a fast rate. Turned the pump off and contacted Jayhawk Mechanical for repairs. They were not able to respond until the beginning of next week.

Down time: None.

1/1-4 /2018 Pumphouse SC2; The RPZ was leaking. Turned the pump off and contacted Jayhawk Mechanical. They repaired the RPZ. Restarted the pump and observed normal operation.

Down time: 93.5 hours.

1/11/2018 Pumphouse SC2; The flow meter was totaling too quickly. Removed and replaced the flow meter with one from inventory. Observed normal operation.

Down time: None.

2/19/2018 Pumphouses SC1, SC2 and SC5; The lights were out on the well field panel. At the pumphouses, the pumps were off and the lights were dim. A fuse was found to be open on a power pole near the old Lind electrical sub-station. Contacted Xcel Energy and they responded. They installed a new fuse. Restarted the pumps and observed normal operation.

Down time: None. Xcel Energy responded right away.

2/20/2018 Pumphouses SC1, SC2 and SC5; The lights were off on the well field panel. At the pumphouses, the pumps were off and the lights were dim. The same fuse was found to be open on the power pole near the old Lind electrical sub-station. Contacted Xcel Energy again and they responded. They thoroughly inspected the power lines and found a location near SC4 where the wind could possibly blow a loose power line into the power pole. They repaired the wire and installed new fuses at a number of locations. Restarted the pumps and observed normal operation.

Down time: 19 hours at SC1, 18.5 hours at SC2 and 16.5 hours at SC5.

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 2/21/2018 | Pumphouse SC2; The ECV had substantial iron bacteria build-up which was blocking flow. Removed the ECV and installed a flow meter in its place. Turned the pump on and the pump restarted normally. The flow rate increased approximately 40%.<br><br>Down time: 19.5 hours. |
| 4/12/2018 | Pumphouses B5, B6, SC2 and SC5; The cold water flow meters required maintenance. Removed them, cleaned them with acid and reinstalled them. Observed normal operation of each flow meter following the work.<br>Down time: 2.5 hours at B5, 3.5 hours at B6, 3 hours at SC2 and 4 hours at SC5. |
| 5/5-7/2018 | Pumphouses SC1, SC2 and SC5; A storm knocked out power to the wells and a fuse is open on the power pole near the old Lind electrical substation. Contacted Xcel Energy and they replaced the fuse and worked on other areas of the power line. Turned the pumps back on and observed normal operation.<br>Down time: 36.5 hours at each pumphouse. |
| 6/27-30/2018 | Pumphouse SC2; The flow meter was no longer totaling and the pump was not producing pressure. Turned the pump off. Likely the pump inlet is packed with iron bacteria.<br>Down time: 98.5 hours. |

**Pumphouse SC5**

| | |
|---|---|
| 11/17-18/2017 | Pumphouses B1, B13, B3, B4, B5, B6, B8, B9, SC1, SC2, SC5; Call from Time Communication that the TGRS was down. At the site, there was a power outage that ceased power to the entire site. Contacted Xcel Energy and they found a blown fuse in the power pole across County Road 10 from Scherer Brothers Lumber. They installed a new fuse and power was restored power. However, the power outage blew the two electric heaters in the treatment center and the electric heater in pumphouse SC1. It also shorted the electrical wire in the conduit between the breaker box and Pump 3 in the treatment center. Contacted Preferred Electric and they repaired the heaters and also replaced the electrical wire to Pump 3. Also, Blower 3 in the treatment center would not start. Replaced a blown fuse and restarted Blower 3. Blower 3 restarted normally.<br><br>Down time: B1 for 8 hours; B13, B4, B6 and B8 for 6.5 hours; B9, SC1 and SC5 for 7.5 hours; B3 and B5 for 4 hours; SC2 for 3 hours. |
| 2/20/2018 | Pumphouses SC1, SC2 and SC5; The lights were off on the well field panel. At the pumphouses, the pumps were off and the lights were dim. The same fuse was found to be open on the power pole near the old Lind electrical sub-station. Contacted Xcel Energy again and they responded. They thoroughly inspected the power lines and found a location near SC4 where the wind could possibly blow a loose power line into the power pole. They repaired the wire and installed new fuses at a number of locations. Restarted the pumps and observed normal operation.<br>Down time: 19 hours at SC1, 18.5 hours at SC2 and 16.5 hours at SC5. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 4/12/2018 | Pumphouses B5, B6, SC2 and SC5; The cold water flow meters required maintenance. Removed them, cleaned them with acid and reinstalled them. Observed normal operation of each flow meter following the work.<br>Down time: 2.5 hours at B5, 3.5 hours at B6, 3 hours at SC2 and 4 hours at SC5. |
| 4/28-29/2018 | Pumphouse SC5; The flow rate slowed overnight. Removed and cleaned the strainer screen and reset the pilot. Restarted the pump and observed normal operation.<br>Down time: 9 hours. |
| 5/4/2018 | Pumphouse SC5; The RPZ was venting out the overflow. Closed the ECV, turned the pump off and exercised the RPZ blow off valves. Turned the pump back on and the RPZ leaked. Contacted Jayhawk Mechanical and they repaired the leak. Turned the pump back on and observed normal operation.<br>Down time: 4 hours. |
| 5/5-7/2018 | Pumphouses SC1, SC2 and SC5; A storm knocked out power to the wells and a fuse is open on the power pole near the old Lind electrical substation. Contacted Xcel Energy and they replaced the fuse and worked on other areas of the power line. Turned the pumps back on and observed normal operation.<br>Down time: 36.5 hours at each pumphouse. |
| 5/14/2018 | Pumphouse SC5; The flow rate slowed overnight due to build-up of manganese in the ECV control piping. Flushed the control piping and cleaned and replaced the strainer screen. Reset the pilot to operating flow rate and pressure and observed normal operation.<br>Down time: 1.5 hours. |
| 7/13/2018 | Pumphouse SC5 - The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was running normally.<br>Down time: 1.5 hours. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 7/31/2018 | Pumphouses B13, B4, B6, B9, SC1 and SC5 - Turned the TGRS to perform troubleshooting on the PLC controls due to the B3, B4, B5 communication issues with the PLC. Found a bad common ground terminal on the B1 through B6 data line protector. Replaced the data line protector and restarted the TGRS. The communication issues continued and additional troubleshooting necessary.<br>Down time: 3 hours at B13, B9, SC1 and SC5. B4 and B6 had 1.5 hours of down time. |
| 8/25/2018 | Pumphouse SC5. The light was flashing on the well field panel. Reset the PLC and the light came back on steady. At the pumphouse, the pump was running normally.<br>Down time: 5 hours. |
| 9/13/2018 | Pumphouse SC5. The RPZ was venting out the overflow. Turned the pump off, flushed piping and exercised valves. Turned the pump on and opened and closed the ECV to actuate RPZ spring valve. The RPZ stopped leaking and normal operation was observed.<br>Down time: None. |
| 9/14/2018 | Pumphouse SC5. The light was flashing on the well field panel. Reset the PLC and the light came on steady. At the pumphouse, the pump was running normally.<br>Down time: 8 hours. |

**Treatment System**

| | |
|---|---|
| 10/18/2017 | Treatment System; Replaced the airflow pressure gauge on the blower inlet for tower 3.<br>Down time: None. |
| 10/27/2017 | Treatment System; The flow meter for pump 4 no longer totals correctly. Removed the flow meter from Pump 4 and switched it with the flow meter from Pump 3. Observed normal operation.<br>Down time: None. |
| 10/27/2017 | Treatment System; The ECV for pump 4 would not close on command. Installed a new solenoid valve in the control piping. Cycled the valve three times and observed normal operation.<br>Down time: None. |
| 11/5/2017 | Daylight savings time; Adjusted the spreadsheet accordingly to reflect the addition of one hour.<br>Down time: None. |
| 12/25/2017 | Christmas Day; The inspection was not performed. Meter readings were estimated.<br>Down time: None. |
| 1/1/2018 | The daily inspection was not performed due to the New Year's Day holiday. Meter readings were estimated.<br>Down time: None. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 3/6/2018 | Treatment System and Well Field; There was a snow storm last night. DK Concrete was on site and plowed snow.<br>Down time: None. |
| 4/15/2018 | Treatment system and well field; The inspection was not performed due to a snow storm. Meter readings were estimated.<br>Down time: None. |
| 4/19/2018 | Treatment System; ECV 4 would not close on command. Turned off pumphouses B9 and B6 to minimize well field cycling. Rebuilt the pilot and replaced the solenoid valve. Following the work, turned Pump 4 on and actuated ECV 4. ECV 4 did not close properly. Additional troubleshooting necessary.<br>Down time: 2 hours at B6 and 2 hours at B9. |
| 5/1/2018 | Treatment System; ECV 4 will not close on command. Installed a new seal kit in the pilot and replaced the solenoid body but the valve did not close. Likely a new 10-inch valve seal kit will need to be installed for the valve to close. Scheduled the installation.<br><br>Down time: None. |
| 5/8/2018 | Pumphouse Roads; Contracted JL Weber to repair the snow melt erosion ruts to the site roads.<br>Down time: None. |
| 5/8-9/2018 | Treatment System and Well Field; Preferred Electric performed the annual electrical inspection.<br>Down time: None. |
| 5/29/2018 | Treatment System and Well Field; Call from Time Communications - "TGRS Fail". At the Site, found the power was out to the treatment system. Found a fusible link open on a power pole west of Building 116. Contacted Xcel Energy and they responded. They replaced the fuse and found a dead raccoon near the power pole which was likely the cause of the power outage.<br>Down time: 1.5 hours at B4 and B9; 2 hours at B1; 2.5 hours at B13 and SC5; 14.5 hours at B6 and 20 hours at B5. |
| 6/8/2018 | Treatment System; ECV 4 no longer closes. Turned the pumps in B5 and B9 to off to stop the well field from cycling with only Pump 3 in the treatment system operating. Replaced the valve seals in ECV 4. Turned Pump 4 on and cycled ECV 4. Observed normal operation. Turned the pumps in B5 and B9 back on for normal operation.<br><br>Down time: 7 hours at B5 and 7.5 hours at B9. |
| 7/4/2018 | The daily inspection was not performed due to the Independence Day holiday. Meter readings were estimated.<br>Down time: None. |

**Appendix G.3**

**Maintenance Activities By Location**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| | |
|---|---|
| 7/8/2018 | Treatment System - The auto dialer backup battery was low. Replaced the auto dialer battery.<br>Down time: None. |
| 9/3/2018 | Labor Day holiday. No inspection was performed. Meter readings were estimated.<br>Down time: None. |

# APPENDIX H

## TGRS Chemical Data

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | |
|---|---|---|---|
| | **B1** | | |
| 03F302 | 11/17/87 | 1040 | |
| 03F302 | 12/15/87 | 2120 | |
| 03F302 | 01/12/88 | 2580 | |
| 03F302 | 04/28/88 | 2900 | |
| 03F302 | 07/19/88 | 4300 | |
| 03F302 | 10/21/88 | 4800 | |
| 03F302 | 03/16/89 | 5800 | |
| 03F302 | 04/20/89 | 4500 | |
| 03F302 | 07/19/89 | 2700 | |
| 03F302 | 10/24/89 | 2300 | |
| 03F302 | 01/18/90 | 2700 | 2100 duplicate |
| 03F302 | 05/08/90 | 1300 | |
| 03F302 | 07/13/90 | 1900 | 1900 duplicate |
| 03F302 | 12/19/90 | 1800 | |
| 03F302 | 03/19/91 | 1300 | |
| 03F302 | 06/05/91 | 1400 | |
| 03F302 | 09/05/91 | 1300 | |
| 03F302 | 12/04/91 | 1200 | |
| 03F302 | 03/06/92 | 1200 | |
| 03F302 | 06/05/92 | 890 | |
| 03F302 | 09/01/92 | 1100 | |
| 03F302 | 03/03/93 | 840 | |
| 03F302 | 09/15/93 | 860 | |
| 03F302 | 03/03/94 | 430 | |
| 03F302 | 09/07/94 | 520 | |
| 03F302 | 03/14/95 | 400 | 390 duplicate |
| 03F302 | 09/11/95 | 360 | 360 duplicate |
| 03F302 | 06/06/96 | 320 | |
| 03F302 | 09/10/96 | 380 | |
| 03F302 | 12/11/96 | 340 | |
| 03F302 | 06/09/97 | 260 | |
| 03F302 | 12/08/97 | 250 | 240 duplicate |
| 03F302 | 06/08/98 | 250 | |
| 03F302 | 12/02/98 | 300 | |
| 03F302 | 06/17/99 | 310 | |
| 03F302 | 12/07/99 | 275 | |
| 03F302 | 06/09/00 | 840 | |
| 03F302 | 12/13/00 | 180 | 180 duplicate |
| 03F302 | 06/05/01 | 180 | |
| 03F302 | 12/21/01 | 220 | 220 dup |
| 03F302 | 06/04/02 | 180 | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | | |
|---|---|---|---|---|
| 03F302 | 12/13/02 | 190 | | |
| 03F302 | 06/10/03 | 190 | | |
| 03F302 | 12/18/03 | 150 | | |
| 03F302 | 06/15/04 | 130 | 120 duplicate | |
| 03F302 | 12/01/04 | 110 | | |
| 03F302 | 06/03/05 | 120 | | |
| 03F302 | 12/20/05 | 79 | | |
| 03F302 | 06/06/06 | 100 | | |
| 03F302 | 12/04/06 | 98 | | |
| 03F302 | 6/4/2007 | 110 | | |
| 03F302 | 12/13/07 | 110 | 110 dup | |
| 03F302 | 6/11/2008 | 130 | | |
| 03F302 | 12/03/08 | 93 | | |
| 03F302 | 6/3/2009 | 89 | | |
| 03F302 | 12/08/09 | 67 | | |
| 03F302 | 6/1/2010 | 70 | | |
| 03F302 | 12/06/10 | 84 | | |
| 03F302 | 6/3/2011 | 86 | | |
| 03F302 | 12/05/11 | 99 | | |
| 03F302 | 5/29/2012 | 98 | | |
| 03F302 | 12/13/12 | 91 | | |
| 03F302 | 6/14/2013 | 68 | | |
| 03F302 | 12/03/13 | 55 | | |
| 03F302 | 6/3/2014 | 54 | | |
| 03F302 | 12/4/2014 | 38 | | |
| 03F302 | 6/5/2015 | 35 | 34 dup | |
| 03F302 | 12/8/2015 | 41 | | |
| 03F302 | 6/6/2016 | 52 | 51 dup | |
| 03F302 | 12/7/2016 | 53 | | |
| 03F302 | 6/7/2017 | 56 | | |
| 03F302 | 12/7/2017 | 80 | | |
| 03F302 | 6/8/2018 | 46 | 45 dup | 74% |
| | **B2** | | | |
| 03F303 | 11/17/87 | 190 | | |
| 03F303 | 12/15/87 | 282 | | |
| 03F303 | 01/12/88 | 375 | | |
| 03F303 | 04/28/88 | 274 | | |
| 03F303 | 07/19/88 | 700 | | |
| 03F303 | 10/21/88 | 1000 | | |
| 03F303 | 03/16/89 | 1200 | | |
| 03F303 | 04/20/89 | 1100 | | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | |
|---|---|---|---|
| 03F303 | 07/19/89 | 860 | |
| 03F303 | 10/24/89 | 850 | |
| 03F303 | 01/18/90 | 650 | |
| 03F303 | 05/08/90 | 700 | |
| 03F303 | 07/13/90 | 510 | |
| 03F303 | 12/19/90 | 320 | |
| 03F303 | 03/19/91 | 380 | |
| 03F303 | 06/05/91 | 350 | |
| 03F303 | 09/05/91 | 360 | |
| 03F303 | 12/04/91 | 360 | |
| 03F303 | 03/06/92 | 400 | |
| 03F303 | 06/05/92 | 390 | |
| 03F303 | 09/01/92 | 430 | |
| 03F303 | 03/03/93 | 340 | |
| 03F303 | 09/15/93 | 390 | 350 duplicate |
| 03F303 | 03/03/94 | 250 | |
| 03F303 | 09/07/94 | 180 | 160 duplicate |
| 03F303 | 03/14/95 | 120 | |
| 03F303 | 09/11/95 | 140 | |
| 03F303 | 06/06/96 | 106 | |
| 03F303 | 09/10/96 | 135 | |
| 03F303 | 12/11/96 | 87.9 | |
| 03F303 | 06/09/97 | 61.5 | |
| 03F303 | 12/08/97 | 61.6 | <0.56 duplicate |
| 03F303 | 06/08/98 | 57 | |
| 03F303 | 12/02/98 | 65 | |
| 03F303 | 06/17/99 | 10.5 | |
| 03F303 | 12/07/99 | 60 | |
| 03F303 | 06/09/00 | 58 | |
| 03F303 | 12/14/00 | 40 | |
| 03F303 | 06/05/01 | 37 | |
| 03F303 | 12/21/01 | 47 | |
| 03F303 | 06/04/02 | 44 | |
| 03F303 | 12/16/02 | 51 | |
| 03F303 | 06/11/03 | 49 | 47 duplicate |
| 03F303 | 12/19/03 | 34 | |
| 03F303 | 06/15/04 | 35 | 33 duplicate |
| 03F303 | 06/03/05 | 34 | |
| 03F303 | 06/06/06 | 30 | |
| 03F303 | 06/05/07 | 25 | |
| 03F303 | 06/18/08 | 22 | |
| 03F303 | 06/03/09 | 25 | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | | |
|---|---|---|---|---|
| 03F303 | 06/01/10 | 30 | | |
| 03F303 | 06/03/11 | 25 | | |
| 03F303 | 05/29/12 | 28 | | |
| 03F303 | 06/14/13 | 29 | 28 duplicate | |
| 03F303 | 06/03/14 | 27 | | |
| 03F303 | 06/05/15 | 27 | | |
| 03F303 | 06/06/16 | 26 | | |
| 03F303 | 06/08/17 | 27 | | |
| 03F303 | 06/15/18 | 23 | | 43% |
| | **B3** | | | |
| 03F304 | 11/17/87 | 5.1 | | |
| 03F304 | 12/15/87 | 8.33 | | |
| 03F304 | 01/12/88 | 8.2 | | |
| 03F304 | 04/28/88 | 6.62 | | |
| 03F304 | 07/19/88 | 9.5 | | |
| 03F304 | 03/16/89 | 6 | | |
| 03F304 | 04/20/89 | 11 | | |
| 03F304 | 07/19/89 | 4.6 | | |
| 03F304 | 10/24/89 | 5.4 | | |
| 03F304 | 01/18/90 | 5.1 | | |
| 03F304 | 05/08/90 | 6.7 | | |
| 03F304 | 07/13/90 | 7.3 | | |
| 03F304 | 12/19/90 | 5.41 | | |
| 03F304 | 03/19/91 | 8.34 | | |
| 03F304 | 06/05/91 | 9.42 | 8 duplicate | |
| 03F304 | 09/05/91 | 7.83 | | |
| 03F304 | 12/04/91 | 7.28 | | |
| 03F304 | 03/06/92 | 7.3 | | |
| 03F304 | 06/05/92 | 8.28 | 7.52 duplicate | |
| 03F304 | 09/01/92 | 7.33 | 6.67 duplicate | |
| 03F304 | 03/03/93 | 8.84 | 7.48 duplicate | |
| 03F304 | 09/15/93 | 12.1 | | |
| 03F304 | 03/03/94 | 17.6 | | |
| 03F304 | 09/07/94 | 31.5 | | |
| 03F304 | 03/14/95 | 19.5 | | |
| 03F304 | 09/11/95 | 27.4 | | |
| 03F304 | 06/06/96 | 20.1 | | |
| 03F304 | 09/10/96 | 27.1 | | |
| 03F304 | 12/11/96 | 22 | | |
| 03F304 | 06/09/97 | 18.7 | | |
| 03F304 | 12/08/97 | 18.6 | | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | | |
|---|---|---|---|---|
| 03F304 | 06/08/98 | 22.5 | | |
| 03F304 | 12/02/98 | 11 | 11 Duplicate | |
| 03F304 | 06/17/99 | 67 | | |
| 03F304 | 12/07/99 | 6.8 | | |
| 03F304 | 06/09/00 | 8.3 | | |
| 03F304 | 12/14/00 | 7.8 | | |
| 03F304 | 06/05/01 | 8.7 | | |
| 03F304 | 12/21/01 | 1.9 | | |
| 03F304 | 06/04/02 | 5.3 | 5.1 dup | |
| 03F304 | 12/13/02 | 5.1 | | |
| 03F304 | 06/10/03 | 7.1 | | |
| 03F304 | 12/18/03 | 5.8 | | |
| 03F304 | 06/15/04 | 6.2 | | |
| 03F304 | 12/01/04 | 6.9 | | |
| 03F304 | 06/03/05 | 6.7 | 6.3 dup | |
| 03F304 | 12/20/05 | 5.8 | | |
| 03F304 | 06/06/06 | 7.8 | | |
| 03F304 | 12/04/06 | 6.8 | | |
| 03F304 | 06/04/07 | 6.5 | | |
| 03F304 | 12/13/07 | 5.7 | | |
| 03F304 | 06/11/08 | 6.4 | | |
| 03F304 | 12/03/08 | 5.7 | | |
| 03F304 | 06/03/09 | 4.6 | | |
| 03F304 | 12/08/09 | 3.9 | | |
| 03F304 | 06/01/10 | 4.1 | | |
| 03F304 | 12/06/10 | 4.3 | | |
| 03F304 | 06/03/11 | 3.9 | | |
| 03F304 | 12/05/11 | 3.6 | | |
| 03F304 | 05/29/12 | 2.9 | | |
| 03F304 | 12/13/12 | 4.1 | | |
| 03F304 | 06/14/13 | 3.3 | | |
| 03F304 | 12/03/13 | 3.2 | | |
| 03F304 | 06/03/14 | 3.4 | | |
| 03F304 | 12/04/14 | 2.6 | | |
| 03F304 | 06/05/15 | 2.4 | | |
| 03F304 | 12/08/15 | 2.2 | | |
| 03F304 | 06/06/16 | 2.6 | | |
| 03F304 | 12/07/16 | 3.1 | | |
| 03F304 | 06/07/17 | 3.2 | | |
| 03F304 | 12/07/17 | 3.5 | | |
| 03F304 | 06/08/18 | 3.8 | | 51% |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | |
|---|---|---|---|
| | **B4** | | |
| 03F305 | 11/17/87 | 22.9 | |
| 03F305 | 12/15/87 | 54 | |
| 03F305 | 01/12/88 | 61 | |
| 03F305 | 04/28/88 | 26.3 | |
| 03F305 | 07/19/88 | 38 | |
| 03F305 | 03/16/89 | 68 | |
| 03F305 | 04/20/89 | 100 | |
| 03F305 | 07/19/89 | 140 | |
| 03F305 | 10/23/89 | 430 | |
| 03F305 | 01/18/90 | 590 | |
| 03F305 | 05/08/90 | 1200 | 1100 duplicate |
| 03F305 | 07/13/90 | 1600 | |
| 03F305 | 12/19/90 | 1800 | |
| 03F305 | 03/19/91 | 2100 | 2100 duplicate |
| 03F305 | 06/05/91 | 2100 | |
| 03F305 | 09/05/91 | 2900 | 2400 duplicate |
| 03F305 | 12/04/91 | 2800 | |
| 03F305 | 03/06/92 | 2600 | |
| 03F305 | 06/05/92 | 2700 | |
| 03F305 | 09/01/92 | 3000 | |
| 03F305 | 03/03/93 | 2600 | |
| 03F305 | 09/15/93 | 2700 | |
| 03F305 | 03/03/94 | 2800 | |
| 03F305 | 09/07/94 | 2600 | |
| 03F305 | 03/14/95 | 1900 | |
| 03F305 | 09/11/95 | 2300 | |
| 03F305 | 06/06/96 | 1400 | |
| 03F305 | 09/10/96 | 2100 | |
| 03F305 | 12/11/96 | 1800 | |
| 03F305 | 06/09/97 | 1800 | 1500 duplicate |
| 03F305 | 12/08/97 | 1400 | |
| 03F305 | 06/08/98 | 1700 | |
| 03F305 | 12/02/98 | 1000 | |
| 03F305 | 06/17/99 | 1000 | |
| 03F305 | 12/07/99 | 780 | |
| 03F305 | 06/09/00 | 630 | |
| 03F305 | 12/14/00 | 490 | |
| 03F305 | 06/05/01 | 500 | |
| 03F305 | 12/21/01 | 530 | |
| 03F305 | 06/04/02 | 420 | |
| 03F305 | 12/13/02 | 440 | 420 duplicate |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | | |
|---|---|---|---|---|
| 03F305 | 06/10/03 | 520 | | |
| 03F305 | 12/18/03 | 350 | | |
| 03F305 | 06/15/04 | 320 | <1 duplicate | |
| 03F305 | 12/01/04 | 300 | | |
| 03F305 | 06/03/05 | 260 | | |
| 03F305 | 12/20/05 | 220 | 220 duplicate | |
| 03F305 | 06/06/06 | 220 | | |
| 03F305 | 12/04/06 | 180 | 180 duplicate | |
| 03F305 | 06/04/07 | 170 | | |
| 03F305 | 12/13/07 | 190 | | |
| 03F305 | 06/11/08 | 160 | | |
| 03F305 | 12/03/08 | 170 | 170 duplicate | |
| 03F305 | 06/03/09 | 130 | | |
| 03F305 | 12/08/09 | 140 | | |
| 03F305 | 06/01/10 | 140 | | |
| 03F305 | 12/06/10 | 140 | | |
| 03F305 | 06/03/11 | 120 | | |
| 03F305 | 12/05/11 | 120 | | |
| 03F305 | 05/29/12 | 110 | | |
| 03F305 | 12/13/12 | 120 | | |
| 03F305 | 06/14/13 | 110 | | |
| 03F305 | 12/03/13 | 100 | | |
| 03F305 | 06/03/14 | 100 | | |
| 03F305 | 12/04/14 | 88 | | |
| 03F305 | 06/05/15 | 86 | | |
| 03F305 | 12/08/15 | 89 | | |
| 03F305 | 06/06/16 | 85 | | |
| 03F305 | 12/07/16 | 87 | | |
| 03F305 | 06/06/17 | 81 | | |
| 03F305 | 12/07/17 | 92 | | |
| 03F305 | 06/08/18 | 65 | 80 Duplicate | 87% |

| | **B5** | |
|---|---|---|
| 03F306 | 11/17/87 | 1500 |
| 03F306 | 12/15/87 | 2130 |
| 03F306 | 01/12/88 | 2420 |
| 03F306 | 04/28/88 | 530 |
| 03F306 | 07/19/88 | 2920 |
| 03F306 | 10/21/88 | 1400 |
| 03F306 | 03/16/89 | 2800 |
| 03F306 | 04/20/89 | 2700 |
| 03F306 | 07/19/89 | 2200 |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | |
|---|---|---|---|
| 03F306 | 10/23/89 | 2700 | |
| 03F306 | 01/18/90 | 3300 | |
| 03F306 | 05/08/90 | 4200 | |
| 03F306 | 07/13/90 | 4900 | 4700 duplicate |
| 03F306 | 12/19/90 | 6400 | |
| 03F306 | 03/19/91 | 7000 | |
| 03F306 | 06/05/91 | 6400 | |
| 03F306 | 09/05/91 | 7200 | |
| 03F306 | 12/04/91 | 7500 | |
| 03F306 | 03/06/92 | 6900 | |
| 03F306 | 06/05/92 | 6400 | |
| 03F306 | 09/01/92 | 8200 | |
| 03F306 | 03/03/93 | 7300 | |
| 03F306 | 09/15/93 | 7500 | |
| 03F306 | 03/03/94 | 5600 | 4900 duplicate |
| 03F306 | 09/07/94 | 4900 | |
| 03F306 | 03/14/95 | 3400 | |
| 03F306 | 09/11/95 | 4300 | |
| 03F306 | 06/06/96 | 3100 | |
| 03F306 | 09/10/96 | 3700 | |
| 03F306 | 12/11/96 | 3100 | |
| 03F306 | 06/09/97 | 2400 | |
| 03F306 | 12/08/97 | 1700 | |
| 03F306 | 06/08/98 | 1600 | |
| 03F306 | 12/02/98 | 970 | |
| 03F306 | 06/17/99 | 950 | |
| 03F306 | 12/07/99 | 750 | 750 duplicate |
| 03F306 | 06/09/00 | 550 | |
| 03F306 | 12/13/00 | 410 | |
| 03F306 | 06/05/01 | 400 | |
| 03F306 | 12/21/01 | 420 | |
| 03F306 | 06/04/02 | 340 | |
| 03F306 | 12/13/02 | 310 | |
| 03F306 | 06/10/03 | 400 | |
| 03F306 | 12/18/03 | 260 | |
| 03F306 | 06/15/04 | 260 | |
| 03F306 | 12/01/04 | 240 | |
| 03F306 | 06/03/05 | 210 | |
| 03F306 | 12/20/05 | 190 | |
| 03F306 | 06/06/06 | 230 | |
| 03F306 | 12/04/06 | 180 | |
| 03F306 | 06/04/07 | 170 | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | | |
|---|---|---|---|---|
| 03F306 | 12/13/07 | 150 | | |
| 03F306 | 06/11/08 | 170 | | |
| 03F306 | 12/03/08 | 150 | | |
| 03F306 | 06/03/09 | 120 | | |
| 03F306 | 12/08/09 | 130 | | |
| 03F306 | 06/01/10 | 130 | | |
| 03F306 | 12/06/10 | 120 | | |
| 03F306 | 06/03/11 | 100 | | |
| 03F306 | 12/05/11 | 110 | 110 duplicate | |
| 03F306 | 05/29/12 | 100 | | |
| 03F306 | 12/13/12 | 110 | 110 duplicate | |
| 03F306 | 06/14/13 | 110 | | |
| 03F306 | 12/03/13 | 85 | | |
| 03F306 | 06/03/14 | 87 | | |
| 03F306 | 12/04/14 | 76 | | |
| 03F306 | 06/04/15 | 72 | | |
| 03F306 | 12/08/15 | 82 | | |
| 03F306 | 06/09/16 | 85 | | |
| 03F306 | 12/07/16 | 75 | | |
| 03F306 | 06/06/17 | 75 | | |
| 03F306 | 12/07/17 | 79 | 79 Dup | |
| 03F306 | 06/11/18 | 63 | | 85% |
| | **B6** | | | |
| 03F307 | 11/17/87 | 2370 | | |
| 03F307 | 12/15/87 | 3270 | | |
| 03F307 | 01/12/88 | 3300 | | |
| 03F307 | 04/28/88 | 3400 | | |
| 03F307 | 07/19/88 | 2860 | | |
| 03F307 | 10/21/88 | 3200 | | |
| 03F307 | 03/16/89 | 4170 | | |
| 03F307 | 04/20/89 | 3600 | | |
| 03F307 | 07/19/89 | 2400 | 2400 duplicate | |
| 03F307 | 10/23/89 | 3300 | | |
| 03F307 | 01/19/90 | 2700 | | |
| 03F307 | 05/08/90 | 3200 | | |
| 03F307 | 07/13/90 | 2800 | | |
| 03F307 | 12/19/90 | 3500 | 2900 , 3400 duplicate | |
| 03F307 | 03/19/91 | 2900 | | |
| 03F307 | 06/06/91 | 2500 | | |
| 03F307 | 09/05/91 | 2700 | | |
| 03F307 | 12/04/91 | 2700 | | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | |
|---|---|---|---|
| 03F307 | 03/06/92 | 2700 | 2500 duplicate |
| 03F307 | 06/05/92 | 2400 | |
| 03F307 | 09/01/92 | 2600 | |
| 03F307 | 03/03/93 | 2100 | |
| 03F307 | 09/15/93 | 2400 | |
| 03F307 | 03/03/94 | 1600 | |
| 03F307 | 09/07/94 | 1400 | |
| 03F307 | 03/14/95 | 770 | |
| 03F307 | 09/11/95 | 840 | |
| 03F307 | 06/06/96 | 670 | |
| 03F307 | 09/10/96 | 640 | |
| 03F307 | 12/11/96 | 600 | |
| 03F307 | 09/06/97 | 198 | |
| 03F307 | 12/08/97 | 380 | |
| 03F307 | 06/08/98 | 450 | |
| 03F307 | 12/02/98 | 325 | 300 Duplicate |
| 03F307 | 06/17/99 | 340 | <1 Duplicate |
| 03F307 | 12/07/99 | 290 | |
| 03F307 | 06/09/00 | 250 | 240 duplicate |
| 03F307 | 12/13/00 | 230 | |
| 03F307 | 06/05/01 | 200 | |
| 03F307 | 12/20/01 | 240 | |
| 03F307 | 06/04/02 | 190 | |
| 03F307 | 12/13/02 | 180 | 180 duplicate |
| 03F307 | 06/10/03 | 170 | |
| 03F307 | 12/18/03 | 130 | |
| 03F307 | 06/15/04 | 130 | |
| 03F307 | 12/01/04 | 120 | |
| 03F307 | 06/03/05 | 110 | |
| 03F307 | 12/20/05 | 95 | |
| 03F307 | 06/06/06 | 120 | |
| 03F307 | 12/04/06 | 100 | |
| 03F307 | 06/04/07 | 96 | |
| 03F307 | 12/13/07 | 85 | |
| 03F307 | 06/11/08 | 93 | |
| 03F307 | 12/03/08 | 90 | |
| 03F307 | 06/03/09 | 72 | |
| 03F307 | 12/08/09 | 75 | |
| 03F307 | 06/01/10 | 66 | |
| 03F307 | 12/06/10 | 58 | |
| 03F307 | 06/03/11 | 49 | |
| 03F307 | 12/05/11 | 51 | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | | |
|---|---|---|---|---|
| 03F307 | 05/29/12 | 45 | | |
| 03F307 | 12/13/12 | 48 | | |
| 03F307 | 06/14/13 | 46 | | |
| 03F307 | 12/03/13 | 40 | | |
| 03F307 | 06/03/14 | 39 | | |
| 03F307 | 12/04/14 | 32 | | |
| 03F307 | 06/04/15 | 29 | | |
| 03F307 | 12/08/15 | 29 | 28 Duplicate | |
| 03F307 | 06/06/16 | 27 | | |
| 03F307 | 12/07/16 | 26 | | |
| 03F307 | 06/06/17 | 22 | 22 Duplicate | |
| 03F307 | 12/07/17 | 31 | | |
| 03F307 | 06/08/18 | 25 | | 89% |
| | **B7** | | | |
| 03F308 | 03/16/89 | 75 | | |
| 03F308 | 04/20/89 | 44 | | |
| 03F308 | 07/19/89 | 29 | | |
| 03F308 | 10/23/89 | 32 | | |
| 03F308 | 01/19/90 | 22 | | |
| 03F308 | 05/08/90 | 23 | | |
| 03F308 | 07/13/90 | 20 | | |
| 03F308 | 12/19/90 | 17.4 | 16.3 duplicate | |
| 03F308 | 03/19/91 | 13.2 | | |
| 03F308 | 06/06/91 | 8.22 | | |
| 03F308 | 09/05/91 | 12.7 | | |
| 03F308 | 12/04/91 | 10.7 | | |
| 03F308 | 03/06/92 | 11 | | |
| 03F308 | 06/05/92 | 8.52 | | |
| 03F308 | 09/01/92 | 9.2 | | |
| 03F308 | 03/03/93 | 9.73 | | |
| 03F308 | 09/15/93 | 7.78 | | |
| 03F308 | 03/03/94 | 5.41 | | |
| 03F308 | 09/07/94 | 5.21 | | |
| 03F308 | 03/14/95 | 3.18 | | |
| 03F308 | 09/11/95 | 3.56 | | |
| 03F308 | 06/06/96 | 3.04 | | |
| 03F308 | 09/10/96 | 2.93 | | |
| 03F308 | 12/11/96 | 1.87 | | |
| 03F308 | 06/09/97 | 1.32 | | |
| 03F308 | 12/08/97 | 1.9 | | |
| 03F308 | 06/08/98 | 2 | | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | | |
|---|---|---|---|---|
| 03F308 | 12/02/98 | 1.9 | | |
| 03F308 | 06/17/99 | 1.8 | | |
| 03F308 | 12/07/99 | 1.5 | | |
| 03F308 | 06/09/00 | 1.5 | | |
| 03F308 | 12/14/00 | 1.1 | | |
| 03F308 | 06/05/01 | 1.2 | | |
| 03F308 | 12/20/01 | 1.3 | | |
| 03F308 | 06/04/02 | 1.2 | | |
| 03F308 | 12/13/02 | 1.2 | | |
| 03F308 | 06/10/03 | 1.7 | | |
| 03F308 | 12/19/03 | 1.3 | | |
| 03F308 | 06/15/04 | 1.7 | | |
| 03F308 | 06/03/05 | 1.9 | | |
| 03F308 | 06/06/06 | 2.4 | | |
| 03F308 | 06/04/07 | 2.3 | | |
| 03F308 | 06/03/09 | 2 | | |
| 03F308 | 06/03/11 | 2.2 | | |
| 03F308 | 06/25/13 | 2.4 | | |
| 03F308 | 06/04/15 | 2.2 | | |
| 03F308 | 07/21/16 | 1.7 | | |
| 03F308 | 06/15/18 | 1.8 | | -64% |
| | **B11** | | | |
| 03F312 | 12/19/88 | | | |
| 03F312 | 03/16/89 | 1.3 | | |
| 03F312 | 04/20/89 | 5 | | |
| 03F312 | 07/19/89 | 10 | | |
| 03F312 | 10/24/89 | 31 | | |
| 03F312 | 01/18/90 | 26 | | |
| 03F312 | 05/08/90 | 22 | | |
| 03F312 | 07/13/90 | 20 | | |
| 03F312 | 12/19/90 | 17.9 | | |
| 03F312 | 03/19/91 | 17 | | |
| 03F312 | 06/05/91 | 18.4 | | |
| 03F312 | 09/05/91 | 21.8 | | |
| 03F312 | 12/04/91 | 18.1 | | |
| 03F312 | 03/06/92 | 17.6 | 16.8 duplicate | |
| 03F312 | 06/05/92 | 19.3 | | |
| 03F312 | 09/01/92 | 20.6 | | |
| 03F312 | 03/03/93 | 16.7 | | |
| 03F312 | 09/15/93 | 14.9 | | |
| 03F312 | 03/03/94 | 16.1 | | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | |
|---|---|---|---|
| 03F312 | 09/07/94 | 13.6 | |
| 03F312 | 03/14/95 | 8.2 | |
| 03F312 | 09/11/95 | 9.46 | |
| 03F312 | 06/06/96 | 4.05 | 3.96 duplicate |
| 03F312 | 09/10/96 | 7.47 | |
| 03F312 | 12/11/96 | 9.23 | 7.03 duplicate |
| 03F312 | 06/09/97 | 4.62 | |
| 03F312 | 12/08/97 | 4.89 | |
| 03F312 | 06/08/98 | 5.55 | |
| 03F312 | 12/01/98 | 4.9 | |
| 03F312 | 06/17/99 | 6 | |
| 03F312 | 12/07/99 | 6 | |
| 03F312 | 06/09/00 | 6 | |
| 03F312 | 12/13/00 | 4.8 | |
| 03F312 | 06/05/01 | 4.7 | |
| 03F312 | 12/21/01 | 3 | |
| 03F312 | 06/04/02 | 3.9 | |
| 03F312 | 12/13/02 | 4.2 | |
| 03F312 | 06/10/03 | 4.6 | |
| 03F312 | 12/18/03 | 3.3 | 3.1 duplicate |
| 03F312 | 06/15/04 | 2.8 | |
| 03F312 | 12/01/04 | 3.2 | |
| 03F312 | 06/03/05 | 3.2 | <1 dup |
| 03F312 | 12/20/05 | 1.9 | |
| 03F312 | 06/06/06 | 2.3 | |
| 03F312 | 12/04/06 | 2.1 | |
| 03F312 | 06/04/07 | 2.4 | |
| 03F312 | 12/13/07 | 1.9 | |
| 03F312 | 06/11/08 | 1.8 | |
| 03F312 | 12/03/08 | 1.6 | |
| 03F312 | 06/03/09 | 1.5 | |
| 03F312 | 12/08/09 | 1.5 | |
| 03F312 | 06/01/10 | 1.6 | |
| 03F312 | 12/06/10 | 1.7 | |
| 03F312 | 06/03/11 | 1.4 | |
| 03F312 | 12/05/11 | 1.6 | |
| 03F312 | 05/29/12 | 1.5 | |
| 03F312 | 12/13/12 | 1.6 | |
| 03F312 | 06/14/13 | 0.78 | |
| 03F312 | 12/03/13 | 0 | |
| 03F312 | 06/03/14 | 0 | |
| 03F312 | 12/31/14 | 0 | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | | |
|---|---|---|---|---|
| 03F312 | 06/05/15 | 0 | | |
| 03F312 | 12/08/15 | 0 | | |
| 03F312 | 06/06/16 | 0 | | |
| 03F312 | 06/08/17 | 0 | | |
| 03F312 | 06/15/18 | 0 | | 100% |
| | **B13** | | | |
| 03F319 | 12/13/02 | 34 | | |
| 03F319 | 02/19/03 | 100 | | |
| 03F319 | 03/05/03 | 150 | | |
| 03F319 | 04/10/03 | 130 | | |
| 03F319 | 05/08/03 | 200 | | |
| 03F319 | 06/10/03 | 300 | 290 duplicate | |
| 03F319 | 07/02/03 | 240 | | |
| 03F319 | 8/13/03 | 320 | | |
| 03F319 | 9/9/03 | 240 | | |
| 03F319 | 12/18/03 | 370 | | |
| 03F319 | 6/15/04 | 280 | | |
| 03F319 | 12/1/04 | 230 | | |
| 03F319 | 06/03/05 | 170 | | |
| 03F319 | 12/20/05 | 160 | | |
| 03F319 | 06/06/06 | 150 | | |
| 03F319 | 12/04/06 | 150 | | |
| 03F319 | 07/03/07 | 130 | | |
| 03F319 | 12/13/07 | 160 | | |
| 03F319 | 06/11/08 | 170 | | |
| 03F319 | 12/03/08 | 140 | | |
| 03F319 | 06/03/09 | 200 | | |
| 03F319 | 12/08/09 | 180 | | |
| 03F319 | 06/01/10 | 200 | | |
| 03F319 | 12/06/10 | 190 | | |
| 03F319 | 06/03/11 | 110 | | |
| 03F319 | 12/05/11 | 97 | | |
| 03F319 | 05/29/12 | 150 | | |
| 03F319 | 12/13/12 | 260 | | |
| 03F319 | 06/14/13 | 230 | | |
| 03F319 | 12/03/13 | 200 | | |
| 03F319 | 06/03/14 | 140 | | |
| 03F319 | 12/04/14 | 120 | | |
| 03F319 | 06/05/15 | 110 | | |
| 03F319 | 12/08/15 | 100 | 100 Duplicate | |
| 03F319 | 06/06/16 | 130 | | |

**Appendix H.1**

## TRCLE Concentrations in TGRS Extraction Wells

| Well | Date | | | |
|---|---|---|---|---|
| 03F319 | 12/07/16 | 76 | | |
| 03F319 | 06/07/17 | 55 | | |
| 03F319 | 12/07/17 | 160 | 160 Dup | |
| 03F319 | 06/08/18 | 110 | | 70% |
| | **SC1** | | | |
| 03U301 | 03/16/89 | 2750 | | |
| 03U301 | 04/20/89 | 1100 | | |
| 03U301 | 07/19/89 | 1100 | | |
| 03U301 | 10/24/89 | 3000 | | |
| 03U301 | 01/18/90 | 1700 | | |
| 03U301 | 05/08/90 | 57 | | |
| 03U301 | 07/13/90 | 1200 | | |
| 03U301 | 12/19/90 | 1300 | | |
| 03U301 | 03/19/91 | 1100 | | |
| 03U301 | 06/04/91 | 1000 | | |
| 03U301 | 09/05/91 | 1200 | | |
| 03U301 | 09/05/91 | 9.14 | | |
| 03U301 | 12/04/91 | 1200 | | |
| 03U301 | 03/06/92 | 1200 | | |
| 03U301 | 06/05/92 | 1200 | | |
| 03U301 | 09/01/92 | 1400 | | |
| 03U301 | 03/03/93 | 1600 | 1500 duplicate | |
| 03U301 | 09/15/93 | 1400 | | |
| 03U301 | 03/03/94 | 1800 | 1800 duplicate | |
| 03U301 | 09/07/94 | 1800 | | |
| 03U301 | 03/14/95 | 780 | | |
| 03U301 | 09/11/95 | 1300 | | |
| 03U301 | 06/12/96 | 1200 | | |
| 03U301 | 12/11/96 | 1500 | | |
| 03U301 | 06/09/97 | 1100 | 910 duplicate | |
| 03U301 | 12/08/97 | 1000 | | |
| 03U301 | 06/08/98 | 1200 | | |
| 03U301 | 12/01/98 | 940 | | |
| 03U301 | 06/17/99 | 970 | | |
| 03U301 | 12/07/99 | 850 | | |
| 03U301 | 06/09/00 | 850 | | |
| 03U301 | 12/13/00 | 580 | | |
| 03U301 | 06/05/01 | 650 | | |
| 03U301 | 12/20/01 | 1100 | | |
| 03U301 | 06/04/02 | 860 | | |
| 03U301 | 12/13/02 | 1000 | | |

## Appendix H.1

## TRCLE Concentrations in TGRS Extraction Wells

| Well | Date | | | |
|---|---|---|---|---|
| 03U301 | 06/11/03 | 1100 | | |
| 03U301 | 12/19/03 | 960 | | |
| 03U301 | 06/15/04 | 900 | | |
| 03U301 | 12/01/04 | 860 | | |
| 03U301 | 06/03/05 | 880 | | |
| 03U301 | 12/20/05 | 700 | | |
| 03U301 | 06/06/06 | 710 | | |
| 03U301 | 12/04/06 | 720 | | |
| 03U301 | 06/04/07 | 750 | | |
| 03U301 | 12/13/07 | 800 | | |
| 03U301 | 06/11/08 | 700 | | |
| 03U301 | 12/03/08 | 820 | | |
| 03U301 | 06/03/09 | 670 | | |
| 03U301 | 12/08/09 | 610 | | |
| 03U301 | 06/01/10 | 740 | | |
| 03U301 | 12/06/10 | 750 | | |
| 03U301 | 06/03/11 | 590 | | |
| 03U301 | 12/05/11 | 860 | | |
| 03U301 | 05/29/12 | 830 | 790 duplicate | |
| 03U301 | 12/13/12 | 790 | | |
| 03U301 | 06/14/13 | 920 | | |
| 03U301 | 12/03/13 | 990 | | |
| 03U301 | 06/03/14 | 920 | | |
| 03U301 | 12/04/14 | 970 | | |
| 03U301 | 06/05/15 | 940 | | |
| 03U301 | 12/08/15 | 1000 | | |
| 03U301 | 06/06/16 | 1700 | | |
| 03U301 | 12/07/16 | 3600 | | |
| 03U301 | 06/07/17 | 2600 | | |
| 03U301 | 12/07/17 | 2500 | | |
| 03U301 | 06/08/18 | 1400 | | -141% |
| | **SC2** | | | |
| 03U314 | 01/05/89 | 37000 | | |
| 03U314 | 03/16/89 | 12000 | | |
| 03U314 | 04/20/89 | 11000 | | |
| 03U314 | 07/19/89 | 8900 | | |
| 03U314 | 10/24/89 | 8600 | | |
| 03U314 | 01/19/90 | 6500 | | |
| 03U314 | 05/08/90 | 6500 | | |
| 03U314 | 07/19/90 | 6300 | | |
| 03U314 | 12/19/90 | 6200 | | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | |
|---|---|---|---|
| 03U314 | 03/19/91 | 5800 | 5800 duplicate |
| 03U314 | 06/05/91 | 6000 | |
| 03U314 | 09/05/91 | 5400 | |
| 03U314 | 12/04/91 | 7300 | 7100 duplicate |
| 03U314 | 03/06/92 | 4700 | |
| 03U314 | 06/05/92 | 4300 | |
| 03U314 | 09/01/92 | 4900 | |
| 03U314 | 03/03/93 | 2600 | |
| 03U314 | 09/15/93 | 1600 | 1500 duplicate |
| 03U314 | 03/03/94 | 1300 | |
| 03U314 | 09/07/94 | 1100 | |
| 03U314 | 03/14/95 | 670 | |
| 03U314 | 09/11/95 | 600 | |
| 03U314 | 06/06/96 | 500 | MIR |
| 03U314 | 09/10/96 | 470 | 470 duplicate |
| 03U314 | 12/11/96 | 440 | |
| 03U314 | 06/09/97 | 240 | |
| 03U314 | 12/08/97 | 218 | |
| 03U314 | 06/08/98 | 191 | |
| 03U314 | 12/01/98 | 190 | |
| 03U314 | 06/17/99 | 190 | |
| 03U314 | 12/07/99 | 160 | |
| 03U314 | 06/09/00 | 87.5 | |
| 03U314 | 12/13/00 | 100 | |
| 03U314 | 06/05/01 | 84 | 82 duplicate |
| 03U314 | 12/20/01 | 93 | 91 dup |
| 03U314 | 06/04/02 | 91 | |
| 03U314 | 12/13/02 | 78 | |
| 03U314 | 06/11/03 | 61 | |
| 03U314 | 12/19/03 | 69 | |
| 03U314 | 06/15/04 | 58 | |
| 03U314 | 12/01/04 | 52 | |
| 03U314 | 06/03/05 | 48 | 44 dup |
| 03U314 | 12/20/05 | 44 | |
| 03U314 | 06/06/06 | 43 | 42 dup |
| 03U314 | 12/04/06 | 50 | |
| 03U314 | 06/04/07 | 52 | |
| 03U314 | 12/13/07 | 45 | |
| 03U314 | 06/11/08 | 41 | |
| 03U314 | 12/03/08 | 37 | |
| 03U314 | 06/03/09 | 36 | |
| 03U314 | 12/08/09 | 45 | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | | |
|---|---|---|---|---|
| 03U314 | 06/01/10 | 32 | | |
| 03U314 | 12/06/10 | 40 | | |
| 03U314 | 06/03/11 | 33 | 32 dup | |
| 03U314 | 12/05/11 | 39 | | |
| 03U314 | 05/29/12 | 30 | | |
| 03U314 | 12/13/12 | 47 | | |
| 03U314 | 06/14/13 | 41 | | |
| 03U314 | 12/03/13 | 37 | | |
| 03U314 | 06/03/14 | 36 | | |
| 03U314 | 12/04/14 | 34 | | |
| 03U314 | 06/05/15 | 28 | | |
| 03U314 | 12/08/15 | 40 | | |
| 03U314 | 06/06/16 | 40 | | |
| 03U314 | 12/07/16 | 45 | | |
| 03U314 | 06/08/17 | 38 | 37 dup | |
| 03U314 | 12/07/17 | 46 | | |
| 03U314 | 06/08/18 | 28 | | 72% |
| | **SC3** | | | |
| 03U315 | 01/05/89 | 58 | | |
| 03U315 | 03/16/89 | 870 | | |
| 03U315 | 04/20/89 | 1300 | | |
| 03U315 | 07/19/89 | 940 | | |
| 03U315 | 10/24/89 | 1700 | | |
| 03U315 | 01/19/90 | 2100 | | |
| 03U315 | 05/08/90 | 2100 | 2000 duplicate | |
| 03U315 | 07/13/90 | 2100 | | |
| 03U315 | 12/19/90 | 1300 | | |
| 03U315 | 03/19/91 | 940 | | |
| 03U315 | 06/05/91 | 830 | | |
| 03U315 | 09/05/91 | 700 | | |
| 03U315 | 12/04/91 | 440 | | |
| 03U315 | 03/06/92 | 330 | | |
| 03U315 | 06/05/92 | 310 | | |
| 03U315 | 09/01/92 | 250 | 210 duplicate | |
| 03U315 | 03/03/93 | 150 | | |
| 03U315 | 09/15/93 | 88 | | |
| 03U315 | 03/03/94 | 110 | | |
| 03U315 | 09/07/94 | 69 | | |
| 03U315 | 03/14/95 | 41.6 | | |
| 03U315 | 09/11/95 | 51.3 | | |
| 03U315 | 06/06/96 | 43.3 | MIR | |

## Appendix H.1

## TRCLE Concentrations in TGRS Extraction Wells

| Well | Date | | | |
|---|---|---|---|---|
| 03U315 | 09/10/96 | 38 | | |
| 03U315 | 12/11/96 | 30.8 | | |
| 03U315 | 06/09/97 | 20.9 | | |
| 03U315 | 12/08/97 | 15.9 | | |
| 03U315 | 06/08/98 | 18.4 | 18 duplicate | |
| 03U315 | 12/01/98 | 15 | | |
| 03U315 | 06/17/99 | 14 | | |
| 03U315 | 12/07/99 | 10 | | |
| 03U315 | 06/09/00 | 6.9 | | |
| 03U315 | 12/13/00 | 5.5 | | |
| 03U315 | 06/05/01 | 4.6 | | |
| 03U315 | 12/20/01 | 3.8 | | |
| 03U315 | 06/04/02 | 4.6 | | |
| 03U315 | 12/13/02 | 2.1 | | |
| 03U315 | 06/11/03 | 1.9 | | |
| 03U315 | 12/19/03 | 1.5 | | |
| 03U315 | 06/15/04 | 1.3 | | |
| 03U315 | 06/03/05 | 6.1 | | |
| 03U315 | 06/04/07 | 0.81 | | |
| 03U315 | 06/03/09 | 0.58 | | |
| 03U315 | 06/03/11 | 0.35 | JP | |
| 03U315 | 06/14/13 | 0.36 | JP | |
| 03U315 | 06/05/15 | 0.44 | JP | |
| 03U315 | 07/22/16 | 0.33 | JP | |
| 03U315 | 06/15/18 | 0.3 | JP | 95% |

| | SC4 | | |
|---|---|---|---|
| 03U316 | 01/05/89 | 1 | |
| 03U316 | 03/16/89 | 2.9 | |
| 03U316 | 04/20/89 | 4.9 | |
| 03U316 | 07/19/89 | 4.2 | |
| 03U316 | 10/24/89 | 5.5 | |
| 03U316 | 01/19/90 | 10 | 9 duplicate |
| 03U316 | 05/08/90 | 12 | |
| 03U316 | 07/13/90 | 14 | |
| 03U316 | 12/19/90 | 14.9 | |
| 03U316 | 03/19/91 | 14.3 | |
| 03U316 | 06/04/91 | 18.1 | |
| 03U316 | 09/05/91 | 16.6 | |
| 03U316 | 12/04/91 | 16.7 | |
| 03U316 | 03/06/92 | 17.6 | |
| 03U316 | 06/05/92 | 18.1 | 17.7 duplicate |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | | |
|---|---|---|---|---|
| 03U316 | 09/01/92 | 20.8 | | |
| 03U316 | 03/03/93 | 17.8 | | |
| 03U316 | 09/15/93 | 22.7 | | |
| 03U316 | 03/03/94 | 23.2 | | |
| 03U316 | 09/07/94 | 24.2 | 23 duplicate | |
| 03U316 | 03/14/95 | 14.4 | 12.4 duplicate | |
| 03U316 | 09/11/95 | 19.4 | | |
| 03U316 | 06/06/96 | 23 | 19.7 duplicate | |
| 03U316 | 09/10/96 | 24.4 | | |
| 03U316 | 12/11/96 | 28.6 | | |
| 03U316 | 06/09/97 | 24.2 | | |
| 03U316 | 12/22/98 | 23 | | |
| 03U316 | 06/17/99 | 22 | | |
| 03U316 | 12/07/99 | 31 | 29 duplicate | |
| 03U316 | 06/09/00 | 18 | | |
| 03U316 | 12/13/00 | 6.9 | | |
| 03U316 | 06/06/01 | 5 | | |
| 03U316 | 12/20/01 | 5.5 | | |
| 03U316 | 06/04/02 | 8.9 | 5.5 dup | |
| 03U316 | 12/13/02 | 5 | | |
| 03U316 | 06/11/03 | 7 | | |
| 03U316 | 12/19/03 | 8 | | |
| 03U316 | 06/03/05 | 0.6 | | |
| 03U316 | 06/04/07 | 5.5 | | |
| 03U316 | 06/03/09 | 4.9 | | |
| 03U316 | 06/03/11 | 3.8 | | |
| 03U316 | 06/24/13 | 3.5 | | |
| 03U316 | 06/05/15 | 2.6 | | |
| 03U316 | 07/22/16 | 2.7 | | |
| 03U316 | 06/15/18 | 2.2 | | 68% |
| | **SC5** | | | |
| 03U317 | 01/05/89 | 1 | | |
| 03U317 | 03/16/89 | 12000 | | |
| 03U317 | 04/20/89 | 19000 | | |
| 03U317 | 07/19/89 | 18000 | | |
| 03U317 | 10/25/89 | 21000 | 18000 duplicate | |
| 03U317 | 01/19/90 | 15000 | | |
| 03U317 | 05/08/90 | 3200 | | |
| 03U317 | 07/13/90 | 13000 | | |
| 03U317 | 12/19/90 | 23000 | 18000 duplicate | |
| 03U317 | 03/19/91 | 14000 | | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | |
|---|---|---|---|
| 03U317 | 06/04/91 | 15000 | |
| 03U317 | 09/05/91 | 19000 | |
| 03U317 | 12/04/91 | 12000 | |
| 03U317 | 03/06/92 | 17000 | |
| 03U317 | 06/05/92 | 18000 | |
| 03U317 | 09/01/92 | 16000 | |
| 03U317 | 03/03/93 | 16000 | |
| 03U317 | 09/15/93 | 14000 | |
| 03U317 | 03/03/94 | 15000 | 8 |
| 03U317 | 09/07/94 | 12000 | |
| 03U317 | 03/14/95 | 6700 | |
| 03U317 | 09/11/95 | 8400 | |
| 03U317 | 06/06/96 | 7400 | MIR |
| 03U317 | 09/10/96 | 8000 | |
| 03U317 | 12/11/96 | 6800 | |
| 03U317 | 06/09/97 | 4700 | |
| 03U317 | 12/08/97 | 7100 | 6700 duplicate |
| 03U317 | 06/08/98 | 4700 | |
| 03U317 | 12/01/98 | 5500 | |
| 03U317 | 06/17/99 | 6500 | |
| 03U317 | 12/07/99 | 7000 | |
| 03U317 | 06/09/00 | 7200 | 6800 duplicate |
| 03U317 | 12/13/00 | 2800 | |
| 03U317 | 06/05/01 | 2500 | |
| 03U317 | 12/20/01 | 3900 | |
| 03U317 | 06/04/02 | 2600 | |
| 03U317 | 12/13/02 | 2500 | |
| 03U317 | 06/11/03 | 2600 | |
| 03U317 | 12/19/03 | 3100 | |
| 03U317 | 06/15/04 | 3000 | |
| 03U317 | 12/01/04 | 3600 | 3500 dup |
| 03U317 | 06/03/05 | 3100 | |
| 03U317 | 12/20/05 | 3100 | |
| 03U317 | 06/06/06 | 1900 | |
| 03U317 | 12/04/06 | 2500 | |
| 03U317 | 06/04/07 | 2400 | 2400 dup |
| 03U317 | 12/13/07 | 3200 | |
| 03U317 | 06/11/08 | 2900 | 2600 dup |
| 03U317 | 12/03/08 | 4100 | |
| 03U317 | 06/03/09 | 2800 | |
| 03U317 | 12/08/09 | 2600 | |
| 03U317 | 06/01/10 | 2000 | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | | |
|---|---|---|---|---|
| 03U317 | 12/06/10 | 2200 | | |
| 03U317 | 06/03/11 | 1800 | | |
| 03U317 | 12/05/11 | 2400 | | |
| 03U317 | 05/29/12 | 2500 | 2300 dup | |
| 03U317 | 12/13/12 | 3500 | 3500 dup | |
| 03U317 | 06/14/13 | 2600 | | |
| 03U317 | 12/03/13 | 2200 | | |
| 03U317 | 06/03/14 | 2200 | 2200 dup | |
| 03U317 | 12/04/14 | 1800 | 1800 dup | |
| 03U317 | 06/05/15 | 2000 | | |
| 03U317 | 12/08/15 | 2200 | | |
| 03U317 | 06/06/16 | 2600 | | |
| 03U317 | 12/07/16 | 3300 | | |
| 03U317 | 06/08/17 | 3100 | | |
| 03U317 | 12/07/17 | 2900 | | |
| 03U317 | 06/08/18 | 2200 | | 21% |

| | **B8** | | |
|---|---|---|---|
| PJ#309 | 11/18/88 | 0 | |
| PJ#309 | 03/16/89 | 200 | |
| PJ#309 | 04/20/89 | 320 | |
| PJ#309 | 07/19/89 | 190 | |
| PJ#309 | 10/23/89 | 270 | |
| PJ#309 | 01/18/90 | 260 | |
| PJ#309 | 05/08/90 | 280 | |
| PJ#309 | 07/13/90 | 250 | |
| PJ#309 | 12/19/90 | 220 | |
| PJ#309 | 03/19/91 | 260 | |
| PJ#309 | 06/05/91 | 300 | |
| PJ#309 | 09/05/91 | 260 | |
| PJ#309 | 12/04/91 | 210 | |
| PJ#309 | 03/06/92 | 160 | |
| PJ#309 | 06/05/92 | 140 | |
| PJ#309 | 09/01/92 | 160 | |
| PJ#309 | 03/03/93 | 130 | |
| PJ#309 | 09/15/93 | 110 | 8 |
| PJ#309 | 03/03/94 | 92 | |
| PJ#309 | 09/07/94 | 73 | |
| PJ#309 | 03/14/95 | 49 | |
| PJ#309 | 09/11/95 | 56 | |
| PJ#309 | 06/06/96 | 43.4 | |
| PJ#309 | 09/10/96 | 49.8 | 49.6 duplicate |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | |
|---|---|---|---|
| PJ#309 | 12/11/96 | 42.9 | |
| PJ#309 | 06/09/97 | 27.5 | |
| PJ#309 | 12/08/97 | 28.6 | |
| PJ#309 | 06/08/98 | 36.4 | |
| PJ#309 | 12/02/98 | 24 | |
| PJ#309 | 06/17/99 | 27 | |
| PJ#309 | 12/07/99 | 26 | |
| PJ#309 | 06/09/00 | 24 | |
| PJ#309 | 12/13/00 | 21 | |
| PJ#309 | 06/05/01 | 21 | |
| PJ#309 | 12/21/01 | 20 | |
| PJ#309 | 06/04/02 | 22 | |
| PJ#309 | 12/13/02 | 20 | |
| PJ#309 | 06/10/03 | 23 | |
| PJ#309 | 12/18/03 | 20 | 19 duplicate |
| PJ#309 | 06/15/04 | 21 | |
| PJ#309 | 12/01/04 | 20 | |
| PJ#309 | 06/03/05 | 24 | |
| PJ#309 | 12/20/05 | 16 | |
| PJ#309 | 06/06/06 | 21 | |
| PJ#309 | 12/04/06 | 21 | |
| PJ#309 | 06/04/07 | 22 | |
| PJ#309 | 12/13/07 | 19 | |
| PJ#309 | 06/11/08 | 26 | |
| PJ#309 | 12/03/08 | 25 | |
| PJ#309 | 06/03/09 | 23 | 23 duplicate |
| PJ#309 | 12/08/09 | 24 | |
| PJ#309 | 06/01/10 | 22 | 22 duplicate |
| PJ#309 | 12/06/10 | 21 | |
| PJ#309 | 06/03/11 | 18 | |
| PJ#309 | 12/05/11 | 17 | |
| PJ#309 | 05/29/12 | 16 | |
| PJ#309 | 12/13/12 | 16 | |
| PJ#309 | 06/14/13 | 16 | |
| PJ#309 | 12/03/13 | 14 | 14 dup |
| PJ#309 | 06/03/14 | 13 | |
| PJ#309 | 12/04/14 | 11 | |
| PJ#309 | 06/05/15 | 10 | |
| PJ#309 | 12/08/15 | 11 | |
| PJ#309 | 06/06/16 | 8.8 | |
| PJ#309 | 12/07/16 | 9.9 | |
| PJ#309 | 06/06/17 | 8.9 | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | | |
|---|---|---|---|---|
| PJ#309 | 12/07/17 | 9.6 | 9.4 dup | |
| PJ#309 | 06/08/18 | 7.9 | | 62% |
| | **B9** | | | |
| PJ#310 | 03/16/89 | 470 | | |
| PJ#310 | 04/20/89 | 700 | | |
| PJ#310 | 07/19/89 | 480 | | |
| PJ#310 | 10/11/89 | 560 | | |
| PJ#310 | 01/19/90 | 630 | | |
| PJ#310 | 05/08/90 | 500 | | |
| PJ#310 | 07/13/90 | 690 | | |
| PJ#310 | 12/19/90 | 610 | | |
| PJ#310 | 03/19/91 | 580 | | |
| PJ#310 | 06/06/91 | 470 | | |
| PJ#310 | 09/05/91 | 590 | | |
| PJ#310 | 12/04/91 | 520 | | |
| PJ#310 | 03/06/92 | 520 | | |
| PJ#310 | 06/05/92 | 540 | | |
| PJ#310 | 09/01/92 | 700 | | |
| PJ#310 | 03/03/93 | 580 | | |
| PJ#310 | 09/15/93 | 480 | | |
| PJ#310 | 03/03/94 | 450 | | |
| PJ#310 | 09/07/94 | 380 | | |
| PJ#310 | 03/14/95 | 330 | | |
| PJ#310 | 09/11/95 | 340 | | |
| PJ#310 | 06/06/96 | 290 | | |
| PJ#310 | 09/10/96 | 290 | | |
| PJ#310 | 12/11/96 | 240 | | |
| PJ#310 | 06/09/97 | 190 | | |
| PJ#310 | 12/08/97 | 152 | | |
| PJ#310 | 06/08/98 | 210 | | |
| PJ#310 | 12/02/98 | 140 | | |
| PJ#310 | 06/17/99 | 160 | 155 Duplicate | |
| PJ#310 | 12/07/99 | 150 | | |
| PJ#310 | 06/09/00 | 120 | | |
| PJ#310 | 12/13/00 | 110 | 110 duplicate | |
| PJ#310 | 06/05/01 | 100 | 96 duplicate | |
| PJ#310 | 12/21/01 | 120 | | |
| PJ#310 | 06/04/02 | 120 | | |
| PJ#310 | 12/13/02 | 120 | | |
| PJ#310 | 06/10/03 | 140 | | |
| PJ#310 | 12/18/03 | 110 | | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | | |
|---|---|---|---|---|
| PJ#310 | 06/15/04 | 120 | | |
| PJ#310 | 12/01/04 | 110 | | |
| PJ#310 | 06/03/05 | 120 | | |
| PJ#310 | 12/20/05 | 88 | | |
| PJ#310 | 06/06/06 | 120 | | |
| PJ#310 | 12/04/06 | 120 | | |
| PJ#310 | 07/03/07 | 97 | 96 dup | |
| PJ#310 | 12/13/07 | 90 | | |
| PJ#310 | 06/11/08 | 100 | | |
| PJ#310 | 12/03/08 | 90 | | |
| PJ#310 | 06/03/09 | 71 | | |
| PJ#310 | 12/08/09 | 73 | 69 duplicate | |
| PJ#310 | 06/01/10 | 66 | | |
| PJ#310 | 12/06/10 | 74 | 73 dup | |
| PJ#310 | 06/03/11 | 58 | | |
| PJ#310 | 12/05/11 | 60 | | |
| PJ#310 | 05/29/12 | 56 | | |
| PJ#310 | 12/13/12 | 55 | | |
| PJ#310 | 06/14/13 | 55 | 54 dup | |
| PJ#310 | 12/03/13 | 46 | | |
| PJ#310 | 06/03/14 | 50 | | |
| PJ#310 | 12/04/14 | 44 | | |
| PJ#310 | 06/04/15 | 42 | | |
| PJ#310 | 12/08/15 | 42 | | |
| PJ#310 | 06/06/16 | 37 | | |
| PJ#310 | 12/07/16 | 33 | | |
| PJ#310 | 06/06/17 | 33 | | |
| PJ#310 | 12/07/17 | 37 | | |
| PJ#310 | 06/11/18 | 29 | | 74% |
| | **B10** | | | |
| PJ#311 | 03/16/89 | 150 | | |
| PJ#311 | 04/20/89 | 82 | | |
| PJ#311 | 07/19/89 | 67 | | |
| PJ#311 | 10/24/89 | 52 | | |
| PJ#311 | 01/19/90 | 47 | | |
| PJ#311 | 05/08/90 | 17 | | |
| PJ#311 | 07/13/90 | 30 | | |
| PJ#311 | 12/19/90 | 30.9 | | |
| PJ#311 | 03/19/91 | 24.8 | | |
| PJ#311 | 06/06/91 | 25 | 24.8 duplicate | |
| PJ#311 | 09/05/91 | 25.1 | | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | | | |
|---|---|---|---|---|---|
| PJ#311 | 12/04/91 | 25.4 | | | |
| PJ#311 | 03/06/92 | 25.2 | | | |
| PJ#311 | 06/05/92 | 23.6 | | | |
| PJ#311 | 09/01/92 | 20.9 | | | |
| PJ#311 | 03/03/93 | 19.6 | | | |
| PJ#311 | 09/15/93 | 21.7 | | | |
| PJ#311 | 03/03/94 | 19.2 | | | |
| PJ#311 | 09/07/94 | 22.6 | | | |
| PJ#311 | 03/14/95 | 13.7 | | | |
| PJ#311 | 09/11/95 | 14.7 | | | |
| PJ#311 | 06/06/96 | 10.9 | | | |
| PJ#311 | 09/10/96 | 14.6 | | | |
| PJ#311 | 12/11/96 | 14.3 | | 14.3 duplicate | |
| PJ#311 | 06/09/97 | 7.8 | | | |
| PJ#311 | 12/08/97 | 8.36 | | | |
| PJ#311 | 06/08/98 | 8.71 | | 8.53 duplicate | |
| PJ#311 | 12/02/98 | 7.4 | | | |
| PJ#311 | 06/17/99 | 6.8 | | | |
| PJ#311 | 12/07/99 | 6.3 | | | |
| PJ#311 | 06/09/00 | 6.2 | | | |
| PJ#311 | 12/13/00 | 5.1 | | | |
| PJ#311 | 06/05/01 | 5.1 | | | |
| PJ#311 | 12/20/01 | 1.6 | | | |
| PJ#311 | 06/04/02 | 4.5 | | | |
| PJ#311 | 12/13/02 | 1.1 | | | |
| PJ#311 | 06/10/03 | 0.75 | | | |
| PJ#311 | 12/19/03 | 0.63 | | | |
| PJ#311 | 06/15/04 | 10 | | <1 duplicate | |
| PJ#311 | 06/03/05 | 0.59 | | <1 duplicate | |
| PJ#311 | 06/04/07 | 0.52 | | | |
| PJ#311 | 06/03/09 | 0.47 | | | |
| PJ#311 | 06/03/11 | 0.39 | JP | | |
| PJ#311 | 06/14/13 | 0.57 | JP | 0.53JP duplicate | |
| PJ#311 | 06/04/15 | 0.44 | JP | | |
| PJ#311 | 07/21/16 | 0 | | | |
| PJ#311 | 06/15/18 | 0 | | | 100% |
| | **B12** | | | | |
| PJ#313 | 03/16/89 | 18 | | | |
| PJ#313 | 04/20/89 | 27 | | | |
| PJ#313 | 07/19/89 | 25 | | | |
| PJ#313 | 10/23/89 | 15 | | | |

**Appendix H.1**

**TRCLE Concentrations in TGRS Extraction Wells**

| Well | Date | | | |
|---|---|---|---|---|
| PJ#313 | 01/19/90 | 14 | | |
| PJ#313 | 05/08/90 | 17 | | |
| PJ#313 | 07/13/90 | 12 | | |
| PJ#313 | 12/19/90 | 10.3 | | |
| PJ#313 | 03/19/91 | 9.12 | | |
| PJ#313 | 06/05/91 | 6.97 | | |
| PJ#313 | 12/04/91 | 7.64 | 7.55 duplicate | |
| PJ#313 | 03/06/92 | 5.76 | | |
| PJ#313 | 06/05/92 | 5.78 | | |
| PJ#313 | 09/01/92 | 6.11 | | |
| PJ#313 | 03/03/93 | 4.95 | | |
| PJ#313 | 09/15/93 | 4.17 | | |
| PJ#313 | 03/03/94 | 4.47 | | |
| PJ#313 | 09/07/94 | 3.84 | | |
| PJ#313 | 03/14/95 | 2.51 | | |
| PJ#313 | 09/11/95 | 2.61 | 2.61 duplicate | |
| PJ#313 | 06/06/96 | 2.7 | MIR | |
| PJ#313 | 09/10/96 | 2.25 | | |
| PJ#313 | 12/11/96 | 0.868 | | |
| PJ#313 | 06/09/97 | 0 | | |
| PJ#313 | 12/22/98 | 0 | | |
| PJ#313 | 06/17/99 | 0 | <1 duplicate | |
| PJ#313 | 12/07/99 | 0 | | |
| PJ#313 | 06/09/00 | 0 | | |
| PJ#313 | 12/14/00 | 0 | | |
| PJ#313 | 06/05/01 | 0.18 | | |
| PJ#313 | 12/20/01 | 0 | | |
| PJ#313 | 06/04/02 | 0.22 | | |
| PJ#313 | 12/16/2002 | 0.093 | | |
| PJ#313 | 6/10/2003 | 0 | | |
| PJ#313 | 12/19/03 | 0 | | |
| PJ#313 | 6/3/2005 | 0 | | |
| PJ#313 | 6/4/2007 | 0 | | |
| PJ#313 | 6/3/2009 | 0 | | |
| PJ#313 | 6/3/2011 | 0 | | |
| PJ#313 | 6/14/2013 | 0 | | |
| PJ#313 | 6/4/2015 | 0 | | |
| PJ#313 | 7/21/2016 | 0 | | |
| PJ#313 | 6/15/2018 | 0 | <1.0 dup | 100% |

**Appendix H.2**

**Influent/Effluent Database**
**Fiscal Year 2018**
**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 | | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| TGRSE | 10/3/2017 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 2.3 |
| TGRSE | 10/3/2017 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 2.2 |
| TGRSE | 11/2/2017 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 2.4 |
| TGRSE | 11/2/2017 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 2.4 |
| TGRSE | 12/7/2017 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.9 |
| TGRSE | 12/7/2017 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.9 |
| TGRSE | 1/4/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.4 |
| TGRSE | 2/6/2018 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.4 |
| TGRSE | 2/6/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.4 |
| TGRSE | 3/1/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.6 UB0.43 |
| TGRSE | 3/1/2018 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.6 UB0.43 |
| TGRSE | 4/3/2018 | | < 1.0 UJT8.0JD37.0 | < 1.0 UJT8.0JD31.3 | < 1.0 UJT8.0JMS73.5JD41.1 | < 1.0 UJT8.0JD23.0 | < 1.0 UJT8.0JD33.7 | < 1.0 UJT8.0JD23.2 | 2.3 UB0.46JT8.0JD38.4 |
| TGRSE | 4/3/2018 | D | < 1.0 UJT8.0 | < 1.0 UJT8.0 | < 1.0 UJT8.0 | < 1.0 UJT8.0 | < 1.0 UJT8.0 | < 1.0 UJT8.0 | 2.1 UB0.46JT8.0 |
| TGRSE | 5/2/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.7 UB0.38 |
| TGRSE | 6/11/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 UJL74.6JMS74.6 | 1.7 |
| TGRSE | 6/11/2018 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 UJL74.6 | 1.6 |
| TGRSE | 7/5/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.7 |
| TGRSE | 7/5/2018 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.7 |
| TGRSE | 8/3/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.7 |
| TGRSE | 8/3/2018 | D | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.7 |
| TGRSE | 9/5/2018 | | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | < 1.0 | 1.7 |

**Appendix H.2**

**Influent/Effluent Database**
**Fiscal Year 2018**
**TGRS, OU2**
**Arden Hills, Minnesota**

| Location | Date | | 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 |
| | | | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L | µg/L |
| TGRSI | 10/3/2017 | | 39 | 2 | 2.7 | < 1.0 | 3.3 | 1.1 | 220 |
| TGRSI | 11/2/2017 | | 35 | 1.9 | 3.4 | < 1.0 | 5.4 | 0.85 JP | 220 |
| TGRSI | 12/7/2017 | | 42 | 2.1 | 3.2 | < 1.0 | 3.9 | 0.91 JP | 230 |
| TGRSI | 1/4/2018 | | 45 | 2.3 | 3.3 | < 1.0 | 3.9 | 1.2 | 230 |
| TGRSI | 1/4/2018 | D | 45 | 2.2 | 3.4 | < 1.0 | 3.8 | 1.2 | 220 |
| TGRSI | 2/6/2018 | | 34 | 1.8 | 2.5 | < 1.0 | 3.6 | 0.95 JP | 200 |
| TGRSI | 3/1/2018 | | 40 | 2 | 3.2 | < 1.0 | 4.1 | 1 | 200 |
| TGRSI | 4/3/2018 | | 44 JT8.0 | 2.1 JT8.0 | 3.9 JT8.0 | < 1.0 UJT8.0 | 3.8 JT8.0 | 1.1 JT8.0 | 190 JT8.0 |
| TGRSI | 5/2/2018 | | 44 | 2.1 | 3 | < 1.0 | 2.8 | 0.99 JP | 210 |
| TGRSI | 5/2/2018 | D | 42 | 2 | 2.8 | < 1.0 | 2.9 | 0.96 JP | 220 |
| TGRSI | 6/11/2018 | | 35 | 1.8 | 2.6 | < 1.0 | 2.9 | 0.76 JL74.6 | 180 |
| TGRSI | 7/5/2018 | | 37 | 2.1 | 2.8 | < 1.0 | 3.2 | 0.68 JP | 190 |
| TGRSI | 8/3/2018 | | 37 | 2.2 | 2.8 | < 1.0 | 2.7 | 1.3 | 190 |
| TGRSI | 9/5/2018 | | 32 | 2.1 | 2.6 | < 1.0 | 3.2 | 1.3 | 170 |
| TGRSI | 9/5/2018 | D | 32 | 2 | 2.5 | < 1.0 | 3.1 | 1.3 | 170 |

Notes:

(1) Cleanup levels for TGRS are from the OU2 ROD.

D - Field Duplicate
MDL - Method Detection Limit
RL - Reporting Limit
JP - Result is qualified as estimated since the detection is below the laboratory reporting limit
JT# - Result is qualified as estimated due to sample temperature exceedance. The following numerical value is the associated sample temperature.
JL# - Result is qualified as estimated due to outlying LCS recovery. The following numerical value is the associated %LCS recovery.
JMS# - Result is qualified as estimated due to outlying MS recovery. The following numerical value is the associated % MS recovery.
JD# - Result is qualified as estimated due to outlying RPD value. The following numerical value is the associated outlying RPD value.
UB# - Result is qualified as non-detect. The following numerical value is The associated blank concentration.

# APPENDIX I

## Maros Decision Matrix

# Appendix I

## Table I.1
## Maros Decision Matrix

| Kendall S | Confidence | Coefficient of Varience | Trend |
|---|---|---|---|
| S > 0 | > 95% | NA | Definitely Increasing |
| S > 0 | 90-95% | NA | Probably Increasing |
| S > 0 | < 90% | NA | No Trend |
| S</= 0 | < 90% | >/= 1 | No Trend |
| S </= 0 | < 90% | < 1 | Stable |
| S < 0 | 90-95% | NA | Probably Decreasing |
| S < 0 | >95% | NA | Definitely Decreasing |

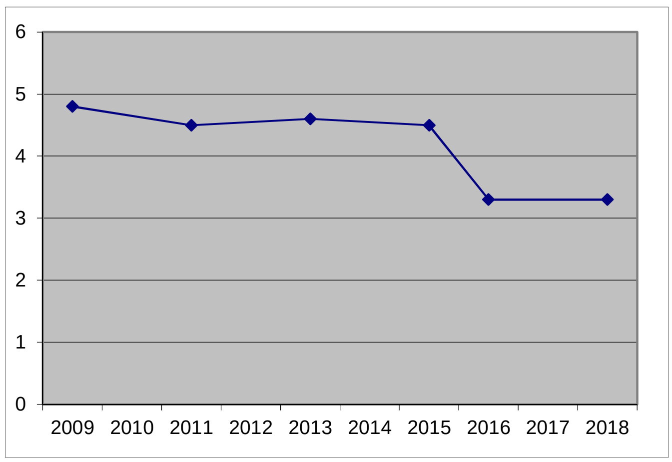
## Table I.2
## Confidence Values for Six Data Pairs

| Kendall S | Confidence |
|---|---|
| 1 | 50.00% |
| 3 | 64.00% |
| 5 | 76.50% |
| 7 | 86.40% |
| 9 | 93.20% |
| 11 | 97.20% |
| 13 | 99.17% |
| 15 | 99.86% |

**WELL 03L848**
**MANN-KENDALL STATISTICAL ANALYSIS**
**OU3 - 2018**

| Date | TCE (µg/l) | Mann-Kendall Calculation: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6/14/2009 | **4.8** | 1 | | | | | | | | |
| 6/24/2011 | **4.5** | 1 | -1 | | | | | | | |
| 6/27/2013 | **4.6** | 1 | -1 | 1 | | | | | | |
| 6/11/2015 | **4.5** | 1 | -1 | 0 | -1 | | | | | |
| 7/27/2016 | **3.3** | 1 | -1 | -1 | -1 | -1 | | | | |
| 6/28/2018 | **3.3** | 1 | -1 | -1 | -1 | -1 | 0 | | | |
| | | | | | | | | | | |
| | N | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | 15 |
| | sum | | -5 | -1 | -3 | -2 | 0 | 0 | Kendall S | -11 |
| | Possibles | 15 | | | | | | | | |
| | | | | | | | | | Kendall tau | -0.733 |

| | |
|---|---|
| Mean | 4.17 |
| STNDEV | 0.6802 |
| COV | 0.1632 |
| Trend: | Negative |
| Confidence (lookup) | 97.20% |



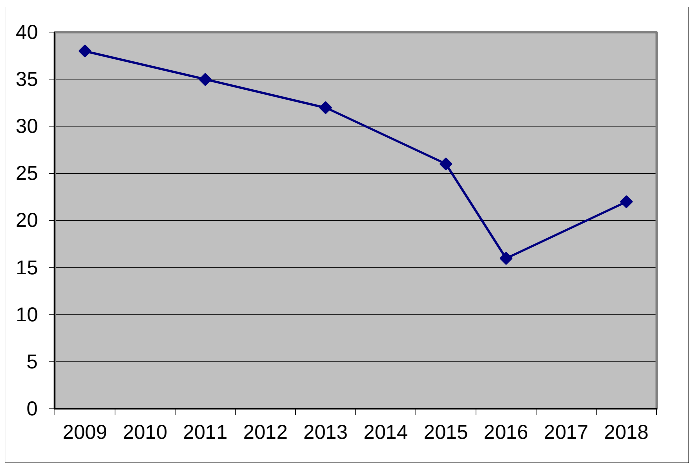

Raw Data
03L848

| Date | TCE | | Date | TCE | |
|---|---|---|---|---|---|
| 12/2/1987 | 570 | | 6/21/2007 | 5.4 | |
| 5/3/1989 | 270 | | 6/21/2007 | 5.3 | D |
| 7/20/1989 | 130 | | 6/17/2009 | 4.8 | |
| 10/19/1989 | 610 | | 6/17/2009 | 2.6 | D |
| 4/19/1990 | 460 | | 6/24/2011 | 4.5 | |
| 7/19/1990 | 260 | | 6/27/2013 | 4.9 | |
| 3/18/1991 | 250 | | 6/11/2015 | 4.4 | |
| 3/18/1992 | 92 | | 6/11/2015 | 4.5 | D |
| 3/9/1993 | 52.9 | | 7/27/2016 | 3.3 | |
| 6/6/1994 | 27 | | 6/28/2018 | 3.3 | |
| 9/15/1994 | 27.1 | | | | |
| 12/8/1994 | 22 | | | | |
| 3/10/1995 | 16.6 | | | | |
| 6/3/1996 | 11.3 | | | | |
| 6/5/1997 | 9.34 | | | | |
| 6/5/1997 | 8.57 | D | | | |
| 6/29/1998 | 10.7 | | | | |
| 6/4/1999 | 7.3 | | | | |
| 6/12/2001 | 3.5 | | | | |
| 6/1/2003 | 3.8 | | | | |
| 6/21/2005 | 5.8 | | | | |

**WELL 04U673**
**MANN-KENDALL STATISTICAL ANALYSIS**
**OU3 - 2018**

| Date | TCE (µg/l) | Mann-Kendall Calculation: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6/18/2009 | **38** | 1 | | | | | | | | |
| 6/24/2011 | **35** | 1 | -1 | | | | | | | |
| 6/24/2013 | **32** | 1 | -1 | -1 | | | | | | |
| 6/12/2015 | **26** | 1 | -1 | -1 | -1 | | | | | |
| 7/26/2016 | **16** | 1 | -1 | -1 | -1 | -1 | | | | |
| 6/29/2018 | **22** | 1 | -1 | -1 | -1 | -1 | 1 | | | |
| N | | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | 15 |
| | sum | | -5 | -4 | -3 | -2 | 1 | 0 | Kendall S | -13 |
| Possibles | | 15 | | | | | | | | |
| | | | | | | | | | Kendall tau | -0.867 |

| | |
|---|---|
| Mean | 28.17 |
| STNDEV | 8.3526 |
| COV | 0.2965 |
| Trend: | Negative |
| Confidence (lookup) | 99.17% |




Raw Data

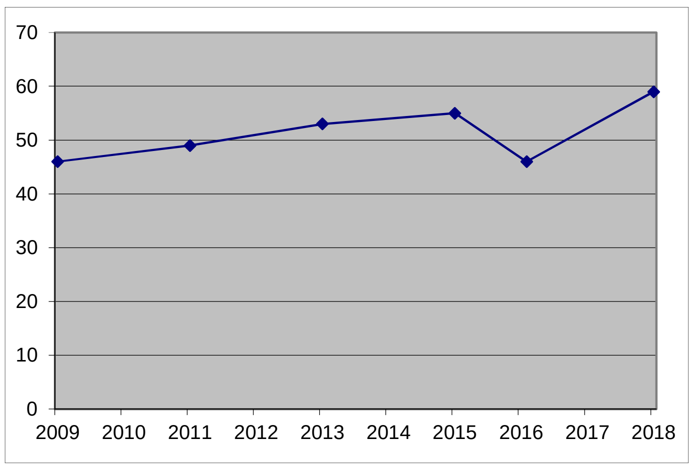
| 04U673 | Date | TCE | Date | TCE | |
|---|---|---|---|---|---|
| | 11/24/1987 | 145 | 3/15/1995 | 160 | |
| | 1/21/1988 | 580 | 3/15/1995 | 140 | |
| | 5/16/1988 | 560 | 9/12/1995 | 260 | |
| | 8/4/1988 | 253 | 6/12/1996 | 125 | |
| | 11/1/1988 | 1700 | 6/12/1997 | 60.4 | |
| | 5/3/1989 | 700 | 6/25/1998 | 81.9 | |
| | 7/21/1989 | 1200 | 6/4/1999 | 74 | |
| | 10/19/1989 | 1100 | 6/12/2001 | 2.9 | |
| | 5/1/1990 | 3100 | 6/1/2003 | 15 | |
| | 3/11/1991 | 990 | 6/1/2004 | 51 | |
| | 3/11/1991 | 940 | 6/22/2005 | 49 | |
| | 6/17/1991 | 410 | 6/21/2007 | 42 | |
| | 3/12/1992 | 460 | 6/18/2009 | 38 | |
| | 6/4/1992 | 430 | 6/24/2011 | 35 | |
| | 9/8/1992 | 540 | 6/27/2013 | 32 | |
| | 3/3/1993 | 280 | 6/12/2015 | 26 | |
| | 9/13/1993 | 190 | 7/26/2016 | 15 | |
| | 3/3/1994 | 270 | 7/26/2016 | 16 | D |
| | 6/6/1994 | 210 | 6/29/2018 | 22 | |
| | 9/8/1994 | 170 | | | |
| | 12/8/1994 | 190 | | | |

**WELL 04U832**
**MANN-KENDALL STATISTICAL ANALYSIS**
**OU3 - 2018**

| Date | TCE (µg/l) | Mann-Kendall Calculation: | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6/19/2009 | **46** | 1 | | | | | | | |
| 6/23/2011 | **49** | 1 | 1 | | | | | | |
| 6/27/2013 | **53** | 1 | 1 | 1 | | | | | |
| 6/10/2015 | **55** | 1 | 1 | 1 | 1 | | | | |
| 7/27/2016 | **46** | 1 | 0 | -1 | -1 | -1 | | | |
| 6/28/2018 | **59** | 1 | 1 | 1 | 1 | 1 | 1 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| N | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | 15 |
| sum | | 4 | 2 | 1 | 0 | 1 | 0 | Kendall S | 8 |
| Possibles | 15 | | | | | | | | |
| | | | | | | | | Kendall tau | 0.533 |

| | |
|---|---|
| Mean | 51.33 |
| STNDEV | 5.2409 |
| COV | 0.1021 |
| Trend: | Positive |
| Confidence (lookup) | 89.81% |



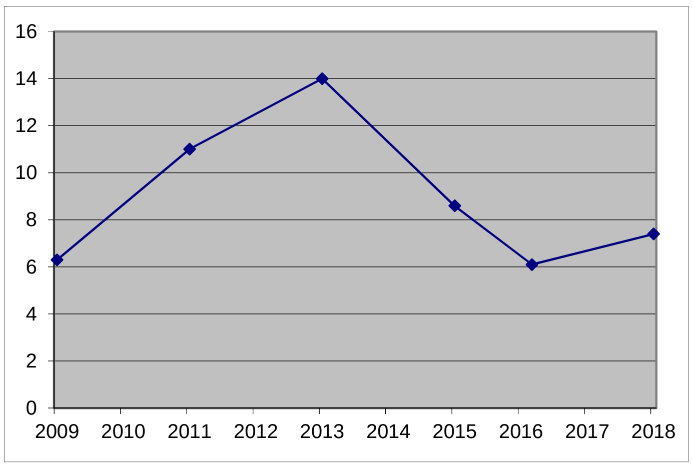

Raw Data

| 04U832 | Date | TCE | Date | TCE |
|---|---|---|---|---|
| | 11/24/1987 | 100 | 6/17/2008 | 48 |
| | 12/16/1988 | 65 | 6/19/2009 | 46 |
| | 4/25/1990 | 69.53 | 6/23/2011 | 49 |
| | 3/19/1991 | 47.6 | 6/27/2013 | 53 |
| | 3/25/1992 | 52.5 | 6/10/2015 | 55 |
| | 3/16/1993 | 42 | 7/27/2016 | 46 |
| | 3/16/1993 | 45.9 | 6/28/2018 | 59 |
| | 6/10/1994 | 49 | | |
| | 9/13/1994 | 49.5 | | |
| | 12/7/1994 | 43.3 | | |
| | 12/7/1994 | 47.1 | | |
| | 3/10/1995 | 56 | | |
| | 6/3/1996 | 41 | | |
| | 6/4/1997 | 35.2 | | |
| | 6/25/1998 | 36.4 | | |
| | 6/7/1999 | 29 | | |
| | 6/14/2001 | 3.5 | | |
| | 6/1/2003 | 4.1 | | |
| | 6/23/2005 | 41 | | |
| | 6/13/2006 | 54 | | |
| | 6/22/2007 | 56 | | |

**WELL 04U845**
**MANN-KENDALL STATISTICAL ANALYSIS**
**OU3 - 2018**

| Date | TCE (µg/l) | | Mann-Kendall Calculation: | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6/17/2009 | **6.3** | 1 | | | | | | | | |
| 6/23/2011 | **11** | 1 | 1 | | | | | | | |
| 6/25/2013 | **14** | 1 | 1 | 1 | | | | | | |
| 6/11/2015 | **8.6** | 1 | 1 | -1 | -1 | | | | | |
| 8/2/2016 | **6.1** | 1 | -1 | -1 | -1 | -1 | | | | |
| 6/27/2018 | **7.4** | 1 | 1 | -1 | -1 | -1 | 1 | | | |
| | N | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | 15 |
| | sum | | 3 | -2 | -3 | -2 | 1 | 0 | Kendall S | -3 |
| | Possibles | 15 | | | | | | | | |
| | | | | | | | | | Kendall tau | -0.2 |

| | |
|---|---|
| Mean | 8.90 |
| STNDEV | 3.08 |
| COV | 0.3458 |
| Trend: | Negative |
| Confidence (lookup) | 64.00% |




Raw Data

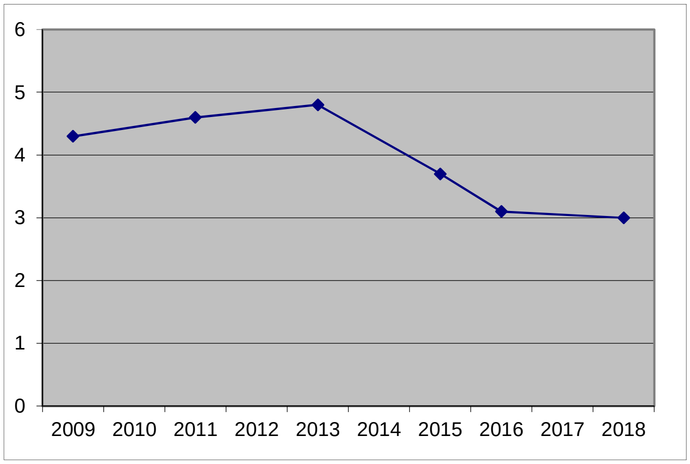
| 04U845 | Date | TCE | Date | TCE |
|---|---|---|---|---|
| | 12/1/1987 | 59 | 6/13/2006 | 14 |
| | 12/16/1988 | 155 | 6/13/2006 | 14 |
| | 5/4/1989 | 100 | 6/22/2007 | 15 |
| | 7/20/1989 | 160 | 6/17/2008 | 15 |
| | 10/20/1989 | 62 | 6/17/2009 | 6.3 |
| | 4/26/1990 | 38 | 6/23/2011 | 11 |
| | 3/20/1991 | 100 | 6/25/2013 | 14 |
| | 3/23/1992 | >50.10 | 6/11/2015 | 8.6 |
| | 3/23/1992 | 100 | 8/2/2016 | 6.1 |
| | 3/15/1993 | 84 | 6/27/2018 | 7.4 |
| | 6/8/1994 | 64 | | |
| | 9/13/1994 | 70 | | |
| | 12/7/1994 | 54 | | |
| | 3/10/1995 | 39.5 | | |
| | 6/4/1996 | 51.2 | | |
| | 6/5/1997 | 30.8 | | |
| | 6/25/1998 | 32.9 | | |
| | 6/7/1999 | 35 | | |
| | 6/13/2001 | 4.3 | | |
| | 6/1/2003 | 4 | | |
| | 6/22/2005 | 20 | | |

**WELL 04U848**
**MANN-KENDALL STATISTICAL ANALYSIS**
**OU3 - 2016**

| Date | TCE (µg/l) | Mann-Kendall Calculation: | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6/17/2009 | **4.3** | 1 | | | | | | | |
| 6/24/2011 | **4.6** | 1 | 1 | | | | | | |
| 6/27/2013 | **4.8** | 1 | 1 | 1 | | | | | |
| 6/11/2015 | **3.7** | 1 | -1 | -1 | -1 | | | | |
| 7/27/2016 | **3.1** | 1 | -1 | -1 | -1 | -1 | | | |
| 6/28/2018 | **3.0** | 1 | -1 | -1 | -1 | -1 | -1 | | |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| N | | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | 15 |
| | sum | | -1 | -2 | -3 | -2 | -1 | 0 | Kendall S | -9 |
| Possibles | | 15 | | | | | | | | |
| | | | | | | | | | Kendall tau | -0.6 |

| | |
|---|---|
| Mean | 3.92 |
| STNDEV | 0.7679 |
| COV | 0.1961 |
| Trend: | Negative |
| Confidence (lookup) | 93.20% |



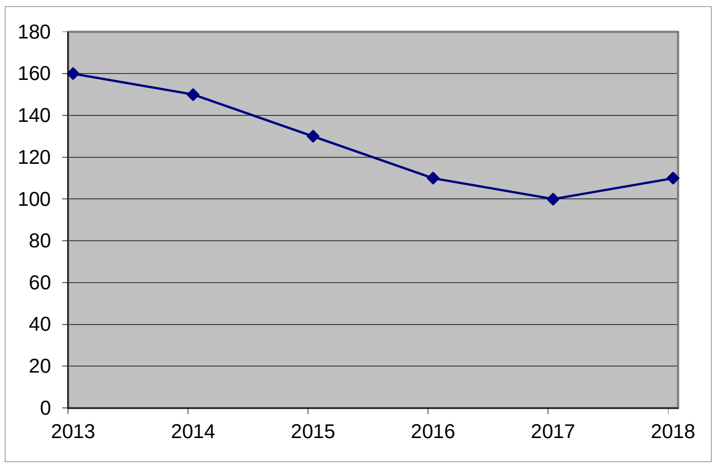

Raw Data

| 04U848 | Date | TCE | Date | TCE |
|---|---|---|---|---|
| | 12/2/1987 | 700 | 6/1/2003 | 0.46 JP |
| | 8/24/1988 | 470 | 6/21/2005 | 5.6 |
| | 5/3/1989 | 150 | 6/21/2007 | 5.3 |
| | 7/20/1989 | 700 | 6/17/2009 | 4.3 |
| | 10/19/1989 | 280 | 6/24/2011 | 4.6 |
| | 4/19/1990 | 240 | 6/27/2013 | 4.8 |
| | 7/19/1990 | 140 | 6/11/2015 | 3.7 |
| | 9/17/1990 | 150 | 7/27/2016 | 3.1 |
| | 3/18/1991 | 64 | 6/28/2018 | 3.0 |
| | 3/18/1992 | 22.5 | | |
| | 3/18/1992 | 23.4 | | |
| | 3/10/1993 | 26 | | |
| | 6/6/1994 | 12.2 | | |
| | 9/15/1994 | 16.8 | | |
| | 12/8/1994 | 15.6 | | |
| | 3/10/1995 | 9.94 | | |
| | 6/3/1996 | 6.15 | | |
| | 6/5/1997 | 3.3 | | |
| | 6/29/1998 | 4.19 | | |
| | 6/4/1999 | 3.6 | | |
| | 6/12/2001 | 0.49 J | | |

**WELL 03M848**
**MANN-KENDALL STATISTICAL ANALYSIS**
**OU3 - 2017**

| Date | TCE (µg/l) | Mann-Kendall Calculation: | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 6/27/2013 | **160** | 1 | | | | | | | | |
| 6/9/2014 | **150** | 1 | -1 | | | | | | | |
| 6/11/2015 | **130** | 1 | -1 | -1 | | | | | | |
| 6/14/2016 | **110** | 1 | -1 | -1 | -1 | | | | | |
| 6/8/2017 | **100** | 1 | -1 | -1 | -1 | -1 | | | | |
| 6/28/2018 | **110** | 1 | -1 | -1 | -1 | 0 | 1 | | | |
| N | | 6 | 5 | 4 | 3 | 2 | 1 | 0 | | 15 |
| | sum | | -5 | -4 | -3 | -1 | 1 | 0 | Kendall S | -12 |
| Possibles | | 15 | | | | | | | | |
| | | | | | | | | | Kendall tau | -0.8 |

| | |
|---|---|
| Mean | 126.67 |
| STNDEV | 24.2212 |
| COV | 0.1912 |
| Trend: | Negative |
| Confidence (lookup) | 98.19% |



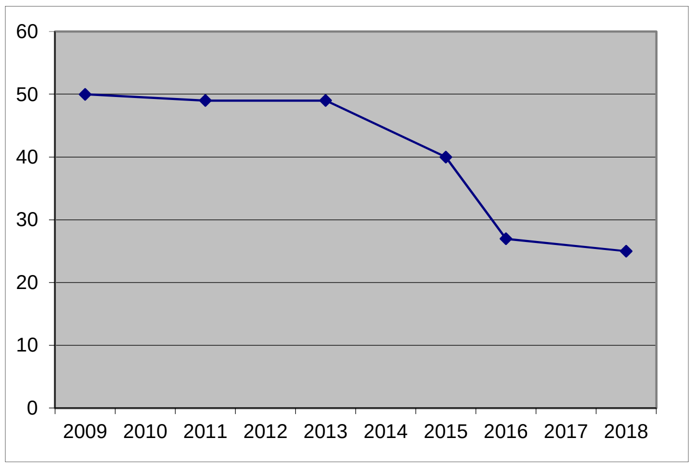

Raw Data

| 03M848 | Date | TCE | Date | TCE |
|---|---|---|---|---|
| | 12/2/1987 | 440 | 6/1/2003 | 450 |
| | 4/19/1990 | 190 | 6/21/2005 | 230 |
| | 7/19/1990 | 190 | 6/13/2006 | 190 |
| | 9/17/1990 | 330 | 6/21/2007 | 150 |
| | 3/18/1991 | 310 | 6/18/2008 | 130 |
| | 6/4/1991 | 730 | 6/17/2009 | 130 |
| | 9/3/1991 | 700 | 6/8/2010 | 130 |
| | 3/18/1992 | 640 | 6/24/2011 | 150 |
| | 6/3/1992 | >50.10 | 6/24/2011 | 160 D |
| | 6/3/1992 | 570 D | 6/1/2012 | 190 |
| | 9/3/1992 | >50.10 | 6/1/2012 | 180 D |
| | 3/9/1993 | 1300 | 6/27/2013 | 160 |
| | 3/9/1993 | 970 D | 6/9/2014 | 150 |
| | 3/17/1994 | 910 | 6/9/2014 | 150 D |
| | 3/16/1995 | 59 | 6/11/2015 | 130 |
| | 6/21/1996 | 1400 | 6/14/2016 | 110 |
| | 6/26/1997 | 510 | 6/14/2016 | 110 D |
| | 6/29/1998 | 660 | 6/8/2017 | 100 |
| | 6/4/1999 | 700 | 6/28/2018 | 110 |
| | 6/4/1999 | 650 D | | |
| | 6/12/2001 | 370 | | |

**WELL 04U859**
**MANN-KENDALL STATISTICAL ANALYSIS**
**OU3 - 2016**

| Date | TCE (µg/l) | Mann-Kendall Calculation: | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6/18/2009 | **50** | 1 | | | | | | | |
| 6/24/2011 | **49** | 1 | -1 | | | | | | |
| 6/27/2013 | **49** | 1 | -1 | 0 | | | | | |
| 6/10/2015 | **40** | 1 | -1 | -1 | -1 | | | | |
| 7/29/2016 | **27** | 1 | -1 | -1 | -1 | -1 | | | |
| 6/28/2018 | **25** | 1 | -1 | -1 | -1 | -1 | -1 | | |
| N | | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 15 |
| | sum | | -5 | -3 | -3 | -2 | -1 | 0 | Kendall S -14 |
| Possibles | | 15 | | | | | | | |
| | | | | | | | | | Kendall tau -0.933 |

| | |
|---|---|
| Mean | 40.00 |
| STNDEV | 11.4543 |
| COV | 0.2864 |
| Trend: | Negative |
| Confidence (lookup) | 99.51% |



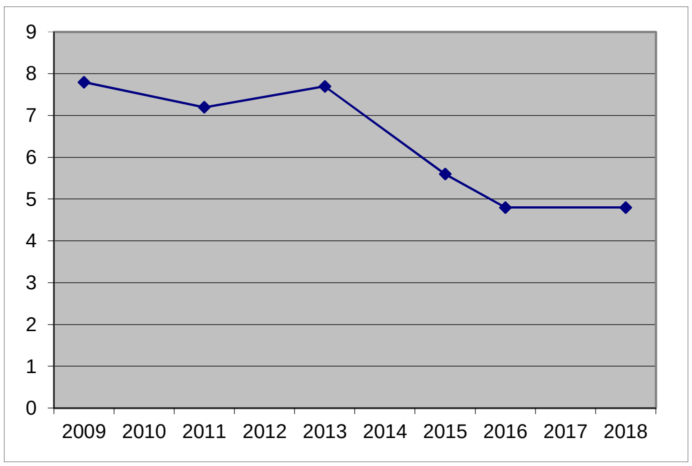

Raw Data

| 04U859 | Date | TCE | Date | TCE |
|---|---|---|---|---|
| | 11/13/1987 | 0.3 | 6/18/2009 | 50 |
| | 12/15/1988 | 8.5 | 6/24/2011 | 49 |
| | 4/30/1990 | 5.59 | 6/27/2013 | 49 |
| | 3/19/1991 | 5.24 | 6/10/2015 | 40 |
| | 3/20/1992 | 9.29 | 7/29/2016 | 27 |
| | 3/11/1993 | 40.5 | 6/28/2018 | 25 |
| | 3/18/1994 | 47 | | |
| | 3/18/1994 | 49.5 | | |
| | 6/9/1994 | 48.9 | | |
| | 9/14/1994 | 64 | | |
| | 12/7/1994 | 52.5 | | |
| | 3/10/1995 | 43.8 | | |
| | 6/3/1996 | 50.8 | | |
| | 6/4/1997 | 31.9 | | |
| | 6/25/1998 | 42 | | |
| | 6/25/1998 | 46.8 | | |
| | 6/7/1999 | 75 | | |
| | 6/13/2001 | 8.4 | | |
| | 6/1/2003 | 4.4 | | |
| | 6/22/2005 | 71 | | |
| | 6/21/2007 | 60 | | |

**WELL 03L859**
**MANN-KENDALL STATISTICAL ANALYSIS**
**OU3 - 2016**

| Date | TCE (µg/l) | Mann-Kendall Calculation: | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6/18/2009 | **7.8** | 1 | | | | | | | |
| 6/24/2011 | **7.2** | 1 | -1 | | | | | | |
| 6/27/2013 | **7.7** | 1 | -1 | 1 | | | | | |
| 6/10/2015 | **5.6** | 1 | -1 | -1 | -1 | | | | |
| 7/29/2016 | **4.8** | 1 | -1 | -1 | -1 | -1 | | | |
| 6/28/2018 | **4.8** | 1 | -1 | -1 | -1 | -1 | 0 | | |
| N | | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 15 |
| sum | | | -5 | -2 | -3 | -2 | 0 | 0 | Kendall S -12 |
| Possibles | | 15 | | | | | | | |
| | | | | | | | | | Kendall tau -0.8 |

| | |
|---|---|
| Mean | 6.32 |
| STNDEV | 1.4148 |
| COV | 0.2240 |
| Trend: | Negative |
| Confidence (lookup) | 98.19% |



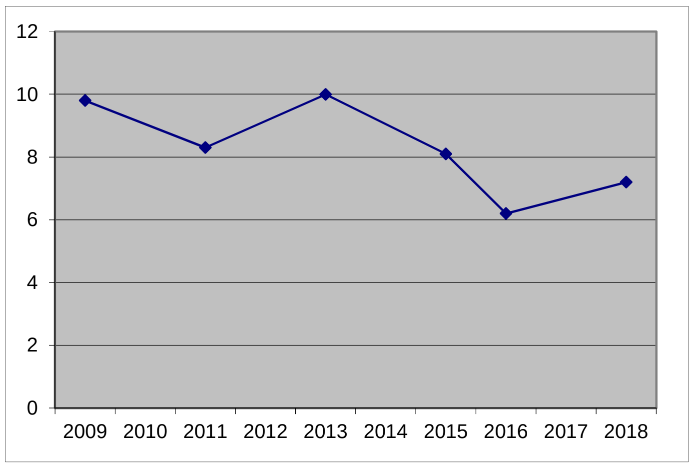

Raw Data
03L859

| Date | TCE | | Date | TCE |
|---|---|---|---|---|
| 11/13/1987 | <0.2 | | 7/29/2016 | 4.8 |
| 12/15/1988 | <1 | | 6/28/2018 | 4.8 |
| 4/30/1990 | <0.5 | | | |
| 3/19/1991 | <0.5 | | | |
| 3/20/1992 | 2.14 | | | |
| 3/11/1993 | 3.5 | | | |
| 3/18/1994 | 2.98 | | | |
| 6/9/1994 | 6.27 | | | |
| 9/14/1994 | 5.67 | D | | |
| 9/14/1994 | 5.67 | | | |
| 12/7/1994 | 4.75 | | | |
| 3/10/1995 | 4.55 | | | |
| 6/3/1996 | 5.96 | | | |
| 6/4/1997 | 2.86 | | | |
| 6/1/2004 | 10 | | | |
| 6/22/2005 | 8.9 | | | |
| 6/21/2007 | 9 | | | |
| 6/18/2009 | 7.8 | | | |
| 6/24/2011 | 7.2 | | | |
| 6/27/2013 | 7.7 | | | |
| 6/10/2015 | 5.6 | | | |

**WELL 04U854**
**MANN-KENDALL STATISTICAL ANALYSIS**
**OU3 - 2016**

| Date | TCE (µg/l) | Mann-Kendall Calculation: | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 6/18/2009 | **9.8** | 1 | | | | | | | |
| 6/23/2011 | **8.3** | 1 | -1 | | | | | | |
| 6/25/2013 | **10** | 1 | 1 | 1 | | | | | |
| 6/11/2015 | **8.1** | 1 | -1 | -1 | -1 | | | | |
| 7/28/2016 | **6.2** | 1 | -1 | -1 | -1 | -1 | | | |
| 6/28/2018 | **7.2** | 1 | -1 | -1 | -1 | -1 | 1 | | |
| N | | 6 | 5 | 4 | 3 | 2 | 1 | 0 | 15 |
| | sum | | -3 | -2 | -3 | -2 | 1 | 0 | Kendall S -9 |
| Possibles | | 15 | | | | | | | |
| | | | | | | | | | Kendall tau -0.6 |

| | |
|---|---|
| Mean | 8.27 |
| STNDEV | 1.4692 |
| COV | 0.1777 |
| Trend: | Negative |
| Confidence (lookup) | 93.20% |




Raw Data

| 04U854 | Date | TCE | | Date | TCE |
|---|---|---|---|---|---|
| | 10/20/1987 | 48.4 | | 6/23/2011 | 8.3 |
| | 11/13/1987 | 50.7 | | 6/25/2013 | 10 |
| | 12/16/1988 | 140 | | 6/11/2015 | 8.1 |
| | 5/4/1989 | 27.3 | | 7/28/2016 | 6.2 |
| | 7/20/1989 | 360 | | 7/28/2016 | 6.0 D |
| | 10/17/1989 | 89 | | 6/28/2018 | 7.2 |
| | 4/30/1990 | 67 | | | |
| | 3/13/1992 | 83 | | | |
| | 3/15/1993 | 70 | | | |
| | 6/8/1994 | 35.3 | | | |
| | 9/14/1994 | 36.6 | | | |
| | 12/7/1994 | 32 | | | |
| | 3/9/1995 | 25 | | | |
| | 6/4/1996 | 26.7 | | | |
| | 6/5/1997 | 17.6 D | | | |
| | 6/5/1997 | 16.5 | | | |
| | 6/1/2004 | <1.0 D | | | |
| | 6/1/2004 | 14 | | | |
| | 6/23/2005 | 11 | | | |
| | 6/21/2007 | 11 | | | |
| | 6/18/2009 | 9.8 | | | |

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