Fiscal Year 2021 Annual Performance Report
New Brighton/Arden Hills Superfund Site
Twin Cities Army Ammunition Plant

Prepared for

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LIST OF ACRONYMS AND ABBREVIATIONS

APR	Annual Performance Report
AO	Advanced oxidation
AOP	Advanced oxidation potential
ARARs	Applicable or Relevant and Appropriate Requirements
Army	U.S. Army
AS	Air sparging
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)
EBS	Environmental Baseline Survey
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Difference
FFA	Federal Facility Agreement
FS	Feasibility study
FY	Fiscal year
GAC	Granular activated carbon
GOS	Global Operating Strategy
gpm	Gallon per minute
HRL	Health Risk Limit
JV	PIKA Arcadis U.S., Inc. a Joint Venture
LUC	Land use control
LUCRD	Land use control remedial design
MCL	Maximum contaminant level
MDH	Minnesota Department of Health
MDL	Method detection limit
MDNR	Minnesota Department of Natural Resources
MNA	Monitored natural attenuation
MNARNG	Minnesota Army National Guard
MOS	Micro Operating Strategy
MPCA	Minnesota Pollution Control Agency

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

NB/AH	New Brighton/Arden Hills
NBCGRS	New Brighton Contaminated Groundwater Recovery System
NBM	New Brighton Municipal
OS	Operating Strategy
OU	Operable Unit
PCE	Perchloroethylene or tetrachloroethene
PGAC	Permanent granular activated carbon
PGRS	Plume Groundwater Recovery System
PLC	Programmable logic controller
PM	Preventative maintenance
POTW	Publicly Owned Treatment Works
PP	Proposed Plan
PTA	Primer/Tracer Area
QAPP	Quality Assurance Project Plan
RAO	Remedial Action Objective
RI	Remedial Investigation
RL	Reporting limit
ROD	Record of Decision
SGRS	Source Groundwater Recovery System
Shaw	Shaw Environmental & Infrastructure, Inc. (formerly Stone & Webster)
Site	New Brighton/Arden Hills Superfund Site
SRI-FS	Supplemental Remedial Investigation and Feasibility Study
SVE	Soil vapor extraction
SWBCA	Special well boring and construction area
SWCA	Special well construction area
TCAAP	Twin Cities Army Ammunition Plant
TCE	Trichloroethene
TGRS	TCAAP Groundwater Recovery System
USACHPPM	U.S. Army Center for Health Promotion and Preventive Medicine
USAEC	U.S. Army Environmental Command
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VFD	Variable frequency drive

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

VOC	Volatile organic compound
Wenck	Wenck Associates, Inc. (now Stantec)
WWP	Wet well pump
µg/L	Microgram(s) per liter

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ES. EXECUTIVE SUMMARY

This Fiscal Year (FY) 2021 Annual Performance Report (APR) summarizes the status of remedy implementation and addresses how the remedies are performing for each of the three operable units (OUs) related to the New Brighton/Arden Hills (NB/AH) Superfund Site. Figure 1-1 shows the site location and Figure 1-2 shows the approximate locations of the three OUs. This APR covers FY 2021 (1 October 2020 through 30 September 2021).

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

- OU1 ROD; signed 1993; amended 2006 (#1); Explanations of Significant Difference (ESD) signed 2020 (#1)

- OU2 ROD; signed 1997; amended 2007 (#1), 2009 (#2 and #3), 2012 (#4), 2014 (#5), and 2018 (#6); ESDs signed in 2009 (#1 and #2) and 2021 (#3)

- OU3 ROD; signed 1992; amended 2006 (#1).

The RODs, and subsequent amendments and ESDs, present the major components of the final remedies for the media of concern. This APR looks at each of the major components and addresses:

- Are the remedies being implemented? (Compliance check with the RODs and ROD amendments)

- Are the remedies doing what they are supposed to?

Sampling events typically occur annually during June and alternate between major and minor sampling events which affects OU1 deep groundwater, OU2 deep groundwater, and OU3 wells. Most OU1, OU2 deep groundwater, and OU3 wells are sampled during major sampling events with a small number of wells sampled during minor years. Selected wells located at Building 102, Site A, Site C, and Site K are sampled annually. Offsite Well Inventory wells are sampled every four years and coincide with major sampling events. For FY 2021, a minor sampling event was conducted. The 2021 minor sampling event is presented in detail in Appendix A.

Table ES-1 summarizes the status of remedial actions at the end of FY 2021. Following are summaries of the accomplishments for each OU, as well as other activities during FY 2021.

Operable Unit 1 (OU1)

OU1 consists of the "north" plume of volatile organic compound (VOC) groundwater impacts. The current remedy for OU1 consists of pumping from six municipal wells (New Brighton Municipal [NBM] wells NBM #3, #4, #5, #6, #14, and #15) and treating the extracted groundwater through the Permanent Granular Activated Carbon (PGAC) and

Ultraviolet/Peroxide Advanced Oxidation Process (AOP) systems. The remediation system began pumping in 1990 to treat TCE. The treated water is distributed by the New Brighton water supply system as potable water. Routine OU1 remedy pumping was ceased on 15 April 2015, with notice to the U.S. Environmental Protection Agency (EPA)/Minnesota Pollution Control Agency (MPCA), due to detection of 1,4-dioxane in the Prairie du Chien and Jordan Aquifer municipal wells. A new treatment system using ultraviolet/AOP was brought online in November 2018. ESD#1 to the 1993 OU1 ROD was prepared to add 1,4-dioxane to the list of contaminants of concern (COCs) and to document the addition of AOP treatment for 1,4-dioxane. This modification was needed because the PGAC system does not remove 1,4-dioxane.

FY 2021 activities include:

- The Minnesota Department of Health (MDH) Special Well Boring and Construction Area (SWBCA) 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. A sitewide well inspection was completed in FY 2020 and an inspection report including well abandonment recommendations for the Twin Cities Army Ammunition Plant (TCAAP) was submitted during FY 2021 (U.S. Army [Army] 2021a). Well abandonments are scheduled to take place in FY 2022. One well (04U884) was added to the well inventory list for FY 2021 and will be evaluated for abandonment or alternate water supply based on data collected at that time.

- Please note that for the purposes of this report, the Special Well Construction Area (SWCA) is synonymous with the SWBCA. SWCA has historically been referenced in RODs and other reporting documents. However, in the most recent modification (MDH 2016), the MDH references this area now as the SWBCA for TCAAP.

Operable Unit 2 (OU2)

OU2 is defined as the TCAAP property boundary in 1983, when the NB/AH Superfund Site was placed on the National Priorities List. Sites within OU2 include Shallow Soil Sites, Deep Soil Sites, Site A Shallow Groundwater, Site C Shallow Groundwater and Surface Water, Site I Shallow Groundwater, Site K Shallow Groundwater, Building 102, Deep Groundwater, and various Aquatic Sites.

In accordance with the Site A Shallow Groundwater: 10-Year Evaluation Report (Wenck Associates, Inc. [Wenck] 2008a), and with regulatory approval, the groundwater extraction system was shut down on 24 September 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 remained in stand-by mode in case MNA did not adequately control plume migration and one or more extraction wells needed to be restarted. In late 2015, following review of FY 2015 groundwater monitoring results, MNA was deemed an acceptable remedy by EPA and MPCA. The Army, EPA, and MPCA drafted an amendment to the 1997 OU2 ROD in FY 2017 to document the change in this remedy component. Formal approval of the ROD amendment was received during FY 2018 (OU2 ROD Amendment #6 [2018]). Annual monitoring was completed in FY 2021 per the monitoring plan.

Summary of activities within OU2 during FY 2021:

- Shallow Soil Sites: No activities were conducted other than ongoing U.S. Army (Army) implementation of land use controls (LUCs).

- Deep Soil Sites: No activities were conducted other than ongoing Army implementation of LUCs.

- Site A Shallow Groundwater:

  - An investigation in FY 2021 (Army 2021b) determined through the installation of three new monitoring wells that the groundwater plume was not impacting the residential community to the north. In addition, soil vapor investigation did not identify any risk to receptors.

  - Monitoring results from three of the four contingency wells located along the north side of County Road I did not exceed the approved action levels, which are equal to the cleanup levels for all Site A COCs in FY 2021. Well 01U902 exceeded the trigger level, but no further contingency action is required based on the findings of the groundwater and soil vapor investigation.

  - The MDH SWBCA remains in effect. In FY 2021, there were no new 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 13 November 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 2021.

  - None of the groundwater contingency locations exceeded the approved lead trigger levels in FY 2021.

  - 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 were 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 contained by the TCAAP Groundwater Recovery System (TGRS).

  - Monitoring well 01U667 will be reinstalled during FY 2022 and sampled.

- Site K Shallow Groundwater:

  - The Site K groundwater extraction trench and treatment system continued to operate as designed. For FY 2021, the system captured and treated 3,314,732 gallons of water and maintained a continuous zone of capture downgradient of the former Building 103. A total of 5.18 pounds of VOCs were removed in FY 2021.

  - Groundwater samples were collected from all 11 wells scheduled for sampling in FY 2021, including replacement wells 01U608R, 01U609R, and 01U611R that were installed in FY 2021. 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 20 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 (01U608R, 01U609R, and 01U611R) were reinstalled during FY 2021.

  - U.S. Geological Survey Maryland-Delaware-DC Water Science Center commenced groundwater treatability study work in FY 2021 to assess bioremediation as a destructive remedy for VOCs in Site K groundwater plume. Groundwater injection and monitoring points were installed in September 2021, and pilot scale biostimulation and bioaugmentation were conducted through the remainder of 2021. Additional work, including quarterly groundwater monitoring, will continue throughout FY 2022.

- Building 102 Shallow Groundwater:

  — VOC concentrations were generally similar to those observed in the prior year.

  — The well adjacent to Rice Creek (01U048) continued to show shallow groundwater discharging to Rice Creek with VOC levels below the site cleanup levels.

- Aquatic Sites: All aquatic sites are closed except Round Lake. The Supplemental Remedial Investigation-Feasibility Study (SRI-FS) has been completed at Round Lake. The Final Proposed Plan (PP) was published in July 2021. The Public comment period was held from 9 July 2021 to 13 August 2021 A ROD is currently in process and will include a response to comments.

- Deep Groundwater:

  — The OU2 Deep Groundwater remedy is the TCAAP Groundwater Recovery System (TGRS).

  — The TGRS operated in accordance with the 1997 OU2 ROD.

  — The TGRS operated at a rate sufficient to support the conclusion that the OU2 5 micrograms per liter TCE source area footprint is hydraulically captured respective of the 1997 OU2 ROD. In FY 2021, the TGRS extracted and treated approximately 929,903,186 gallons of water. The mass of VOCs removed was 1,746 pounds, 266 pounds less than FY 2020. The total VOC mass removed by the TGRS through FY 2021 is 224,226 pounds.

  — Groundwater analytical data collected from monitoring wells show either a decrease or stable condition in TCE concentrations. The 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 2021. Sample results were similar to those reported from FY 2015 to FY 2020.

  — ESD #3 document dated 15 October 2020 was prepared to address the addition of 1,4-dioxane as a COC and included the following improvements for the deep groundwater remedy:

    - Installation of new source area extraction wells at Site D, Site G, and Site I

    - Routing of the new source area extraction wells and one existing source area extraction well to a new AO system, to remove and treat 1,4-dioxane and TCE
    - Routing of the effluent from the Source Groundwater Recovery System (SGRS) to a co-located new air stripper to remove residual VOC contaminants
    - Discharge of the treated groundwater from the SGRS to the gravel pit

- The SGRS is currently under construction with an estimated completion date of June 2022.

- Once completed, the expanded TGRS groundwater extraction and treatment for on-site Deep Groundwater within OU2 will consist of two individual systems: the SGRS and the Boundary Groundwater Recovery System (BGRS), as follows:

    - The SGRS will provide enhanced source area contaminant mass removal at Site D, Site G, and Site I. The SGRS will include the operation of two existing source area extraction wells (SC-1 and SC-5 previously routed to the Building 116 groundwater treatment system) and seven new source area extraction wells. The SGRS will use AO for treatment of 1,4-dioxane and TCE, and air stripping for treatment of residual VOCs.
    - The current Building 116 groundwater treatment system will continue to operate as the BGRS, providing supplemental hydraulic containment and treatment of low VOC concentration groundwater. The BGRS will include operating seven existing groundwater extraction wells along the southwest portion of the property boundary for supplemental hydraulic containment and the existing air stripping system to treat low VOC concentration boundary groundwater.

Operable Unit 3 (OU3)

OU3 contains the South Plume of VOC groundwater impacts, which is treated by MNA. Overall, the statistical evaluation of groundwater data collected in FY 2021 indicates stable to declining concentration trends at the center and edge of the South Plume. 1,4-dioxane sampling continued in FY 2021 with results similar to those reported over the last six years.

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

Round Lake

The Army has been working with regulators, landowners and other stakeholders since an informal dispute was resolved in 2016. After a series of collaborative meetings, a Final SRI-FS was submitted to regulators in March 2021. A Draft PP was submitted to regulators in April 2021. Comments received were incorporated, and a Final PP was submitted on 7 July 2021. An open house and public meeting were held in July 2021, with comments received. The Army will incorporate a response to comments into the ROD still under development at the end of FY21.

1. INTRODUCTION

1.1 PURPOSE

This APR is intended to both summarize the status of remedy implementation and address remedy performance. This APR covers remedial actions at the NB/AH Superfund (Site) from 1 October 2020 through 30 September 2021 (FY 2021). The NB/AH Site is divided into three designated OUs: OU1, OU2, and OU3 (Figure 1-2). OU1 encompasses off-site deep groundwater also referred to as the North Plume. OU2 includes over 20 sites with soil, sediment, surface water, and groundwater impacts in the area that comprised TCAAP in 1983, when the NB/AH Site was placed on the National Priorities List. OU3 consists of off-site deep groundwater sometimes referred to as the South Plume. RODs were developed and signed for each OU:

- OU1 ROD; signed 1993; amended 2006 (#1); ESD signed 2020 (#1)
- OU2 ROD; signed 1997; amended 2007 (#1), 2009 (#2 and #3), 2012 (#4), 2014 (#5), and 2018 (#6); ESDs signed in 2009 (#1 and #2) and 2021 (#3)
- OU3 ROD; signed 1992; amended 2006 (#1).

The RODs, subsequent amendments, and 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 U.S. Army (Army), EPA, and 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 upon within work plans or design documents. With performance standards identified, this APR then addresses both questions discussed above through a series of sub-questions, written to facilitate a focused and user-friendly document through the utilization of figures and or graphs.

FY 2021 represents a minor sampling event in the monitoring plan. The 2021 minor sampling event is presented in detail in Appendix A. In addition to reporting on FY 2021, 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 2021 through FY 2025, where the next year FY 2021 will drop off and FY 2026 will be added).

1.2 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 1-2). 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 impacts 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, when it was determined the source of impacts and groundwater impacts were from TCAAP, the NB/AH Site was placed on the National Priorities List.

Several known and potential contaminant source areas on the TCAAP property were initially identified within the original TCAAP boundary that is OU2: Sites A, B, C, D, E, F, G, H, I, J, K, 129-3, 129-5, and 129-15 (Figure 1-3). 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 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 1-3.

Since 1983 the size of the federal portion 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 1-3 presents the OU2 property boundaries. Figure 1-4 presents property under federal ownership at the end of FY 2021, along with the organizations responsible for control. The minimal remaining TCAAP (Base Realignment and Closure-controlled) property is currently in the process of being transferred out of federal ownership. These property transfers do not alter the responsibilities or liability of the Army under the FFA.

1.3 HYDROGEOLOGIC UNITS AND WELL NOMENCLATURE

For purposes of studies and work related to the site, four hydrogeologic units have been designated: Unit 1 (the Fridley Formation), Unit 2 (the Twin Cities Formation), Unit 3 (the Hillside Sand), and Unit 4 (the Prairie du Chien and Jordan Formations), 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 well identification 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.

1.4 DATA COLLECTION, MANAGEMENT, AND PRESENTATION

Performance monitoring data were collected in accordance with the FY 2021: 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 EA on behalf of the Army, Conestoga-Rovers & Associates, Inc. (CRA; now GHD) on behalf of Northrop Grumman, and Barr Engineering 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 2021 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 2021 Monitoring Plan and verified and validated in accordance with the Quality Assurance Project Plan (QAPP) for Performance Monitoring (PIKA Arcadis U.S., Inc. a Joint Venture [JV] 2020a), 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 2021 data are explained in the data table footnotes. Data verification (performed on 100 percent of the data) and data validation (performed on 100 percent of 1,4-dioxane data and a minimum of 10 percent of the data, except at Site K) were provided to EPA and MPCA via submittal of quarterly Data Usability Reports covering FY 2021 information (Arcadis 2021a, 2021b, 2021c; EA 2021). The final EPA approval letter for the FY 2021 Data Usability Reports is included in Appendix C.3.

Completeness

Appendix C.2 summarizes any deviations from the FY 2021 Monitoring Plan. The field and laboratory completeness goals for performance monitoring are both 95 percent, except for TGRS effluent, Site K effluent, and well inventory samples, for which field and laboratory completeness goals are 100 percent. Actual field and laboratory completeness were both 100 percent, 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 percent completeness goals was successful at 100 percent.

Quality Control

The QAPP specifies field duplicates, equipment rinse blanks, and matrix spike/matrix spike duplicates are to be collected at overall frequencies of 10 percent, 10 percent, and 5 percent, respectively. Actual quality control sample frequencies met these goals with respective frequencies of 11 percent, 11 percent, and 7 percent.

Data Validation

The performance monitoring QAPP specifies that data validation be completed at an overall rate of 10 percent, with 100 percent validation of 1,4-dioxane data and well inventory samples. The actual validation rate for VOCs collected in FY 2021 was 59 percent, far exceeding 10 percent, and all data requiring 100 percent data validation were fully validated, meeting the specified validation rates for performance monitoring.

FY 2021 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).

2. OPERABLE UNIT 1: DEEP GROUNDWATER

The 1993 OU1 ROD was amended in 2006 to formalize adoption of groundwater quality statistical analysis. In 2020, an ESD was approved for changes to the treatment system to add 1,4-dioxane as a COC.

In early 2015, MDH notified the City of New Brighton 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 in 2015 exceeding the MDH HRL. NBCGRS ceased pumping operations from the shallow aquifer on 15 April 2015. The City switched to preferential extraction from deep aquifer wells and outside water sources while evaluating removal technologies. A pilot study report for advanced oxidation (AO) technology for treatment of 1,4-dioxane was completed in August 2016.

The New Brighton water treatment plant was upgraded to include ultraviolet/peroxide advanced oxidation potential (AOP) technology to treat 1,4-dioxane in November 2018.

Primary elements of the 1993 OU1 ROD and the 2020 ESD are as follows (amendment changes in italics):

- Providing alternate water supplies to residents with private wells within the North Plume.

- Implementing drilling advisories that would regulate the installation of new private wells within the North Plume as a SWBCA.

- *Extracting groundwater from the North Plume using the New Brighton Contaminated Groundwater Recovery System* (NBCGRS), subject to the following:

  — The initial aggregate groundwater extraction rate shall be consistent with long-term NBCGRS operating history.

  — Future decreases in the aggregate extraction rate will be determined by the Army, EPA, 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.

  — Future changes to the aggregate or individual well extraction rates will 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 1993 OU1 ROD.

- — 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 above (OU1 ROD Amendment #1 (2006), pages 5-2 and 5-3).

- Future changes to the aggregate or individual well extraction rates will 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 1993 OU1 ROD and 2020 ESD and pumping the extracted groundwater to the permanent granular activated carbon (PGAC) and ultraviolet/peroxide advanced oxidation potential (AOP) Water Treatment Facility in New Brighton for removal of VOCs by a pressurized granular activated carbon (GAC) system.

- Discharging all treated water to the New Brighton municipal distribution system.

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

The monitoring requirement 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 EPA and MPCA). There have been no revisions or addendums to the approved 2004 Technical Memorandum, though one is anticipated to be completed in FY 2022. The statistical analysis is conducted annually and is reported in this APR.

The six major components of the remedy prescribed by 1993 OU1 ROD, OU1 Amendment #1 (2006a) and the 2020 ESD are evaluated below, including discussion of the effects of the remedy time-out noted above. Concentrations of 1,4-dioxane remain below the MDH HRL of 1µg/L.

2.1 REMEDY COMPONENT #1: ALTERNATE WATER SUPPLY/WELL ABANDONMENT

Description: **"**Providing an alternative water supply to residents with private wells within the North Plume." (1993 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've achieved the remedy):

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):

- 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

- The well is completed in an affected aquifer

- The well contains detectable concentrations of the NB/AH Site-related COCs identified on page 18 of the 1993 OU1 ROD (or page 26 of the 1992 OU3 ROD, or Table 1 of the 1997 OU2 ROD, as appropriate for the well location)

- The well is used in a manner to cause exposure (uses are defined in the *OU1 Alternate Water Supply Plan*)

- 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 <u>all</u> wells that meet all the following criteria have been offered and provided abandonment (or when the well owners have rejected the offers):

- The well is located within the area affected by groundwater plumes that originate at OU2

- The well is completed in an affected aquifer

- The well contains detectable concentrations of the NB/AH Site-related COCs identified on page 18 of the 1993 OU1 ROD (or page 26 of the 1992 OU3 ROD, or Table 1 of the 1997 OU2 ROD, as appropriate for the well location)

- The well was constructed prior to the MDH SWBCA advisory

- The well is being used by the well owner or use was discontinued due to impacts

- 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, EPA, 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 SWBCA). 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 0.25-miles buffer. The wells are grouped into categories (e.g., location relative to the area of concern, type of use, active/non-active status, sealed). 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:

- Check if the area of concern needs to be adjusted based on the extent of impacts
- Check if there are any previously unknown wells to be added to the database (coordination with the MDH as described in Appendix E)
- Sample wells on a prescribed schedule
- Take the appropriate course of action per results
- Update the well inventory database with any new information (e.g., water quality results, owner information, construction information, well re-categorizing)
- 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 2021, as defined by the 5 µg/L TCE contour line and the 1,4-dioxane µg/L contour line?

As shown on Figure 2-1, the area of concern for TCE did not change significantly during FY 2021. Similarly, the area of concern did not change significantly from FY 2020 for 1,4-dioxane as depicted in Figure 2-4. The well inventory study area encompasses the FY 2021 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?

Well 04U844 was added to the well inventory list for FY 2021 and will be evaluated for abandonment or alternate water supply based on data collected during the next major sampling event in FY 2022. See Appendix E for additional information.

Were any water supply wells within the area of concern for OU1 sampled during FY 2021 (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 2022.

Were any well owners offered an alternate water supply and/or well abandonment during FY 2021?

The Army offered alternate water supply and well abandonment for 4 commercial wells (234421, 234544, 509052, and 537801) during FY 2021 due to exceedances of the MDH HRL for 1,4-dioxane. At this time, the owners of well 234544, R&D Systems, and well 509052, Shriner's Hospital, have requested connection to the municipal water supply. BioClean, the owner of 234421 has rejected the offer for an alternate well supply. The Army is awaiting a response from the remaining well owners.

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. The next major sampling event for well inventory is scheduled for FY 2024.

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

Letters outlining the results of sampling were sent to well owners during FY 2021.

2.2 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 [SWBCA]." (1993 OU1 ROD, page 2).

Performance Standard (how do you know when you've achieved the remedy):

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

Has the MDH issued a SWBCA Advisory?

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

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

No.

2.3 REMEDY COMPONENT #3: EXTRACT GROUNDWATER

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

- The initial aggregate groundwater extraction rate will be consistent with the long-term operating history of the NBCGRS.

- Future decreases in the aggregate extraction rate will be determined by the Army, EPA, 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.

- Future changes to the aggregate or individual well extraction rates will 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 1993 OU1 ROD.

- The facilities comprising the NBCGRS may be modified as necessary to assure the restoration of the full aerial and vertical extent of the aquifer in a timeframe as contemplated above (OU1 ROD Amendment #1 [2006a], pages 5-3 to 5-5).

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 formations. NBM #5 and #6 were existing wells completed in the Jordan formation. NBM #14 and NBM #15 were constructed in the Prairie du Chien formation 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 2-1.

The extracted groundwater is used as part of the New Brighton water supply system, and as such, New Brighton took the lead on design and construction of the system and is responsible for system operation. The federal government is paying for the OU1 remedy.

In 2006, New Brighton and the Army modified the NBCGRS operation to allow more flexibility and to increase removal of contaminant mass from the aquifer. In November 2007, EPA 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 #1 (2006a). 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 #1 (2006a), the pumping allocations will revert to the previous scheme. Currently, optimizations are complete and Army is working with New Brighton to install a well more central to the plume to increase COC mass collection (Army 2022a). As of May 2022, well installation activities are on hold.

Performance Standard (how do you know when you've achieved the remedy):

When the NBCGRS is operating consistently with long-term NBCGRS operating rates and meeting applicable remedial goals.

During FY 2021, did the OU1 extraction system operate per the New Brighton operational plan and consistent with past operations?

Yes. Based on past operations, the target average daily pumping rate is 3.168 million gallons per day as shown in Appendix A.5. In FY 2021, the volume of water pumped by the NBCGRS was 1.158 billion gallons, which translates to a daily average of 3.172 million gallons per day.

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

No.

2.4 REMEDY COMPONENT #4: REMOVAL OF VOCS BY PGAC AND AOP

Description: "Pumping the extracted groundwater to the PGAC Water Treatment Facility in New Brighton for removal of VOCs by a pressurized GAC system" (1993 OU1 ROD, page 2) and 1,4-Dioxane (2020 ESD).

Treatment by the PGAC and the AOP system along with iron and manganese removal and chlorination makes the recovered groundwater suitable for municipal drinking water purposes. The treatment system is located approximately 0.33 miles south of Interstate 694 near Silver Lake Road. The City of New Brighton is responsible for operation and maintenance of the PGAC and AOP, with cost reimbursement from the Army for the operations related to the remedy.

Performance Standard (how do you know when you've achieved the remedy):

When the treated water at or below the maximum contaminant level (MCL) and non-zero MCL goals established by the Safe Drinking Water Act for the constituents of concern, as identified on page 18 of the 1993 OU1 ROD.

Did the treated water meet the MCLs and non-zero maximum contaminant level goals established by the Safe Drinking Water Act for the OU1 chemicals of concern?

Yes.

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

Yes, sampling will continue on a monthly basis.

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

No.

2.5 REMEDY COMPONENT #5: DISCHARGE OF TREATED WATER

Description: "Discharging all of the treated water to the New Brighton municipal distribution system." (1993 OU1 ROD, page 2).

Performance Standard (how do you know when you've achieved the remedy):

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?

Yes.

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

No.

2.6 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" (OU1 ROD Amendment #1 [2006a], page 5-3).

Performance Standard (how do you know when you've achieved the remedy):

When performance groundwater monitoring verifies aquifer restoration per the qualitative and statistical analyses discussed below.

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 2-1 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 2021 was a "minor" sampling year and included sampling of well inventory wells. Also, with the detection of 1,4-dioxane in the NBCGRS wells, EPA and MPCA requested that the Army analyze groundwater samples for 1,4-dioxane at all scheduled OU1 sampling locations during the summer FY2021 and future annual sampling events. All the required and requested sampling was completed, except for well 04J847, where access was not granted by the property owner.

Is any groundwater monitoring proposed prior to the next report?

Yes. Monthly monitoring of the OU1 extraction system 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.

Other groundwater monitoring will be in accordance with the Groundwater Monitoring Plan included as Appendix A.1. A "major" event is planned for FY 2022.

Does groundwater monitoring show aquifer restoration is occurring?

Historical 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. FY 2021 monitoring data are consistent with pre-shutdown data. Since startup in 2018 trichloroethene (TCE) trends in the NBCGRS wells appear to be stable for well NBM #6 and decreasing for wells NBM #3, #4, #5, #14, and #15, (Figure 2-2).

Figure 2-3, Figure 2-4, and Figure 2-5 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 2021, along with cross-section lines, based on the September 2021 sampling event. The southern edge of the TCE and 1,4-dioxane contours in Figures 2-1 and 2-4 are dashed where inferred, as the southern boundary could not be fully delineated in a minor sampling event year. Figure 2-3 presents the combined Upper and Lower Unit 3 TCE plume with the highest concentrations residing near the OU2 source areas. There were minor changes of the plumes in FY 2021, where the northern edge of the Jordan plume shifted to the south below the locations 04J822 and 04J849. The last significant changes of the plume came in FY 2019 with the Unit 3 plume shifting just downgradient of the OU2 source areas, Sites D, G, and I. The plume was updated using groundwater concentration data from the vertical aquifer profiling drilling event that took place from September through December 2019. In general, 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 formation) and bedding-plane fractures (Jordan). Figures 2-4 and 2-5 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.

Figure 2-1 shows the 1 µg/L TCE contour for Upper Unit 4 in 1990, 1999, and 2009 and the 5 µg/L TCE contour for 2021. Figures 2-6 and 2-7 overlap to some extent and should be viewed together. Figures 2-8 depicts a cross-section showing the OU2/OU3 plume. Figure 2-9 depicts the 100 µg/L TCE contour for Upper Unit 4 for certain years between 1990 and 2020, similar to Figure 2-1 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 2-1 shows, the plume footprint remains similar to 2009. Figure 2-9 shows a smaller plume compared to 2009 with the 2021 plume receding towards the northwest, potentially due to the NBCGRS. A slight northward shift was observed in FY 2015 and FY 2016 of the 5 µg/L and 100 µg/L TCE contours on the northwest edge of the plume, likely a result of the NBCGRS remedy time-out beginning in April 2015. This shift was first observed following the FY 2015 sampling event and was observed slightly farther north again in FY 2016. This trend appears to have reversed since the NBCGRS was started back up and the plumes appear to have receded. The water level data from June to September 2021 for Upper Unit 4 are presented as a potentiometric map on Figure 2-10.

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 2004 Technical Memorandum 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 COC concentrations."

The OU1 2004 Technical Memorandum identified five issues that need to be statistically evaluated with respect to the above objective:

- Measure changing concentrations immediately downgradient of the TGRS, as this area is the first to be affected by any potential COC migration via TCAAP.
- Measure changes in the geographical size of the plume over time.
- Measure changes in concentrations immediately downgradient of the NBCGRS, as this is the first area to be affected by any potential COC migration outside of NBCGRS capture.
- 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.

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

The OU1 2004 Technical Memorandum 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 (EPA and MPCA). Appendix D-2-3 shows the factors to consider and potential additional actions that may be implemented if the statistical threshold is triggered. As Appendix D-2-3 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. Groundwater velocities may be reduced in this area and response may be slow. Furthermore, individual wells near the stagnation zone may show increases in COC 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 (less than 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 because 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 from regulators 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 monitoring wells 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 2-2 presents the FY 2021 groundwater quality data for OU1 collected to support the statistical analysis developed by the OU1 Technical Group. Historical TCE concentrations at any well can be viewed in the Appendix D Groundwater Quality: Organic Data spreadsheet included on the FY 2021 APR compact disc. The statistical analysis in Appendix D-2 follows the format described in the OU1 Technical Memorandum and Modification #1.

Table 2-3 summarizes the statistical results wells sampled in FY 2021, from Appendix D-2. Table 2-3 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 2021 and have "increasing" or "no significant" trends are discussed below. For discussion of other wells or well groups, refer to the FY 2020 APR.

Groups 1-4:

Wells from these groups were not sampled during FY 2021 and therefore no new statistical analysis was conducted.

Group 5 Global Plume Wells:

04U855 (Increasing Trend): The overall increasing trend at this well began in 2011, though in more recent sampling events the results have been variable. In 2016 and 2018, the result was 21 µg/L, dropped to 4.5 µg/L in 2019, and increased to 25 µg/L in FY 2021. Continued annual monitoring of this well is appropriate to further evaluate how the OU1 plume is shifting.

04U871 (No Significant Trend): Historical results from this well range from 13 to 32 µg/L, though in recent events the results have been variable. In 2018, the result was 78 µg/L, in 2019 concentrations dropped to 21 µg/L, and the concentration increased to 86 µg/L in 2021. Further monitoring in necessary to determine if a significant trend emerges.

04U872 (No Significant Trend): This concentration has dropped from 7 µg/L in 2018 to 4.47 µg/L in 2021, below the cleanup goal for OU1. Historic concentrations observed at this location have reached 11 µg/L. Further monitoring is necessary to determine if:

04U877 (No Significant Trend): Concentrations of TCE at this well have consistently been below 2 µg/L; therefore, a "No Significant Trend" result is not of concern.

04U879 (No Significant Trend): This well had historically been non-detect until FY 2015 when TCE was 7 µg/L. Concentrations have ranged from 3.5 µg/L to 20 µg/L since FY 2011 and continued annual monitoring is appropriate to further evaluate how the OU1 plume is shifting.

Group 6 (Jordon Wells):

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 below the cleanup goal of 5 µg/L and has remained there since. There was a slight increase from the 2020 value of 1.2 µg/L to the 2021 result of 2.41 µg/L. Continued annual monitoring is appropriate to further evaluate how the OU1 plume is shifting.

Group 6 (Nested Wells):

04U839 (Probably Increasing): This well is near the NBCGRS; therefore, 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 concentrations have been between 27.2 µg/L and 50 µg/L during the five most recent sampling events, though an overall decreasing trend has been observed during the same timeframe. This increase may be influenced by the NBCGRS shut down.

Overall Statistical Assessment:

Discussion of established threshold triggers can be found Appendix D. 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 met the statistical criteria developed in this APR for assessing the remedial progress in the OU1 aquifers. The data show continuing improvement in the OU1 plume through FY 2021. 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 removed a total of approximately 331 pounds of VOCs during FY 2021. NBM Wells #3, #4, #5, #6, #14, and #15 removed 89, 83, 93, 66, 0.3 and 0.3 pounds respectively. The total cumulative VOCs removed by the NBCGRS through the end of FY 2021 is 24,547 pounds.

Figure 2-11 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). Mass removal in FY 2021 was similar to FY 2020, albeit slightly less than mass removal prior 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?

No.

2.7 OTHER RELATED ACTIVITY IN FY 2021

OU1 optimization activities were conducted in October and November 2020 to fill existing data gaps, improve the overall OU1 conceptual site model, and support future remedial optimization by determining if an additional NBCGRS extraction well is recommended to improve contaminant extraction and, if so, to identify a well location that will maximize contaminant mass removal. This work included a program of downhole hydrostratigraphic and groundwater quality profiling on existing OU1 wells. The scope of work consisted of geophysical logging and vertical aquifer profiling of wells under pumping conditions. A final report consisting of the findings and recommendations from these activities was completed and submitted in July 2021 (Army 2022a). A final Well Inspection Report was submitted in September 2021 (Army 2022b). Based on the findings of the investigation and inspections, a new drinking water supply well was scheduled to be installed in May 2022, though as of May 2022, installation is on hold.

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3. 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 1997 OU2 ROD include Amendments #1 (2007), #3 (2009), #4 (2012), #5 (2014), and ESD #2 (2009).

Through the OU2 Remedial Investigation (RI)/FS process, Sites A, C, E, H, 129-3, and 129-5 were found to have inorganic and/or organic COCs above the cleanup goals specified in Table 1 of the 1997 OU2 ROD. Unpermitted landfills, or dumps, were identified within Sites A, B, E, H, and 129-15. The 1997 OU2 ROD (page 2) describes nine remedy components to address the shallow soil and dump sites.

The OU2 ROD Amendment #1 (2007) modified the requirements for Site C-2 soil and sediment (note that Site C groundwater and surface water is addressed separately in Section 6). 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 impacts remain in-place above the cleanup levels. The OU2 ROD Amendment #1 (2007) also specified LUCs as an additional remedy component for Site C-2.

The OU2 ESD Amendment #2 (2009) addressed shallow groundwater at Site I, which is discussed in Section 7.

The OU2 ROD Amendment #3 (2009) affected the shallow soil and dump sites in four principal ways:

- OU2 ROD Amendment #3 (2009) 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 1997 OU2 ROD (see Section 4 of this APR for discussion of the deep soil).

- OU2 ROD Amendment #3 (2009) documented the use of soil covers as part of the final remedy at Sites E, G, H, and 129-15.

- OU2 ROD Amendment #3 (2009) documented final remedies for five sites with soil impacts that were not originally included in the 1997 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 impacts 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.

- OU2 ROD Amendment #3 (2009) 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 impact 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 LUC remedial design (LUCRD).

ESD #1 is discussed in Section 5 (Site A shallow groundwater), Section 8 (Site K shallow groundwater), and Section 11 (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.

The OU2 ROD Amendment #4 (2012) 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 OU2 ROD Amendment #4 (2012) also addressed Building 102 shallow groundwater, discussed in Section 9, and OU2 aquatic sites, discussed in Section 10.

The OU2 ROD Amendment #5 (2014) 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.

3.1 REMEDY COMPONENTS #1 THROUGH #9: SOIL REMEDIATION

The nine remedy components specified in the 1997 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 OU2 ESD #2 (2009) and OU2 ROD Amendment #3 (2009), respectively.

3.2 REMEDY COMPONENT #10: LAND USE CONTROLS

Description: "OU2 ROD Amendments and ESDs established LUCs as part of the remedy for shallow soil and dump sites where impacts remain-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've achieved the remedy):

Initial implementation was done when EPA 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. In Revision 6 of the LUCRD (Army 2020b), shallow and deep soil within OU2 and surface water and sediment (not groundwater) at five aquatic sites within OU2 (Rice Creek, Sunfish Lake, Marsden Lake North, Marsden Lake South, and Pond G) was reported as delisted from the National Priorities List in November 2019 and state superfund Permanent List of Priorities in May 2020.

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

Yes. EPA and MPCA provided consistency approval for the OU2 LUCRD in September 2010 and it has been implemented by the Army and revised as necessary. Figure 1-4 presents property under federal ownership at the end of FY 2021, along with the organizations responsible for control.

Was an annual site inspection for LUCs conducted in FY 2021?

Yes. On 22 July 2021 the Army, MNARNG, 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?

The LUC Site inspection checklist noted that excavation or other man-made soil disturbance had been observed at Site H and that woody vegetation exceeding 2 inches in diameter was present at Site G. A previous version of the LUC inspection report incorrectly noted that "Sites D, E, G, and H had small, woody trees in and around the soil cap that were removed." This text was removed from the final version of this APR.

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4. OPERABLE UNIT 2: DEEP SOIL SITES

For purposes of the 1997 OU2 ROD, Sites D and G were considered deep soil sites because VOC impacts extended to depths between 50 and 170 feet. Some additional shallow soil COCs were also present at Site D, and Site G also contains a dump. The 1997 OU2 ROD (pages 2 to 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
- 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 11) and is not discussed 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 COCs) 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 the OU2 ROD Amendment #3 (2009).

In summary, the deep soil requirements of the 1997 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 3.

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5. OPERABLE UNIT 2: SITE A SHALLOW GROUNDWATER

Shallow groundwater at Site A has been impacted by VOCs and antimony. The selected remedy in the 1997 OU2 ROD incorporates the use of a groundwater extraction system, which began operation 31 May 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 24 September 2008, while implementation of MNA was being evaluated.

Source characterization work has been completed. Stone & Webster Environmental Technology & Services (Stone & Webster) performed investigation work in 1997 and the Final Site A Investigation Report (Stone & Webster 1997) was issued 12 December 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.”

Shaw Environmental and Infrastructure, Inc. (Shaw, formerly Stone & Webster) completed removal of metal-contaminated soils in FY 1999. Construction of an air sparging (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 a concern regarding potential plume spreading. The AS system was being implemented voluntarily by the Army and was not a 1997 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 21 August 2002. The Army submitted a work plan clarification to EPA 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 5-3 and 5-4 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.

The original 8-well groundwater extraction system that was selected in the 1997 OU2 ROD began operation 31 May 1994. On 11 July 2000, with regulatory approval, extraction wells 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, EPA and MPCA approved the Site A Shallow Groundwater: 10-Year Evaluation Report (Wenck Associates, Inc. [Wenck] 2008a). The 10-Year Report was prepared to fulfill a requirement of the 1997 OU2 ROD, which states that for shallow groundwater impacts 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 impacts were 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 EPA and MPCA.

In September 2008, EPA and MPCA approved the Site A Shallow Groundwater: Monitoring and Contingency Plan (Wenck 2008b), and EW-1 through EW-4 (the “first line” of extraction wells) were shut off on 24 September 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 this APR, and thus any changes to monitoring and contingency actions must be approved by EPA and MPCA through revisions to this APR.

The decision to proceed with MNA was based in part on the EPA and MPCA natural attenuation study at the site (2000) and follow-up MPCA/EPA microcosm studies that have verified that abiotic degradation of VOCs in Site A groundwater is occurring at substantial rates. Such degradation acts to reduce COC mass and mobility by breaking down the COCs 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 11 November 2015 Technical Memorandum submitted by the Army that documented the FY 2015 monitoring results and recommended changing the remedy to MNA, EPA and MPCA approved changing the remedy to MNA in lieu of groundwater extraction and discharge. This change was approved in OU2 ROD Amendment #6 in early FY 2018. These extraction wells are included in the monitoring plan for Site A. Therefore, they will not be sealed.

As part of a Site A Work Plan approved in October 2020, the Army conducted an additional groundwater and soil vapor investigation in 2021 as a contingency action. Six direct-push locations were sampled, three new monitoring wells (01U905, 01U906, and 01U907) were installed and sampled, and soil vapor sampling was conducted. These results demonstrated that the Site A shallow groundwater plume was not affecting the residential community to the north and the soil vapor results showed that the constituents of concern were all below MPCA residential Intrusion Screening Values and did not pose a risk to receptors.

5.1 REMEDY COMPONENT #1: GROUNDWATER MONITORING

Description: “Groundwater monitoring to track plume migration and remedy performance.” (1997 OU2 ROD, page 3).

Performance Standard (how do you know when you’ve achieved the remedy):

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 5-1 summarizes performance monitoring requirements, implementing parties, and monitoring plan documents. The FY 2021 Monitoring Plan is included in Appendix A, and the FY 2021 water quality monitoring locations and frequencies are also summarized on Figure 5-1. Any deviations are explained in Appendix C.2. Figure 5-2 presents September 2021 measured groundwater elevations and groundwater contours.

As part of a contingency investigation, three new wells (01U905, 01U906, and 01U907) were installed and sampled in FY 2021.

Were the groundwater monitoring requirements for this remedy met?

Yes.

Is any groundwater sampling proposed prior to the next report?

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

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 is used as a monitoring point in place of 01U108 due to an obstruction that has prevented monitoring since FY 2017. As of the end of FY 2020, 01U108 had been abandoned. In addition, the three new wells installed during the FY 2021 groundwater investigation will be added to the monitoring plan detailed in Appendix A.1.

5.2 REMEDY COMPONENT #3A: LAND USE CONTROLS

Description: The 1997 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've achieved the remedy):

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

Has the MDH issued a SWBCA 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 Site A.

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

Yes. EPA 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 2021?

Yes. On 22 July 2021, the Army, MNARNG, and JV conducted the 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.

5.3 REMEDY COMPONENT #3B: ALTERNATE WATER SUPPLY/WELL ABANDONMENT

Description: The 1997 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've achieved the remedy):

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 2.1 for further information.

Did the boundary of the Site A plume get any bigger during FY 2021, as defined by the 1 µg/L contour?

No. Table 5-2 presents the FY 2021 groundwater quality data for Site A. Using these data, Figure 5-3 shows the tetrachloroethene (PCE) concentrations and Figure 5-4 shows the cis-1,2-dichloroethene (cis-1,2-DCE) concentrations. The latter is a degradation product of the former and represents the larger aerial footprint. The plume for cis-1,2-DCE increased in size to the east and west as shown on Figure 5-5; however, based on sampling of the newly installed wells to the north, did not migrate to the northwest residential area. Beginning in 2019, it appeared that the groundwater plume is moving in a northwestern direction past the boundary of TCAAP and contingency well locations. An investigation to delineate the Site A shallow groundwater plume and assess the potential for vapor intrusion risk to nearby receptors was conducted from March to June 2021. Findings were provided in the Site A Investigation Final Report (Army 2021b). Based on the findings of the investigation, soil vapor results were not considered to pose a risk to receptors, and it was determined that the leading edge of the groundwater plume did not extend into the residential community to the north.

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 2021? If yes, what were the findings?

No wells were sampled.

Were any well owners offered an alternate supply and/or well abandonment in FY 2021?

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.

5.4 REMEDY COMPONENT #5: SOURCE CHARACTERIZATION/ REMEDIATION

Description: "Source characterization/remediation" (1997 OU2 ROD, page 3).

Performance Standard (how do you know when you've achieved the remedy):

Characterization is required to determine whether remedial actions are necessary. Remedial actions are considered complete when all remedial action objectives (RAOs) are met, in this case when soil COC concentrations are below cleanup levels specified in Table 1 of the 1997 OU2 ROD.

Is this remedy component being implemented?

Yes. Source area characterization work has been completed. Stone & Webster Environmental Technology & Services (Stone & Webster) performed investigation work in 1997 and the Final Site A Investigation Report (Stone & Webster 1997) was issued 12 December 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 of source area soil contamination 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 (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 a concern regarding potential plume spreading. The AS system was being implemented voluntarily by the Army and was not a 1997 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 21 August 2002. The Army submitted a work plan clarification to EPA 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 5-3 and 5-4 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?

The three new wells added during the FY 2021 groundwater investigation will be added to the annual monitoring program. No additional vapor intrusion activities are required.

5.5 REMEDY COMPONENT #6: OVERALL REMEDY FOR SITE A SHALLOW GROUNDWATER

Performance Standard (how do you know when you've achieved the remedy):

When the cleanup levels in Table 1 of the 1997 OU2 ROD have been attained throughout the aerial and vertical extent of the Site A plume (1997 OU2 ROD, page 54).

Has the Site A shallow groundwater remedy been completed (i.e., have the cleanup levels in Table 1 of the 1997 OU2 ROD been attained throughout the aerial and vertical extent of the Site A plume)?

No. Table 5-2 presents the FY 2021 groundwater quality data and highlights the values that exceed cleanup levels. The cleanup level of cis-1,2-DCE (70 µg/L) was exceeded at 01U139 (1,030 µg/L) and 01U902 (173 µg/L). None of the other COCs exceeded their respective cleanup levels in FY 2021.

What impact is MNA having on contaminant concentrations?

As evident in Table 5-2, and on Figures 5-3 and 5-4, 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 5-6 shows the cis-1,2-DCE concentrations plotted on geologic cross sections to illustrate the vertical extent of impacts (the cross-section locations are illustrated on Figure 5-4). cis-1,2-DCE continues to be degraded via an abiotic process as the plume migrates. EPA and MPCA initially evaluated attenuation at the site using computer modeling of COC degradation, as documented in Evaluation of Natural Attenuation of Chlorinated Solvents in Ground Water at the Twin Cities Army Ammunition Plant (MPCA and EPA 2000). MPCA conducted a follow-up microcosm study (unpublished), the results of which were presented to the Army and EPA on 10 April 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 the site given the historical lack of detections that led to the 1997 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 5-7, 5-8, 5-9, and 5-10). Collectively, the cis-1,2-DCE water quality trends evident on Figures 5-7 through 5-10 indicate the concentrations have 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 5-10); however, during FY 2021, contingency location 01U902 had a cis-1,2-DCE concentration of 173 µg/L while all other contingency locations remained below the cleanup level. The concentration of cis-1,2-DCE at 01U902 has not been above the cleanup level since FY 2018. A 2021 investigation by the Army (Army 2021b) concluded through the installation of new wells that the groundwater results did not indicate the leading edge of the plume had extended into the residential community to the north.

Concentrations of cis-1,2-DCE in 01U901 and 01U903 have been at or near non-detect since 2008. Throughout their lifetime, these concentrations have been well below the cleanup level.

The concentrations of cis-1,2-DCE in 01U902 had stabilized between 15 and 20 µg/L by June 2013; however, concentrations began to increase in 2016. cis-1,2-DCE concentrations for well 01U902 were 29 µg/L in 2016, 35 µg/L in 2017, and then exceeded the cleanup level with 92 µg/L in 2018. Since 2018, the concentration dropped below the cleanup level with 42 µg/L in FY 2019 and 37 µg/L in FY 2020, now increasing above the cleanup level again in FY 2021 with 173 µg/L.

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 stabilized between approximately 20 and 30 µg/L through FY 2017 before becoming non-detect since FY 2018.

Concentrations of cis-1,2-DCE at EW-8 have been less than 1 µg/L 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 non-detect in FY 2019, FY 2020, and FY 2021.

Through FY 2016, cis-1,2-DCE concentrations at EW-5 appeared to have stabilized below the cleanup level; however, concentrations increased from 32 µg/L in FY 2016, to 200 µg/L in FY 2017, and to 300 µg/L in FY 2018. Since FY 2018, concentrations have once again dropped below cleanup levels to 1.8 µg/L in 2019, 0.4 µg/L in 2020, and 31.8 µg/L in 2021.

A generally increasing trend of cis-1,2-DCE concentrations above the cleanup level had been observed at EW-6 from 78 µg/L in FY 2012 to 290 µg/L in FY 2017. These concentrations have since fallen below the cleanup level every year since FY 2018. The reason for this is unclear but continued monitoring of EW-6 will be performed.

In the monitoring wells located between the two rows of extraction wells (Figure 5-8), 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 µg/L and then to 710 µg/L in FY 2018. This upward trend did not continue as this concentration decreased in June 2019 to 180 µg/L and then increased to 389 µg/L in FY 2020 and 1030 µg/L in FY 2021. Future monitoring will be evaluated to confirm the overall trend.

01U140, after showing three exceedances of the cleanup level between 80 and 100 µg/L in FY 2011 and FY 2012, has shown a steadily declining cis-1,2-DCE concentration to 0.60 µg/L in FY 2019, non-detect in FY 2020, and 3.62 µg/L in FY 2021.

01U157 had two slight exceedances of the cis-1,2-DCE cleanup level in FY 2011 and FY 2012 of 73 µg/L and 96 µg/L and then 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. This peak was not sustained though as the concentration decreased to non-detect in FY 2018, 0.44 µg/L in FY 2019, and 1 µg/L in FY 2020. The concentration increased during FY 2021 to 30.6 µg/L. 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 was 12 µg/L in FY 2018. In June 2019, this concentration increased to 55 µg/L; however, this concentration then became non-detect in 2020. The concentration was 11.3 µg/L in FY 2021. The overall trend at this location still appears to be stable.

In EW-1 through EW-4 (Figure 5-7), concentrations of cis-1,2-DCE have been at or near non-detect since FY 2010 or earlier. Sampling has been discontinued at EW-1 and EW-4, as discussed in Section 6.1. In FY 2020, samples collected showed cis-1,2-DCE concentrations of 0.5 µg/L in EW-2 and non-detect in EW-3.

The three new extraction wells, 01U905, 01U906, and 01U907, installed in the residential community to the north, were all at or near non-detect (non-detect, 0.194 µg/L, and 0.382 µg/L, respectively).

In summary, the cis-1,2-DCE plume has largely stabilized following shutdown of EW-1 through EW-4 in FY 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 in FY 2016, FY 2017, FY 2018, FY 2020, and FY 2021. This 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). The 2021 plume investigation and newly installed monitoring well results further supported the shifting of the axis of the plume by demonstrating through new monitoring well installation that the groundwater plume has not shifted to affect the residential community to the north.

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

Yes. The four contingency locations are 01U901, 01U902, 01U903, and 01U904, 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 had a result in FY 2021 that exceeded the cleanup level of 70 µg/L for cis-1,2-DCE (Table 5-2). As noted previously, 01U901 and 01U903 have been at or near non-detect for cis-1,2-DCE since FY 2008 and well below the cleanup level throughout their history. Concentrations of cis-1,2-DCE in 01U904 show a stable trend with cis-1,2-DCE concentrations below the cleanup level of 70 µg/L with the past three annual events being non-detects. Concentrations of cis-1,2-DCE at 01U902 have been generally increasing since FY 2015, with FY 2018 and FY 2021 being the only years the well exceeded the cleanup level.

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:

- The 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).

- The Army will prepare and submit a plan to address the exceedance to EPA and MPCA for approval.

- The 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 prior to 2008. Increasing VOC groundwater concentrations in any of the wells north of County Road I 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 (now Stantec) Installation Support Services, May 2005. This report concluded the vapor intrusion pathway for the off-site Site A plume was incomplete because the concentrations in groundwater were below the EPA generic screening criteria. However, no actual soil vapor sampling was conducted for that report. In December 2012, MPCA requested that soil vapor sampling be conducted because their 2008/2010 vapor intrusion guidance is newer than the 2005 report and 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 EPA and MPCA in June 2013, and then conducted the vapor intrusion investigation work in July 2013. This work was documented in the 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.

Due to the shifting of the Site A plume downgradient since the June 2013 investigation work, an additional groundwater and soil vapor investigation was conducted in 2021 as a contingency action. New monitoring well installation and soil vapor sampling demonstrated that the Site A shallow groundwater plume was not affecting the residential community to the north and the soil vapor results showed that the constituents of concern were all below MPCA residential Intrusion Screening Values and did not pose a risk to receptors.

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 this contingency action.

The contingency locations from the 2021 investigation will be sampled according to the monitoring plan in FY 2022, and the data will be further evaluated.

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 11 November 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. The OU2 ROD Amendment #6 (2018) 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 2022 according to the monitoring plan in Appendix A.

Do additional remedial measures need to be addressed?

No.

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6. 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 (USAEC) 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. It 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, MPCA took enforcement action, requiring the Army to implement corrective actions. Initially, the Army installed a groundwater recovery trench to contain the lead plume (operated between November 2000 and July 2001). On 6 July 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 OU2 ROD Amendment #1 (2007) incorporated the existing groundwater extraction system as the final remedy.

On 13 November 2008, the groundwater system was shut off (with regulatory approval) because 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 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 EPA and MPCA in November 2008. The OU2 ROD Amendment #1 (2007) prescribes four major components of the remedy, and until a decision is made to formally change the remedy, the original components of the OU2 ROD Amendment #1 (2007) 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 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 this APR, and thus any changes to monitoring and contingency actions must be approved by EPA 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. Evaluation in future APRs will ultimately determine whether EPA, MPCA, and the Army should formally change the remedy, or, should the concentrations observed during annual monitoring events decrease, whether the site should be closed.

6.1 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 [2007], page 39-40).

Performance Standard (how do you know when you've achieved the remedy):

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 6-1 summarizes the performance monitoring requirements, the implementing parties, and the documents that contain the monitoring plans. FY 2021 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 6-1, and any deviations explained in Appendix C.2.

Were the monitoring requirements for this remedy met?

Yes, all groundwater and surface water samples were collected as per the FY 2020 monitoring plan in Appendix A.

Is any sampling proposed prior to the next report?

Yes. Groundwater and surface water monitoring at Site C will continue 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? 2

No.

6.2 REMEDY COMPONENT #2: GROUNDWATER CONTAINMENT

Description: "Three extraction wells, EW-1 through EW-3, will continue collecting contaminated groundwater" (OU2 ROD Amendment #1 [2007], 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.

6.3 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 [2007], 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 extend to the extraction wells, the extraction system is no longer operating, and this remedy component is not currently being implemented.

6.4 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 [2007], page 39).

Performance Standard (how do you know when you've achieved the remedy):

For initial implementation, when EPA and MPCA have provided consistency approval for an OU2 LUCRD document. Implementation will continue until such time 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. EPA and MPCA approved the OU2 LUCRD in September 2010, and it is being implemented by the Army. Revision 6 of the OU2 LUCRD was approved by EPA and MPCA in October 2020. 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. In FY 2021, a goat fence was constructed in Site C. Currently no goats are housed there.

Was an annual site inspection for LUCs conducted in FY 2021?

Yes. On 22 July 2021, the Army, MNARNG, 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.

6.5 REMEDY COMPONENT #5: OVERALL REMEDY FOR SITE C SHALLOW GROUNDWATER

Performance Standard (how do you know when you've achieved the remedy):

When the cleanup levels in Table 1 of the OU2 ROD Amendment #1 (2007) have been attained throughout the aerial 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 (2007) been attained throughout the aerial and vertical extent of the Site C plume)?

No. Table 6-2 presents FY 2021 groundwater quality data and highlights the values that exceed the lead cleanup level. Surface water quality data are presented on Table 6-3. Figure 6-2 presents groundwater elevation contours based on groundwater measurements at Site C wells in June 2020. Figure 6-3 shows the lead results for groundwater and surface water locations. Figures 6-4 and 6-5 show the lead concentrations plotted on geologic cross sections for Site C to illustrate the vertical extent of impacts (the cross-section locations are illustrated on Figure 6-3).

In FY 2021, lead exceeded the groundwater cleanup level of 15 µg/L in two monitoring wells located near the source area (01U573 and 01U574). The lead concentrations at 01U573 and 01U574 were detected at 92.9 µg/L and 35.2 µg/L, respectively. The water quality trends (dissolved lead) for wells nearest the source (01U563, 01U573, 01U574, and 01U575) are shown on Figure 6-6. Figure 6-6 indicates the variable concentrations observed at individual wells in FY 2021 have 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 2021.

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

No. The Site C contingency locations and trigger levels are shown in Table 6-4. 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 6-2 and Table 6-3) show that trigger levels were not exceeded in FY 2021. If a trigger level were exceeded, the Army would implement contingency action(s) specified in the footnotes to Table 6-4.

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.

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7. OPERABLE UNIT 2: SITE I SHALLOW GROUNDWATER

VOCs have been identified in Unit 1 (perched aquifer) at Site I. The selected remedy in the 1997 OU2 ROD consisted of four components: groundwater monitoring, groundwater extraction, POTW discharge, and additional characterization. This section does not include work related to the Deep Groundwater at Site I, which is discussed in Section 11.

The additional investigation and Predesign Investigation 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 SVE, 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. The 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.

7.1 REMEDY COMPONENT #1: GROUNDWATER MONITORING

Description: **"**Groundwater monitoring to track remedy performance." (1997 OU2 ROD, page 3).

Performance Standard (how do you know when you've achieved the remedy):

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

Is the remedy component being implemented?

Yes. Table 7-1 summarizes the performance monitoring requirements, the implementing parties, and documents containing monitoring plans. Appendix A summarizes the FY 2021 monitoring plan, and any deviations are explained in Appendix C.2.

In 2013, EPA and MPCA approved the abandonment of all Site I (Building 502) Unit 1 monitoring wells prior to the demolition of Building 502. Because well 01U667 was not replaced in FY 2021, no groundwater sampling was conducted during FY 2021. Once reinstalled, monitoring well 01U667 will be sampled annually in accordance with the FY 2021 - FY 2025 Monitoring Plan (Appendix A.1). Figure 7-1 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 7-2.

Is any groundwater sampling proposed prior to the next report?

Yes, 01U667 will be reinstalled in FY 2022. Groundwater monitoring at Site I will be in accordance with the monitoring plan provided in Appendix A.1.

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

Yes. Monitoring well 01U667 will be reinstalled.

7.2 REMEDY COMPONENT #2: ADDITIONAL INVESTIGATION

Description: "Additional characterization of the Unit 1 and Unit 2 soil and groundwater." (1997 OU2 ROD, page 3).

Performance Standard (how do you know when you've achieved the remedy):

When the RAOs, namely the site cleanup levels outlined in the ROD have been achieved.

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 OU2 ROD Amendment #2 (2009) removed the groundwater extraction and POTW discharge component of the remedy.

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

No.

7.3 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 [2007], page 39).

Performance Standard (how do you know when you've achieved the remedy):

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

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

Yes. EPA and MPCA provided 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 and 2015, the site is now suitable for unrestricted use/unlimited exposure and soil LUCs at Site I are no longer necessary. EPA and MPCA provided consistency approval for the OU2 LUCRD Revision 5 in March 2018, which formally removes Site I soil LUCs.2

Was an annual site inspection for land use controls conducted in FY 2021?

Yes. On 23 July 2021, the Army, MNARNG, 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.

7.4 REMEDY COMPONENT #4: OVERALL REMEDY FOR SITE I SHALLOW GROUNDWATER

Performance Standard (how do you know when you've achieved the remedy):

When the cleanup levels in Table 1 of the 1997 OU2 ROD have been attained throughout the aerial and vertical extent of the Site I plume (1997 OU2 ROD, page 55).

Has the Site I shallow groundwater remedy been completed (i.e., have the cleanup levels in Table 1 of the 1997 OU2 ROD been attained throughout the aerial and vertical extent of the Site I plume)?

No. Groundwater monitoring was not conducted in FY 2021 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 7-2 presents FY 2013 data and highlights values that 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 7-3 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 Northrup Grumman (Orbital ATK at the time) in their letter dated 12 August 2013, and approved by EPA and MPCA on 14 August 2013, all Unit 1 monitoring wells were abandoned in 2014. In accordance with the Northrup Grumman request and regulatory approval, monitoring well 01U667 will be reinstalled at the same location and depth.

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8. OPERABLE UNIT 2: SITE K SHALLOW GROUNDWATER

VOC impacts have 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 1997 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.

8.1 REMEDY COMPONENT #1: GROUNDWATER MONITORING

Description: "Groundwater monitoring to track remedy performance." (1997 OU2 ROD, page 3).

Performance Standard (how do you know when you've achieved the remedy):

When a monitoring plan is established, and 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 the monitoring plan documents. Appendix A summarizes the FY 2021 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 EPA and MPCA on 14 August 2013 and 7 May 2014. In FY 2017, one Unit 1 monitoring well (01U047) was permanently abandoned as approved by EPA and MPCA in September 2017 and will not be reinstalled once the redevelopment activities are completed.

In 2020, the Army requested the U.S. Geological Survey (USGS) Maryland-Delaware-DC Water Science Center conduct a groundwater treatability study to assess bioremediation as a destructive remedy for VOCs in the Site K groundwater plume. Initial field work began in November 2020 and continued in FY 2021. This work included the installation of new wells where former wells 01U608, 01U609, and 01U611 were previously located. These wells (01U608R, 01U609R, and 01U611R) have been added to the water level monitoring list and/or the annual water quality sampling list consistent with the pre-2014 requirements of the wells they replaced.

The monitoring wells currently included in the Site K Monitoring Plan were sampled in June and August 2021. Figure 8-1 presents the sampling and water level monitoring locations, as well as the location of the monitoring wells that have been abandoned. Figure 8-1 also shows the cross-section alignment.

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?

No.

8.2 REMEDY COMPONENT #2: SENTINEL WELLS

Description: "Installation of sentinel wells at the bottom of Unit 1 and top of Unit 3." (1997 OU2 ROD, page 3).

Performance Standard (how do you know when you've achieved the remedy):

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 liquid to migrate beneath the trench along the Unit 1/Unit 2 interface. These four piezometers are screened at that interface. Figure 8-1 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 dense non-aqueous phase liquid 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 EPA and MPCA-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 regulatory 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 Predesign Investigation Work Plan.

Subsequently, the well was incorporated into the regular TCAAP monitoring plan. The well was sampled in June 2021 for FY 2021 with results presented in Table 8-2. Groundwater elevation data is presented in Table 8-3. Treatment system concentrations for organics and inorganics are presented in Tables 8-4 and 8-5, respectively. A summary of monthly VOC removal data is presented in Table 8-6. 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 11.3 µg/L as presented in Table 8-7. 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.

8.3 REMEDY COMPONENT #3: HYDRAULIC CONTAINMENT

Description: "Use of existing interceptor/recovery trench to contain the plume and remove impacted groundwater." (1997 OU2 ROD, page 3).

Performance Standard (how do you know when you've achieved the remedy):

When the RAOs have been achieved, namely that the trench is operating as designed and capturing all groundwater exceeding the cleanup levels as presented in Table 1 of the 1997 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 8-3. Figure 8-2 presents a plan view of the groundwater contours from the June 2021 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 8-3. As shown on 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 in the spring of 2017 and 2018 and again in the spring of 2019. Well 01U625C is not critical in the collection trench flow evaluation. Historically, this well has maintained a similar groundwater elevation as 01U625B and 01U625D (Appendix D). Based on FY 2016, FY 2017, FY 2018, FY 2019, and FY 2020 groundwater elevation data showing the return to typical levels, the abandonment of 01U625C, without subsequent replacement, is recommended.

Figure 8-4 presents the TCE concentrations from the 2021 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, including replacement wells installed during FY 2021 (01U608R, 01U609R, and 01U611R), is used to confirm the plume contours and measure the progress of remediation. Thus, the contours on Figure 8-4 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 01U627) 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.

8.4 REMEDY COMPONENT #4: GROUNDWATER TREATMENT

Description: “Treatment of contaminated groundwater using air stripping.” (1997 OU2 ROD, page 3).

Performance Standard (how do you know when you’ve achieved the remedy):

When the treatment system operates and meets discharge limits.

Is the remedy component being implemented?

Yes. During FY 2021, the treatment system functioned and was operational 93 percent of FY 2021. During FY 2021, 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.

8.5 REMEDY COMPONENT #5: TREATED WATER DISCHARGE

Description: "Discharge of treated groundwater to Rice Creek." (1997 OU2 ROD, page 3).

Performance Standard (how do you know when you've achieved the remedy):

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 8.6.

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

No.

8.6 REMEDY COMPONENT #6: DISCHARGE MONITORING

Description: "Monitoring to track compliance with discharge requirements." (1997 OU2 ROD, page 3).

Performance Standard (how do you know when you've achieved the remedy):

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 8-4 (organics) and Table 8-5 (inorganics). The discharge met the treatment requirements during FY 2021, with the exception of cyanide in the 7 June 2021, effluent sample. The effluent sample contained a reported cyanide concentration of 56.7 µg/L which is greater than the respective discharge limit of 17 µg/L. The treatment system effluent was resampled on 9 July 2021, and the cyanide concentration reported was <5.00 µg/L. Based on sampling results, no clear evidence was found to justify the elevated cyanide concentration reported in the June 2021 sample. Cyanide had only been detected in the effluent three times since 2014 with none of the detections exceeding the discharge limit. Hence, it is likely that the June 2021 effluent result for cyanide was not representative of the actual effluent cyanide concentration.

As reported in the FY 2017 APR, infrequent exceedances of the phosphorus and zinc discharge criteria have historically occurred, but no cause has been 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 historical exceedances of zinc and phosphorus limits.

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

No.

8.7 REMEDY COMPONENT #7: ADDITIONAL INVESTIGATION

Description: "Additional characterization of the unsaturated Unit 1 soil." (1997 OU2 ROD, page 3).

Performance Standard (how do you know when you've achieved the remedy):

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 regulators on 6 December 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.

8.8 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 [2007], page 39).

Performance Standard (how do you know when you've achieved the remedy):

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

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

Yes. EPA 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 LUCs conducted in FY 2021?

Yes. On 23 July 2021, the Army, MNARNG, 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.

8.9 REMEDY COMPONENT #9: OVERALL REMEDY FOR SITE K

Performance Standard (how do you know when you've achieved the remedy):

Once the cleanup levels in Table 1 of the 1997 OU2 ROD have been attained throughout the aerial and vertical extent of the Site K plume (1997 OU2 ROD, page 55).

Has the Site K shallow groundwater remedy been completed (i.e., have the cleanup levels in Table 1 of the 1997 OU2 ROD been attained throughout the aerial 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 8-6 presents the VOC mass removal and monthly flow rates. The treatment system captured and treated 3,314,732 gallons of water resulting in the removal of 5.18 pounds of VOCs from the aquifer in FY 2021. The cumulative VOC mass removal is 410.1 pounds of VOCs.

As shown on Figure 8-4, June 2021 TCE concentrations ranged from non-detect to 23,600 µg/L (reported at replacement well 01U609R). Monitoring well 01U615 and replacement wells 01U609R and 01U611R monitored the core of the plume.

Prior to abandonment, TCE concentrations at monitoring well 01U609 had been recorded in 2012 and 2014 at 18,000 µg/L and 29,000 µg/L, respectively. The 2021 TCE concentration observed at replacement monitoring well 01U609R is within the previously observed range at 23,600 µg/L.

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 2021 TCE concentration observed at replacement monitoring well 01U611R is below the previously observed range at 2,520 µg/L (2,570 µg/L [duplicate sample]).

The TCE concentration at well 01U615 slightly increased from 1,360 µg/L in 2020 to 1,770 µg/L in 2021; however, this is slightly below the 1,900 µg/L observed in FY 2019. The FY 2021 concentration of TCE at 01U615 is on the low end compared with historical concentrations from the last ten years of sampling, which have ranged from 1,200 µg/L to 3,700 µg/L. Concentrations of cis-1,2-DCE at well 01U615 have increased since FY 2014 with the FY 2021 concentration of 2,400 µg/L, matching the highest concentration ever reported (during 2019) for this well. Recent increases in cis-1,2-DCE are not surprising because this compound is a known degradation product of TCE. Figure 8-5 shows TCE and total 1,2-dichloroethene versus time for 01U615. Water levels measured during the FY 2021 monitoring at 01U615 were slightly higher than FY 2020 elevations. This well has historically exhibited fluctuating groundwater elevations.

Prior to 2014, 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 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 2014 results confirmed that elevated concentrations of TCE and other VOCs are present in the well. Groundwater samples collected downgradient of 01U603 as part of a Site K Geoprobe investigation in September 2014 showed that high TCE concentrations were localized and had not migrated from the immediate vicinity of 01U603. 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 EPA and MPCA in a letter dated 3 February 2015. Since that time, TCE concentrations in 01U603 have steadily declined to below 5.0 µg/L (1.24 µg/L in FY 2020 and 3.24 µg/L in FY 2021 [cleanup level 30 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 has continued to generally decrease from those measured in FY 2014 and previous years. The detected 1,2-dichloroethene concentration is below the cleanup level for Site K of 70 µg/L.

Do additional remedial measures need to be addressed?

No.

8.10 OTHER RELATED ACTIVITY IN FY 2021

As detailed in Section 11, in March 2015, EPA 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. Monitoring well 03U621, screened in the deeper Unit 3 aquifer, had a 1,4-dioxane concentration exceeding the HRL in FY 2015, FY 2016, FY 2017, FY 2018, FY 2019, and FY 2020; therefore, monitoring well 03U621 was sampled for 1,4-dioxane in FY 2021. The 1,4-dioxane concentration at 03U621 increased from 9.3 µg/L (FY 2016) to 11.3 µg/L (FY 2021). 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 8-7 presents the FY 2021 1,4-dioxane sampling results. No Federal MCL has been established for 1,4-dioxane; however, the MDH established an HRL value of 1.0 µg/L as shown in Table 8-7.

As stated previously, USGS Maryland-Delaware-DC Water Science Center continued a groundwater treatability study in FY 2021 to assess bioremediation as a destructive remedy for VOCs in Site K groundwater plume. Laboratory tests on Site K soil and groundwater samples indicated that a bioremediation injection program could accelerate remediation of Site K groundwater. Groundwater injection and monitoring points were installed in September 2021 and pilot scale biostimulation and bioaugmentation were conducted through the remainder of 2021. Additional work will continue throughout FY 2022 and will be reported separately by USGS when completed.

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9. OPERABLE UNIT 2: BUILDING 102 SHALLOW GROUNDWATER

The former Building 102, shown on Figure 9-1, 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 impact was discovered emanating from beneath Building 102 (discovered during the Phase I and Phase II Environmental Site Assessment in support of a 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 EPA 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 the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA). To support the Engineering Evaluation/Cost Analysis, additional groundwater investigation was conducted in FY 2007 and FY 2008 to further define the extent and magnitude of groundwater impacts. 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 Engineering Evaluation/Cost Analysis documenting the additional investigation work and recommending a remedy for Building 102 shallow groundwater was approved by EPA 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). The OU2 ROD Amendment #4 (2012) 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 that verified abiotic degradation of VOCs in Building 102 groundwater was occurring at substantial rates. Such degradation acts to reduce COC mass and mobility by breaking down the COCs as they migrate. The decision to proceed with MNA was also based on the absence of any groundwater receptors.

9.1 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 [2012], page 4-1).

Performance Standard (how do you know when you’ve achieved the remedy):

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 2021 monitoring plan, and any deviations are explained in Appendix C.2. Details of the groundwater monitoring program are discussed in the next section.

9.2 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 [2012], page 4-1).

Performance Standard (how do you know when you've achieved the remedy):

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 9-1 summarizes performance monitoring requirements, implementing parties, and the documents that contain the monitoring plans. The FY 2021 Monitoring Plan is included in Appendix A, documenting the water quality monitoring locations and frequencies. Building 102 groundwater level data collected in September 2021 are shown as groundwater elevation contours on Figure 9-2. Groundwater quality data collected in FY 2021 are shown in Table 9-2. Groundwater quality data for FY 2021 are also shown on an aerial view of Building 102 for three of the COCs: TCE (Figure 9-3), cis-1,2-DCE (Figure 9-4), and vinyl chloride (Figure 9-5). Figure 9-6 shows the vinyl chloride concentrations plotted on a geologic cross section for Building 102 to illustrate the vertical extent of impact (the cross-section location is illustrated on Figure 9-5.)

Following the sampling of 1,4-dioxane at Building 102 from FY 2015 through FY 2019, it was determined that it was not a COC in Building 102 shallow groundwater. Monitoring for 1,4-dioxane was discontinued at Building 102 beginning in FY2020.

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.

9.3 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 [2012], page 4-2).

Performance Standard (how do you know when you've achieved the remedy):

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. EPA 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 2021?

Yes. On 22 July 2021, the Army, MNARNG, and JV conducted the annual inspection of OU2 sites. The completed checklist from the inspection is included as Appendix F.

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

No.

9.4 REMEDY COMPONENT #4: OVERALL REMEDY FOR BUILDING 102 SHALLOW GROUNDWATER

Performance Standard (how do you know when you've achieved the remedy):

When the cleanup levels in OU2 ROD Amendment #4 (2012) have been attained throughout the aerial and vertical extent of the Building 102 plume (OU2 ROD Amendment #4 [2012], 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 (2012) been attained throughout the aerial and vertical extent of the Building 102 plume)?

No. As shown in Table 9-2, cleanup levels have not been reached throughout the aerial extent of the plume and the site cannot be closed. TCE concentrations exceed the cleanup level in three monitoring wells (01L581, 01L584, and 01U581). Wells 01U580 and 01U584 also exceed the cleanup level for vinyl chloride.

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 2021 groundwater quality results include:

- 01U579 and 01U580 (source area): TCE concentration decreased marginally from FY 2018 to FY 2019 in 01U579 and 01U580 from 1.5 µg/L and 1.2 µg/L to 0.45 µg/L and 0.71 µg/L, respectively. These concentrations increased between FY 2020 and FY 2021 with 0.55 µg/L and 1.50 µg/L respectively in 01U579 and 0.23 µg/L and 2.08 µg/L respectively in 01U580. Historically, the concentrations in these two wells have shown relatively large increases and decreases.

- Vinyl chloride was detected at an estimated (estimated because the detection is below the laboratory reporting limit [RL]) value of 0.33 µg/L in 01U584 and a value of 2.61 µg/L in 01U580. These concentrations exceed the cleanup level for vinyl chloride of 0.18 µg/L. Please note that the Pace (TN) RL for vinyl chloride of 1 µg/L does not meet the project reporting limit goal of 0.1/0.09 µg/L. The method detection limit (MDL) for vinyl chloride is 0.3 µg/L, which Pace (TN) reports detections between the MDL and RL. Per the 2020 QAPP (rev 18) the Pace (TN) RL of 1 µg/L and MDL of 0.30 µg/L is considered acceptable for the project at this time.

- 01L582 (further downgradient of the source area): Concentration of cis-1,2-DCE increased (8.6 µg/L to 12.4 ug/L); however, this well appears to be stable and is still below the cleanup level of 70 µg/L. The vinyl chloride concentration decreased to non-detect.

- 01L581 and 01U581 both exceeded the cleanup level for TCE of 5 µg/L in FY 2020 and again exceeded this level in FY 2021. Both wells seemed to stay relatively stable if not slightly decreasing from FY 2020 to FY 2021; 01L581 decreased from 7.1 µg/L to 5.90 µg/L and 01U581 decreased from 22 µg/L to 15.0 µg/L.

- 01L584 and 01U584 also both exceeded the cleanup level for TCE (5 µg/L) in 2020. This was the first time TCE in 01U584 has exceeded the cleanup level since FY 2013 whereas 01L584 has exceeded this level since FY 2012. In FY 2021, 01U584 decreased to below the cleanup level at 3.97 µg/L from its FY 2020 result of 5.72 µg/L and 01L584 decreased to 10.4 µg/L from its FY 2020 result of 15 µg/L.

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. No COCs for Building 102 shallow groundwater had non-flagged detections about their respective cleanup levels in FY 2021 at well 01U048 (Table 9-2).

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, which took place in early 2016, 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. Groundwater 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. 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 – April 2020 Sampling Event for the Rice Creek remeander, TCAAP Redevelopment" to Arcadis in January 2021. According to quarterly groundwater monitoring performed at Building 102 beginning in March 2017 after completion of the remeander through April 2020, there appear to be no impacts to groundwater quality. Ramsey County wells sampled in this event include 01URC1D, 01URC1S, 01URC2D, and 01URC2S. 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. 01URC1D also had low level detections of cis-1,2-DCE in February 2018, August 2018, May 2019, and April 2020; concentrations were 5.7 µg/L, 2.9 µg/L, 1.9 µg/L and 2.2 µg/L, respectively, which are below the MDH HRL of 6 µg/L. As of the April 2020 groundwater monitoring event, there was no apparent change in the Building 102 plume configuration or groundwater flow. Bay West has recommended ceasing groundwater monitoring of the Rice Creek remeander monitoring wells as part of the FY 2020 reporting. For a more detailed summary of the Rice Creek remeander groundwater monitoring, refer to Bay West, 2020.

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 regulatory approval) due to installation of a storm water control basin. Ongoing efforts will be made by the Army to address any issues resulting from Ramsey County's development plans.

10. 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 EPA and MPCA 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. Following comments to the draft FS, it was agreed by the Army 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, EPA 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, EPA, 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 10-1.

EPA 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 (2012), which documents selection of the recommended alternative, was signed in January 2012. The most recent revision, LUCRD Revision 6, was approved by EPA and MPCA in October 2020. This revision documents the partial delisting of soil, surface water, and sediment (not groundwater) at five aquatic sites located within OU2 (Rice Creek, Sunfish Lake, Marsden Lake North, Marsden Lake South, and Pond G).

EPA and MPCA provided consistency for the Pond G Remedial Design / Remedial Action Work Plan in March 2012, and the pond was treated in June 2012. The pond surface water was then monitored in FY 2012 and FY 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.

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11. OPERABLE UNIT 2: DEEP GROUNDWATER

The selected remedy for the Deep Groundwater in the 1997 OU2 ROD consists of the following remedial components that include continued use of the TGRS, with modifications to improve VOC removal from the source area:

- Hydraulic containment and contaminant removal from the source area
- Groundwater treatment
- Treated water discharge
- Institutional controls
- Groundwater monitoring

It also includes an annual review of new and emerging technologies potentially applicable to the Deep Groundwater. This APR documents all performance and monitoring data collected from October 2020 through September 2021.

During FY 2021, the new Source Area Groundwater Recovery System (SGRS) was designed (with 100 percent design drawings issued in July 2021), and it is currently under construction with an estimated completion date of June 2022. Once completed, the TGRS will be defined as consisting of two individual systems: the SGRS that includes AO and air stripping treatment of source are wells and the Boundary Groundwater Recovery System (BGRS) with treatment by the Building 116 air strippers. A separate memo will be prepared and submitted to the agencies formalizing this definition and identifying apparent past inconsistencies with this definition in other earlier documents.

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 (EPA 1987) was prepared providing specific criteria for the Boundary Groundwater Recovery System which started on 19 October 1987. Initially operated as six extraction wells on the southwest OU2 boundary, the Boundary Groundwater Recovery System 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 2021, the TGRS operates with 10 wells including eight boundary extraction wells and two source control wells with treated effluent discharged to the Arsenal Sand and Gravel Pit (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.

In FY 2003, the Army received regulatory 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 TGRS Global Operating Strategy (GOS) for the entire TGRS extraction system and a Micro Operating 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.

In 2013, the Minnesota Safe Drinking Water Limit (HRL) for 1,4-dioxane (an emerging COC) was reduced from 30 µg/L to 1 µg/L. In early 2015, 1,4-dioxane was detected in New Brighton's water supply above the HRL. In March 2015, EPA and MPCA requested sampling and analysis for 1,4-dioxane to be included in 2015 and 2016 TCAAP groundwater sampling events at OU1, OU2, and OU3 monitoring and extraction wells. All locations sampled except two of the extraction wells (B1 and B11) had 1,4-dioxane concentrations exceeding the HRL. Samples collected from the TGRS influent and effluent indicated that no 1,4-dioxane concentration reduction was accomplished by the treatment system.

In 2017, the Army performed a remedy review with EPA and MPCA. The highest 1,4-dioxane concentrations were observed in wells near Site G at concentrations greater than 200 µg/L. 1,4-dioxane-impacted water had historically been discharged from the TGRS treatment system at concentrations less than 20 µg/L to the gravel pit upgradient of Site K. Lesser concentrations have been identified on the western portion of the site, including at Site K (as described in Section 8).

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 regulators in June 2018 that presented the conceptual plan for improving containment in the source areas with additional extraction wells and installing a new treatment system targeting source area contamination. As a result, the ESD #3 document dated 15 October 2020, was prepared that addresses the addition of 1,4-dioxane as a COC and remedial technologies to treat 1,4-dioxane. The ESD #3 (Army 2020a) document lists the following improvements for the deep groundwater remedy:

- Installation of new source area extraction wells at Site D, Site G, and Site I

- Routing of the new source area extraction wells and one existing source area extraction well to a new AO system, to remove and treat 1,4-dioxane and TCE

- Routing of the effluent from the SGRS to a co-located new air stripper to remove residual VOC contaminants

- Discharge of the treated groundwater from the SGRS to the gravel pit.

The Army completed subsurface investigations at Sites D, G and, I in 2020 and 2021. Seven new source area extraction wells were installed (SC-6 to SC-12) and together with two existing wells (SC-1 and SC-5) form the source area groundwater extraction network that will be routed to the new SGRS treatment system where 1,4-dioxane and TCE will be removed prior to combining with TGRS effluent and discharging to the sand and gravel pit. The 100% design document contains the final details of the remedy. As a result of SGRS extraction and treatment, 1,4-dioxane (and VOC) loading into the existing air stripping treatment system and gravel pit discharge will be reduced which in turn will eventually decrease 1,4-dioxane concentrations in groundwater across the site.

TGRS Modifications

As of September 2019, the TGRS has operated with 10 wells including eight boundary extraction wells and two source control wells with treated effluent discharged to the gravel pit where it recharges overburden sands. Extraction well SC2 has been shut down since September 2018 (with agency approval) and is intended to be replaced as part of the TGRS improvements planned during FY 2022.

Remote connectivity control equipment began operating during FY 2021 to allow the remote monitoring of the TGRS and all operating extraction wells except SC1, B3, and B13 that are monitored manually.

As stated earlier, the SGRS is currently under construction with an estimated completion date of June 2022. Once completed, the expanded TGRS groundwater extraction and treatment for on-site Deep Groundwater within OU2 will consist of two individual systems: the SGRS and the BGRS, as follows:

- The SGRS will provide enhanced source area contaminant mass removal at Site D, Site G, and Site I. The SGRS will include the operation of two existing source area extraction wells (SC-1 and SC-5, previously routed to the Building 116 groundwater treatment system) and seven new source area extraction wells (SC-6 to SC-12). The SGRS will use AO for treatment of 1,4-dioxance and TCE, and air stripping for treatment of residual VOCs.

- The current Building 116 groundwater treatment system will continue to operate the BGRS, providing supplemental hydraulic containment and treatment of low VOC concentration groundwater. The BGRS will include operating seven existing groundwater extraction wells along the southwest portion of the property boundary for supplemental hydraulic containment and the existing air stripping system to treat low VOC concentration boundary groundwater.

These modifications will result in increased mass removal of VOCs, destruction of 1,4-dioxane and more efficient hydraulic containment of the source areas. Long term operating conditions of the full system will be determined after the SGRS is completed and tested.

For more detailed discussion on historical modifications refer to previous APRs.

11.1 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 COCs from the source area through pumping of select wells." (1997 OU2 ROD, page 3).

Performance Standard (how do you know when you've achieved the remedy):

When the contaminated source area to the 5 µg/L TCE contour is hydraulically contained and the system is operated to maximize the COC removal from the source area.

Is the remedy component being implemented?

Yes. The TGRS operated in FY 2021 consistent with the requirements of the 1997 OU2 ROD. Table 11-1 presents the TGRS cleanup requirements per the 1997 OU2 ROD. During FY 2021, the TGRS average extraction rate was approximately 1,769 gpm, as shown in Table 11-2. This rate exceeds the GOS Total System Operational Minimum (1,745 gpm), which the Army and the regulators agree meets the 1997 OU2 ROD requirements with an adequate safety factor. Hence, the TGRS performance standard was satisfied for FY 2021.

Two of the three individual well groupings were above their respective MOS minimums for FY 2021. The B1, B11, and B13 well grouping was below the MOS minimum of 415 gpm due to an approved February 2013 B11 shut down and TGRS maintenance event. B11 will continue to be monitored to verify containment.

COC removal in the source area will be maximized once the SGRS begins continuous operation.

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 2021, the TGRS operates with10 wells including eight southwestern boundary extraction wells (B1, B3, B4, B5, B6, B8, B9, and B13) and two source control wells downgradient of interior OU2 source areas (SC1 and SC5). The TGRS layout is presented on Figure 11-1.

On 6 September 2018, GHD (on behalf of the Army) submitted an email to EPA 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). EPA and MPCA agreed to the request in an email dated 11 September 2018. Additional extraction wells at Sites D, G, and I have been installed and are expected to be in full operation by June 2022.

System Operation Specifications

Part of the remedy for deep groundwater at TCAAP is groundwater extraction originally consisting of 17 extraction wells connected by a force main to an air stripping treatment facility. The air stripping treatment facility was designed to include:

- Four air stripping towers
- Four air blowers that provide air to each tower
- Four wet wells that are used to accumulate extracted groundwater before pumping to the towers for treatment
- Four wet well pumps used to pump water from the wet wells to the treatment towers.

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 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 (WWP) 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 handle 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 to 7,000 standard cubic feet per minute. The blowers for Towers 3 and 4 are designed to provide 9,000 to 14,000 standard cubic feet per minute.

The treatment system was modified to allow for two air stripping tower treatments instead of the original design of four air stripping tower treatments, which resulted in a reduction of energy use while still meeting the 5 µg/L TCE effluent discharge limit. WWP#1 and WWP #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 programmable logic controller (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 WWPs according to high water levels occurring in the wet wells; and in turn, cycle-off the WWPs according to low levels occurring within these wet wells.

The system operates such that the WWPs cycle rather than the extraction well pumps. The rationale 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.

- Maintain treatment center WWP#3 and WWP#4 pumping rate equal to or slightly above the WWP#1 and WWP#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 2021 Maintenance and Inspection Activity

During FY 2021, 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 FY 2021 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 the 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?

Yes. At 1,769 gpm, the total extraction well pumping rate was above the GOS Total System Operational Minimum (1,745 gpm) where the Army and the regulators agree that 1997 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 regulators that 1997 OU2 ROD requirements are met with an adequate safety factor.

Figure 11-2 plots the TGRS daily average flow rate from 1 October 2020 through 30 September 2021 and shows operation above the Operational Minimum for the majority of the time (331 days or 91 percent of the time) in FY 2021. Significant loss of extraction water volume occurred due to power outages, reoccurring variable frequency drive (VFD) faults at B1 and SC5, downtime during the failure and replacement of the TGRS control system Uninterrupted Power Supply, and downtime during the replacement of the pump and motor in WWP#4. These issues have since been remedied. Appendix G.2 provides additional information on the various downtimes throughout FY 2021.

The monthly and annual volume of water pumped is presented in Table 11-2. Table 11-2 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 FY.

As shown on Table 11-2, the TGRS successfully captured and treated approximately 929,903,186 gallons of contaminated water from October 2020 through September 2021 based on the sum of the individual pumphouse flow meters. This volume converts to an average flow rate of 1,769 gpm, which exceeds 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 2021 operational notes is presented in Appendix G.2. During FY 2021, the sum of the individual pumphouse flow meters was used to measure total flow volumes in monthly reports for comparison with OS 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 11-3. A summary of average down time for the pumphouses and the treatment center by the category of failure is presented in Table 11-4. 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 force main are presented in Appendix G.3.

Treatment center and extraction well down times resulted primarily from planned preventative maintenance and planned modification of components in the pumphouses, treatment center, and electrical service. The downtime in FY 2021 decreased from FY 2020 (from 15.3 days in FY 2020 to 12.0 days in FY 2021). The decrease in downtime is primarily due to less downtime in the preventative maintenance and system modification categories.

Description of Down Time Categories

Pumphouse component failures accounted for an average of 5.9 days down time per pumphouse. The major pumphouse repairs causing down time were:

- Electrical issues (including power outages – some involving heat related faulting of VFDs (B6 & SC5) and VFD failure (B3)

- Repair of leaking riser pipes in multiple pumphouses (B3 & B8).

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

Treatment center component failures, repairs, and adjustments accounted for an average of 2.0 days down time per pumphouse. The major treatment center repair causing substantial down time was an issue with a failure in the motor control center for Pump 3. The motor control center parts were removed and rebuilt by a vendor, then reinstalled to correct this issue.

Electrical service system failures accounted for an average of 3.9 days down time per pumphouse. Electrical storm damage, failure of the Building 116 main power transformer, site-wide power failure due to damage to an offsite power pole, and downtime during the troubleshooting and replacement of the control system Uninterrupted Power Supply were the primary causes of down time.

System modifications accounted for an average of 0.1 day of respective down time in FY 2021. Most of this down time was related to the temporary shutdown of SC5 to complete electrical work needed for SGRS construction. For the most part, other PM was performed without interruptions to the treatment system. PM procedures are described in the project Operation and Maintenance Manual.
Forcemain failures did not account for any down time in FY 2021.

There were no additional days of down time assigned to the miscellaneous category for FY 2021.

Were there any major operational changes during the year?

Yes. Remote connectivity equipment installation was completed during FY 2021 to allow the remote monitoring of the TGRS and all operating extraction wells except SC1, B3, and B13.

Beginning Saturday, 30 January 2021, a modified daily inspection schedule was implemented for the TGRS. In-person inspections continued on Monday, Wednesday, and Friday of each week. Remote monitoring began for Tuesday, Thursday, and weekends by logging into software to view the real time status of the PLC. Remote monitoring days also included reviewing hourly data collected by the on-site data logger, which is compiled and provided within an automated daily email.

Beginning 1 February 2021, the automated daily data email was used to compile and track extracted water volumes and flow rates, with the exception of extraction wells SC1, B3, and B13, as these are not currently able to be remotely monitored. The flow rates for extraction wells SC1, B3, and B13 are estimated on virtual monitoring days. All automated data is routinely compared to that collected during in-person daily inspections to ensure accuracy. Automated alarm conditions are responded to in-person, as needed, every day of the week.

Did the system achieve hydraulic capture?

Yes. Hydraulic capture was achieved via groundwater extraction greater than the GOS Operational Minimum at which the Army and the regulators agree that the 1997 OU2 ROD hydraulic capture requirements are met with an adequate safety factor. In addition, a remedy review has been conducted and approved by the regulators presenting improvements for consideration toward overall mass removal and TGRS operational efficiency. The OU2 remedy review received regulatory approval in June 2018. General stable or decreasing TCE concentrations were 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 EPA five-year reviews and further discussed below indicates a stable bedrock TCE plume footprint. Groundwater elevation measurements collected in June 2021 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 929,903,186 gallons of water from October 2020 through September 2021. 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 1,746 pounds of VOCs from October 2020 through September 2021. The VOC mass removal in FY 2020 was 2,013 pounds. When comparing the FY 2021 to FY 2020 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 264.7 µg/L in FY 2020 to 227.4 µg/L in FY 2021. Table 11-5 summarizes the individual VOC mass contribution of each extraction well and the entire system. Overall, the TGRS has removed over 112 tons (224,226 pounds) of VOCs from the aquifers since 1987 and 23.8 tons of VOCs since the end of FY 2001 (the TGRS OS was based on data through 2001).

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 and the semi-annual VOC results from each well.

VOC samples were collected semi-annually from the TGRS operating extraction wells. Wells B2 and B11 are shut down but were temporarily operated for June 2021 sampling. Table 11-6 summarizes 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 when dilutions are required due to the high concentrations of some analytes. The locations of the extraction wells are presented on Figure 11-1.

Appendix H.1 presents TCE concentrations 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:

- SC3 (5.5 µg/L in FY 2001 to non-detect [less than 0.190 µg/L] in FY 2020 – 97 percent reduction)
- B10 (5.1 µg/L in FY 2001 to 0.383JP µg/L [reporting limit: 1.0 µg/L] in FY 2020 – 92 percent reduction)
- B6 (230 µg/L in FY 2001 to 22.6 µg/L in FY 2021 – 90 percent reduction)
- B4 (500 µg/L in FY 2001 to 57.2 µg/L in FY 2021 – 88 percent reduction)
- B5 (410 µg/L in FY 2001 to 70.3 µg/L in FY 2021 – 83 percent reduction)
- SC2 (100 µg/L in FY 2001 to 28 µg/L in FY 2018 – 72 percent reduction)
- B3 (8.7 µg/L in FY 2001 to 1.76 µg/L in FY 2021 – 77 percent reduction)
- B9 (110 µg/L in FY 2001 to 22.1 µg/L in FY 2021 – 80 percent reduction)
- SC4 (6.9 µg/L in FY 2001 to 3.18 µg/L in FY 2020 – 54 percent reduction)
- B8 (21 µg/L in FY 2001 to 5.99 µg/L in FY 2021 – 71 percent reduction).

Only four extraction wells (B1, B2, SC5, and SC1) have shown less than a 50 percent reduction in TCE concentrations since FY 2001.

Table 11-5 illustrates seven extraction wells, B1, B4, B5, B9, B13, SC1, and SC5, that are located in the centers of the plume (see Figures 11-6 and 11-7) and achieve the largest rates of VOC removal. These seven wells together accounted for over 98 percent of the VOC mass removed.

The source control wells, SC1 through SC5, together accounted for over 82 percent of the VOC mass removed while accounting for only 5.3 percent of the water pumped by the system. SC5, in particular, removed 76.6 percent of the total VOC mass at a rate of only approximately 77 gpm (4.4 percent of the total water pumped by the system). This illustrates the efficiency of extracting groundwater from near the source areas.

Seven additional source area extraction wells SC-6, SC-7, SC-8, SC-9, SC-10, SC-11, and SC-12 have been installed and will become operational in FY 2022. As a result, VOC and 1,4-dioxane mass removal will substantially increase.

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 since FY 2001, 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. Table 11.7 illustrates VOC concentrations from monitoring wells sampled during FY 2021.

Several wells were identified in previous APRs, or when reviewing the FY 2021 database that have inconsistent or upward trends in TCE concentrations that warrant further observation and discussion:

Well	Operable Unit	Trend Observation
03L806	OU2	Trend identified in FY 2001 APR. TCE concentrations have steadily decreased from 620 µg/L in 2013 to 27.5 µg/L in FY 2021. Maintain annual sampling frequency to determine if this downward trend continues.
04U806	OU2	Trend identified in FY 2001 APR. Dropped from 1,000s of µg/L in early to mid-1990s. TCE steadily decreased from 470 µg/L in FY 2001 to 96 µg/L in FY 2007. In FY 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 FY 2009 with a notable steadily decreasing trend (26.0 µg/L in 2021). Maintain annual sampling frequency.
03U094	OU2	Trend identified during FY 2004 data review. TCE increased from 170 µg/L in FY 2003 to 470 µg/L in FY 2005. From FY 2005 to FY 2013, TCE concentrations decreased to 80 µg/L in FY 2013, a historical low concentration. The TCE concentration increased to 610 µg/L in FY 2015, the highest concentration since 1996. Since then, the TCE concentration decreased to 360 µg/L in FY 2016 and 278 µg/L in FY 2020. Maintain biennial sampling frequency (next event FY 2022).
03M806	OU2	Trend identified during FY 2003 data review. TCE concentrations dropped from approximately 900 µg/L in FY 1987, to less than 100 µg/L from FY 1993 through FY 1996. In FY 2003, TCE increased to 1,300 µg/L, a historical high concentration. TCE concentrations decreased from 680 µg/L in FY 2008 to 263 µg/L (265 µg/L, duplicate) in FY 2021. Maintain annual sampling frequency.
03U711	OU2	Trend identified in FY 2001 APR. TCE concentrations decreased from approximately 1,000 µg/L in FY 1994 to 75 µg/L in FY 1999 but rebounded to 250 µg/L by FY 2004. Since FY 2004, concentrations have steadily decreased to 27 µg/L in FY 2016 and 28.5 µg/L in FY 2020. Maintain biennial sampling frequency (next event FY 2022).

03L809	OU2	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 FY 2001. Since FY 2001, concentrations have decreased to 133 µg/L in FY 2020. Maintain biennial sampling frequency (next event FY 2022).
04U843	OU1	Trend identified in FY 2001 APR. TCE concentrations were below 15 µg/L from the late 1980s through 1997, and then increased to between 22 µg/L and 38 µg/L from 1998 through 2001. In FY 2003, TCE dropped below 1 µg/L, and has since been steadily increasing; it was 207 µg/L in FY 2020. 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 FY 2022).
04U841	OU1	Trend identified in FY 2001 APR. TCE concentrations were below 10 µg/L through 1995, and then increased to 25 µg/L in FY 2001. In FY 2003, TCE decreased to 5 µg/L, but rebounded to 19 µg/L in FY 2005. TCE appears stabilized around 20 µg/L, with concentrations ranging between 10 and 24 µg/L since FY 2005 (10.3 µg/L in FY 2020). The 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 FY 2022).
03U822	OU1	Trend identified during FY 2003 data review. TCE concentrations were below 25 µg/L through FY 1998, and then peaked at 375 µg/L in FY 1999. Concentrations have ranged between 42 and 160 µg/L from FY 2005 to FY 2015 (18.5 µg/L in 2020). 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 FY 2022).
03L822	OU1	Trend identified in FY 2001 APR. TCE concentration increased from less than 5 µg/L during the early 1990s to over 600 µg/L from 1999 through 2003. Concentrations steadily decreased from 620 µg/L in FY 2003 to 180 µg/L in FY 2011 but rebounded slightly in FY 2013 to 220 µg/L. The TCE concentration decreased slightly in FY 2016 to 190 µg/L and again in FY 2020 to 129 µg/L. The 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 COC. Maintain biennial sampling frequency (next event FY 2022).

11.2 REMEDY COMPONENT #2: GROUNDWATER TREATMENT

Description: "Groundwater treatment using air stripping." (1997 OU2 ROD, page 3).

Performance Standard (how do you know when you've achieved the remedy):

When the air stripping treatment facility is treating water and meeting the cleanup requirements in Table 1 of the 1997 OU2 ROD.

Is the remedy component being implemented?

Yes. The air stripping treatment facility has been operating since 1986 (initially with 3 air stripping towers that increased to 4 air stripping towers by 1989).

Did the treatment system meet the treatment requirements in the 1997 OU2 ROD?

Yes. Influent and effluent water were sampled on a monthly basis during FY 2021. The influent and effluent database for FY 2021 is provided in Appendix H.2. Figure 11-3 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 2021 influent TCE concentration was 184.9 µg/L, which is a 12.6 percent decrease from 211.5 µg/L in FY 2020. FY 2021 represents the 21st 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 11-3 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 2021. A review of the FY 2021 database indicates that the effluent remained below the treatment requirements for all other VOC compounds specified in the 1997 OU2 ROD. Comparison of influent and effluent concentrations for all specified VOC compounds indicates an average removal efficiency of 99.9 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 2021 was 2.80 JP µg/L and the average was 2.40 µg/L, which are both well below the discharge limit. The JP qualifier indicates that the result was qualified as estimated since the detection is below the laboratory reporting limit.

What was the mass of VOCs emitted into the air?

The air stripping towers remove VOCs with an efficiency of approximately 98.9 percent. The air emissions are equal to the VOC mass removal rates presented in Table 11-5. Total VOC air emissions averaged 4.8 pounds per day based on the VOC mass removal rates. The total VOC emissions from October 2020 through September 2021 were 1,746 pounds.

Once the SGRS becomes fully operational in FY 2022, VOC air emissions will be significantly reduced by the destruction of VOCs (especially TCE) through the AO treatment system.

11.3 REMEDY COMPONENT #3: TREATED WATER DISCHARGE

Description: "Discharge of treated water to the on-site gravel pit." (1997 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 2021, there were no noticeable changes in gravel pit performance. The gravel pit is accommodating the TGRS discharge as designed.

11.4 REMEDY COMPONENT #4: INSTITUTIONAL CONTROLS

Description: **"**Institutional controls to restrict access to contaminated aquifers and prevent exposure to contaminated groundwater." (1997 OU2 ROD, page 4).

Performance Standard (how do you know when you've achieved the remedy):

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 institutional controls in place for future groundwater use associated with upcoming property redevelopment.

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

Yes. On 20 April 2016, the MDH issued a memorandum updating the SWBCA that noted the rezoning of the TCAAP facility for future development and updated the SWBCA boundary to include the entirety of TCAAP (MDH 2016). As such, all wells and borings constructed or modified within the SWBCA must first be approved by the MDH.

11.5 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." (1997 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 when no technologies are considered. It is envisioned that at any time, any interested party (Army, EPA, and MPCA) can suggest new technologies for consideration. If a technology is agreed to have merit by the Army, EPA, 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
- Any planned evaluations for the following year.

Performance Standard (how do you know when you've achieved the remedy):

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 APR, the Army reports annually on the status of any reviews of emerging technologies.

- In September 2002, EPA and MPCA announced they would be conducting a natural attenuation microcosm study using carbon dating. In October 2002, the Army drilled a boring at Site G to collect soil for the study. The study results were published in 2004.

- 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.

In FY 2021, the Army completed the design and is in the process of implementing the ESD #3 that will consist of the following improvements for the deep groundwater remedy:

- Operation of new source area extraction wells at Site D, Site G, and Site I

- Routing of the new source area extraction wells and existing source area extraction wells to a new AO system, SGRS, to remove and treat 1,4-dioxane and TCE

- Routing of the effluent from the SGRS to a co-located new air stripper to remove residual VOC contaminants

- Discharge of the treated groundwater from the SGRS to the gravel pit.

Were any new technologies identified and considered to have merit during FY 2021?

No.

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. EPA and MPCA published the results of the microcosm study for deep groundwater sediments in 2004 showing that abiotic degradation of cis-1,2-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. After construction of the SGRS is completed, the capabilities of the combined groundwater extraction system will be evaluated to best achieve the OU2 Deep Groundwater objectives of hydraulic containment of the source areas and optimizing mass contaminant removal. Updated air emissions modelling is also planned.

11.6 REMEDY COMPONENT #6: GROUNDWATER MONITORING

Description: "Groundwater monitoring to track remedy performance." (1997 OU2 ROD, page 4).

Performance Standard (how do you know when you've achieved the remedy):

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 2021 was consistent with the 1997 OU2 ROD. Water level measurements and water quality samples were collected as stated in Appendix A.1. Appendix A summarizes the FY 2021 monitoring plan, and any deviations are explained in Appendix C.2. Monitoring was as follows:

Groundwater

TGRS groundwater level measurements were collected during December 2020 and June 2021 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 (8260D) analysis and 1,4-dioxane (8270 Selected Ion Monitoring). FY 2021 was a minor sampling event year in the biennial sampling program and samples were collected from a select list of wells. Table 11-7 presents the groundwater quality data for FY 2021. Figures 11-6 through 11-8 present plan views of the TCE and 1,4-dioxane plumes. Results from the FY 2021 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 FY 2000 to 26.0 µg/L in FY 2021), 03U708 (steady decrease from 120 µg/L in FY 2005 to 47.7 µg/L [47.5 µg/L, duplicate] in FY 2021), 03L806 (620 µg/L in FY 2013 to 27.5 µg/L in FY 2021), 04J077 (610 µg/L in FY 2001 to 33.4 µg/L in FY 2021), and PJ#806 (220 µg/L in FY 2000 to 9.78 µg/L in FY 2021).

Although the general trend at most wells since 1999 appears to be declining or stable, the monitoring well listed below had notable increases in TCE concentration in FY 2021:

- 03U708 (<1.0 µg/L in 2019 to 47.7 µg/L [47.5 µg/L, duplicate] in 2021).

The increase observed and reported for 03U708 is not considered significant when considering the last 10 years of data (39 µg/L in 2011 and 57 µg/L in 2013) but was an increase from that reported in FY 2020. Well 03U708 is within the capture zone of the TGRS extraction system; therefore, the significance of this increase is minimal.

All of these wells will continue to be monitored and no further sampling beyond the scheduled events is necessary at this time.

Estimated TCE Plume Width

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 11-1). Since that time, 23.8 tons of VOCs have been removed from groundwater. TCE concentrations are decreasing across the site, especially at the following wells that have been below 5 µg/L since 2001: B10, SC4, 03L021, 03L833, 03U701, 04J702, 04U701, 04U702, and 04U833. Monitoring well 03U672, which was located outside the southern end of the 5 µg/L TCE plume, decreased from 3.1 µg/L in FY 2001 to not detectable (less than 1 µg/L) from FY 2003 until it was abandoned in FY 2014. Well 03U677 replaced 03U672 in September 2014 and has never contained detectable concentrations of VOCs (including TCE).

As a result, the TCE plume width is narrowing. Figure 11-4 shows FY 2021 TCE data with the 5 µg/L TCE contours for FY 2001 and FY 2021 (including FY 2020 data since FY 2021 was a minor sampling event year in the biennial sampling program). The overall FY 2021 sample results are similar, or lower compared to the previous 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. As shown on Figure 11-4, the TCE plume narrowing along the southwest corner boundary of the Site is more pronounced, having decreased approximately 24 percent from 4,600 feet to 3,500 feet, which represents an approximately 76 percent decrease from the FY 2001 width.

Treatment System

The TGRS treatment system influent and effluent were sampled monthly during FY 2021 in accordance with the FY 2021 to FY 2025 monitoring plan. Groundwater samples from the extraction wells were collected in December 2020 and June 2021 in accordance with the FY 2021 to FY 2025 monitoring plan.

Is there additional monitoring proposed prior to the next report?

No additional monitoring for FY 2022 is proposed beyond what is presented in the Monitoring Plan (Appendix A) of the FY 2021 APR. Table 11-8 and Appendix A of this APR provide the FY 2021 to FY 2025 monitoring plan. Once new extraction wells are operating during FY 2022, then they will be monitored consistent with an approved work plan.

11.7 REMEDY COMPONENT #7: OVERALL REMEDY FOR DEEP GROUNDWATER

Did the TGRS meet the requirements of the 1997 OU2 ROD?

Yes.

- Hydraulic containment in Units 3 and 4 extends upgradient within OU2 beyond the 5 µg/L contour, meeting the VOC criterion in the 1997 OU2 ROD.

- The total average extraction well water pumped exceeded Total System Operational Minimum (1,745 gpm). The FY 2021 annual average extraction rate was 1,769 gpm.

- The TGRS extracted and treated 929,903,186 gallons of water and removed 1,746 pounds of VOCs from October 2020 to September 2021. Average VOC influent concentrations decreased by 16.4 percent from FY 2020.

- 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 COC-specific requirements for all sampling events.

Do any additional measures need to be addressed?

The SGRS is currently under construction with an estimated completion date of June 2022. Once completed, the combined groundwater extraction and treatment for on-site Deep Groundwater within OU2 will result in increased mass removal of VOCs, destruction of 1,4-dioxane and more efficient hydraulic containment of the source areas.

11.8 OTHER RELATED ACTIVITY IN FY 2021

In 2021, monitoring wells proposed for sampling in the FY 2021 Monitoring Plan were sampled for 1,4-dioxane. Table 11-9 presents the results of the 1,4-dioxane sampling for the extraction wells. No Federal MCL has been established for 1,4-dioxane; however, the MDH has established an HRL value of 1.0 µg/L. All extraction wells sampled except extraction wells B2 and B11 had 1,4-dioxane concentrations exceeding the HRL.

The monitoring well sampling results are presented on Table 11-10. A majority of the monitoring wells sampled (9 of 16) had 1,4-dioxane concentrations exceeding the HRL, with the highest concentrations found in the samples at 03M806 (22.4 µg/L, 22.6 µg/L duplicate), 03L806 (19.4 µg/L), and PJ#806 (19.3 µg/L). Figure 11-5 shows the 1,4-dioxane concentrations in plan view for the west portion of OU2 (including FY 2020 data since FY 2021 was a minor sampling event year in the biennial sampling program).

12. OPERABLE UNIT 3: DEEP GROUNDWATER

An amendment to 1992 OU3 ROD was developed, amended, and finalized in August 2006 that significantly changed the OU3 remedy. The basis for the OU3 ROD Amendment #1 (2006b) was the “Groundwater Statistical Evaluation, OU3” technical memorandum, which received consistency from the regulators on 2 May 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 a receded well upstream of the PGRS, which was basically pumping clean water. The OU3 ROD Amendment #1 (2006b) removed the need for a pump and treat remedy, eliminating the PGRS extraction well and treatment train. Figure 12-1 presents an OU3 site plan.

The PGRS was an off-site 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 impacts 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 3 May 1994. In 1997, the PGRS influent dropped below the 1992 OU3 ROD required limits for all VOCs. In December 1999, under an agreement with the regulators, the PGRS pumping rate was reduced from a nominal rate of 1,000 gpm to 400 gpm to help determine if the VOC concentration reductions 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 1992 OU3 ROD requirements.

The results of this evaluation were presented to the regulators on 6 September 2000, and a report titled “Plume History Evaluation, Operable Unit 3,” CRA, was submitted to the regulators on 10 October 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 regulators 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 throughout FY 2004, FY 2005, and FY 2006. The City of New Brighton conducted an evaluation of its municipal system to, in part, determine the future use of the PGRS extraction well and treatment system. The City of New Brighton 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.

12.1 REMEDY COMPONENT #1: MONITORED NATURAL ATTENUATION

Description: "Monitored natural attenuation." (OU3 ROD Amendment #1 [2006b], page 17).

Performance Standard (how do you know when you've achieved the remedy):

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 2021 monitoring plan, and any deviations are explained in Appendix C.2. Details of the groundwater monitoring program are discussed in Section 12.2.

12.2 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 [2006b], page 17).

Performance Standard (how do you know when you've achieved the remedy):

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 2021 monitoring plan, and any deviations are explained in Appendix C.2.

Groundwater samples were collected from three OU3 wells in FY 2021 as part of OU1, OU2, and OU3 minor sampling event. Samples were collected as specified in the monitoring plan and analyzed for VOCs and 1,4-dioxane at locations shown on Figure 12-1. During FY 2020, the chemical sampling at well 04U832 was inadvertently missed (groundwater elevation measurements were collected). As a result, chemical sampling was completed for this well during FY 2021. 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 12-1 summarizes the analytical results for the monitoring wells that were sampled in FY 2021. The wells sampled contained TCE concentrations similar to those reported for the previous sampling events.

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 presented in Table 12-2. In FY 2021 (a minor sampling event), only wells 03M848 and 04U832 were sampled. A summary of the statistical analyses was completed for well 03M848 and 04U832, and the other eight wells were included with FY 2020 results for an overview of the site. 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 decreasing to no trend or stable as concentrations have remained relatively constant 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 94.5 µg/L in FY 2021. In summary, the data collected in FY 2021 from the center of the South Plume represented by 03M848, indicate stable concentration trends.

Are contingency actions warranted?

No. The OU3 ROD Amendment #1 (2006b) 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 2021 showed a decreasing or stable trend.

What groundwater monitoring is proposed before the next report?

The proposed OU3 monitoring requirements are presented in Table 12-3 and Appendix A.

12.3 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 #1 [2006b], page 17).

Performance Standard (how do you know when you've achieved the remedy):

When an SWBCA Advisory is issued.

Has the MDH issued a Special Well Construction Area Advisory?

Yes, in June 1996. In June 1999, via the MDH the SWBCA boundary extended southwest including the Mississippi River and Marshall Avenue to ensure plume coverage. The SWBCA 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.

12.4 REMEDY COMPONENT #4: OVERALL REMEDY FOR OU3

Is the Remedy for OU3 Operating in Compliance with the 1992 OU3 ROD and OU3 ROD Amendment #1 (2006b)?

Yes. In FY 2021, groundwater monitoring took place as prescribed in the Annual Monitoring Plan. The annual sampling round of FY 2021 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.

12.5 OTHER RELATED ACTIVITY IN FY 2021

In FY 2021, samples from three wells were collected for 1,4-dioxane analysis for OU3 annual sampling as presented in Table 12-4. The wells sampled contained 1,4-dioxane concentrations similar to those reported for the previous sampling events.

13. OTHER INSTALLATION RESTORATION ACTIVITIES DURING FY 2021

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.

Round Lake

The Army has been working with regulators, landowners and other stakeholders since an informal dispute was resolved in 2016. After a series of collaborative meetings, a Final SRI-FS was submitted to regulators in March 2021. A Draft PP was submitted to regulators in April 2021. Comments received were incorporated, and a Final PP was submitted on 7 July 2021. An open house and public meeting were held in July 2021, with comments received. The Army will incorporate a response to comments into the ROD still under development at the end of FY21.

The *Tier II Ecological Risk Assessment Report* (USACHPPM 2004) for aquatic sites (including Round Lake), was approved by EPA and MPCA 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, EPA 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, EPA, 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.

EPA and MPCA provided consistency approval for the QAPP for Round Lake Sediment Investigation in January 2011. The sediment sampling work was completed in January to February 2011. A Draft Summary of Investigation Findings was submitted in May 2011, and a meeting between the Army, EPA, MPCA, the Minnesota Department of Natural Resources (MDNR), the U.S. Fish and Wildlife Service (USFWS), 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 EPA 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 EPA 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. EPA 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, EPA, and MPCA did not agree on the ecological risks and commensurate remedy associated with Round Lake. Given the difficulty reaching a consensus, the USAEC 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 EPA and MPCA in March 2014 indicated that significant disagreement remained. In April 2014, the Army, EPA, and MPCA entered an "informal dispute resolution" phase which continued in FY 2015 and FY 2016. In a teleconference between the EPA Region 5 Federal Facilities Chief and Headquarters Department of the Army personnel on 20 September 2016, an agreement was reached in which the Army would submit a revised SRI-FS in the third quarter of FY 2017. The document was submitted for regulator review on 10 May 2017. The regulators provided written comments in July 2017, with the Army responses issued on 6 October 2017. At the end of FY 2018, a revised Final SRI-FS for Round Lake was prepared and submitted to EPA and MPCA on 7 September 2018.

A meeting was held on 18 June 2019 with USFWS, EPA, MPCA, and the Army to consider the current ecological risk to the ecosystem, understand USFWS goals for Round Lake, discuss remedial alternatives, and define the path forward for Round Lake. The Army provided the Round Lake SRI-FS USFWS comments and Army responses to the stakeholders on 19 September 2019. A meeting was held on 25 September 2019 with USFWS, EPA, MPCA, and the Army. The objectives of the meeting were to discuss comments on the SRI-FS, next steps in the CERCLA process, cleanup value, and the list of remedial alternatives. It was agreed that the SRI-FS would be revised based on the agreed upon cleanup value of 0.6 mean probable effect concentration quotient, the agreed list of alternatives, and comments on the SRI-FS. A call was held on 2 October 2019 with USFWS, EPA, MPCA, and the Army to discuss Applicable or Relevant and Appropriate Requirements (ARARs). The Army submitted the Draft Final SRI-FS for the Round Lake New Brighton/Arden Hills Superfund Site and September 2018 SRI-FS for Round Lake New Brighton/Arden Hills Superfund Site USFWS comments and Army responses to the stakeholders and USFWS, EPA, MPCA, and MDNR on 4 December 2019.

EPA and MPCA provided comments on the December 2019 draft of the SRI-FS on 17 and 21 January 2020, respectively. No comments were received from the USFWS before the planned Round Lake meeting was held on 25 February 2020. During the meeting, the Army agreed to prepare draft text to address the ARARs for USFWS review and approval (before the Remedial Action section in the SRI-FS). The USFWS stated that they wanted agreement on the ARARs prior to providing comments on the SRI-FS. MDNR provided comments on 13 April 2020 and a team call with the MDNR was held on 13 May 2020 to discuss their comments and draft Army responses, and the meeting minutes were sent out on 15 June 2020. The USFWS finally provided their comments on 22 May 2020 and the Army provided response on 27 June

2020 prior to the team call on 14 July 2020 to discuss the USFWS comments and Army responses. Draft minutes were provided on 28 July 2020.

The Army provided the Field Habitat Assessment Memo on 30 July 2020, describing the field habitat assessment that the Army planned to conduct in August. The field visit enabled the Army (with the MDNR and USFWS assistance) to verify habitat conditions for the Bald Eagle, Blanding Turtle, and Ghost Tiger Beetle around Round Lake. The assessment was completed on 20 August 2020 and was summarized in MDNR's Round Lake Remediation Planning Site Visit Report dated 31 August 2020 (MDNR 2020).

A revised version of the Draft Final RI-FS was submitted on 17 August 2020. EPA provided a Consistency Letter on 24 August 2020, which requires a Draft PP in 40 days (end of September 2020). A call was held with stakeholders on 1 September 2020 to discuss steps to finalize the SRI-FS. On 3 September 2020, MPCA issued a letter to EPA to request a 30-day extension for the completion of the SRI-FS to allow MPCA and MDNR to complete state coordination. EPA provided concurrence to MPCA's request for extension and the deadline for the Final SRI-FS was changed to 1 October 2020. MPCA provided an email on 2 October 2020 that revised their position on state acceptance of alternatives presented in the Round Lake SRI-FS based on state land use and management needs rather than solely MPCA acceptance based on protectiveness of benthic organisms. The revised MPCA position ranks Alternative 4 100 percent state acceptance, Alternative 8 at 25 percent state acceptance, and all others at zero percent state acceptance. Previously (per their Email from 26 August 2020) their position was Alternatives 4A, 4B, 6A, 6B, 8 and 9 were 100 percent desirable and Alternative 7 was 25 percent based on acceptance to benthic organisms.

Army submitted a "Request for extension to the FS and PP for Round Lake" on 14 October 2020, and it was approved by EPA on 16 October 2020 and MPCA on 19 October 2020. After submittal of the revised Final SRI-FS, which incorporated MPCA's latest comments on 27 October 2020, MPCA provided their Consistency Letter on 28 October 2020. The USFWS comments were provided on 23 November 2020, and the Army held a call with them to discuss the comments on 1 December 2020. The Army requested an additional extension for the SRI-FS to end of January 2021, dated 14 December 2020. The extension was approved by EPA and MPCA on 14 and 15 December 2020, respectively. Final approval letters from EPA and MPCA were received on 12 March 2021 and 15 March 2021, respectively. The PP was finalized in July 2021 and joint consistency approval was granted on 7 July 2021. The Draft ROD is scheduled for submittal in Quarter 2 of FY 2022.

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14. REFERENCES

Arcadis. 2021a. TCAAP Data Usability Report #109, FY2021 1st Quarter Monitoring (October – December 2020). Final Report. June.

———. 2021b. TCAAP Data Usability Report #110, FY2021 2nd Quarter Monitoring (January – March 2021). Final Report. June.

———. 2021c. TCAAP Data Usability Report #111, FY2021 3rd Quarter Monitoring (April – June 2021). Final Report. September.

———. 2021d. "SOURCE GROUNDWATER RECOVERY SYSTEM (SGRS)" drawings Issued For Construction (100% design). July.

EA Engineering, Science, and Technology, Inc., PBC (EA). 2021. Twin Cities Army Ammunition Plant Data Usability Report #112, FY2021 4th Quarter Monitoring (July – September 2021). December.

Federal Facility Agreement. 1987. 12 August.

Minnesota Department of Health (MDH). 2016. Notice of Update to Special Well and Boring Construction area in the Vicinity of the Twin Cities Army Ammunition Plant, Anoka, Hennepin, and Ramsey County, Minnesota. April.

Minnesota Department of Natural Resources (MDNR). 2020. Round Lake Remediation Planning Site Visit Report. Report of Listed Species Habitat Assessment of Round Lake and Shoreline. August.

Montgomery Watson. 1995. Operable Unit 1 Alternate Water Supply Plan. Final Report, October.

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.

Minnesota Pollution Control Agency (MPCA) and U.S. Environmental Protection Agency (EPA). 2000. Evaluation of Natural Attenuation of Chlorinated Solvents in Ground Water at the Twin Cities Army Ammunition Plant. June.

Oak Ridge National Laboratory. 2013. Supplemental Ecological Risk Assessment. October.

PIKA Arcadis U.S., Inc. a Joint Venture (JV). 2017. Addendum #1 Quality Assurance Project Plan for Performance Monitoring. May.

———. 2020a. Quality Assurance Project Plan for Performance Monitoring. June.

———. 2020b. Final Source Investigation Completion Letter Report. October.

———. 2021. Fiscal Year 2020 Annual Performance Report. June.

Stone & Webster Environmental Technology & Services (Stone and Webster). 1997. Final Site A Investigation Report. December.

U.S. Army (Army). 2004. OU1 Technical Group Technical Memorandum, Statistical Evaluation Method for Operable Unit 1 Water Quality Data. Final Report. December.

———. 2020a. Explanation of Significant Differences #3, Change in Groundwater Treatment System and Addition of 1,4-Dioxane as a Contaminant of Concern, New Brighton/Arden Hills Superfund Site. Final Report. October.

———. 2020b. Land Use Control Remedial Design Report. Revision 6. October.

———. 2021a. Well Inspection Report at the Twin Cities Army Ammunition Plant, Arden Hills, Minnesota. March.

———. 2021b. Site A Investigation Final Report. September.

———. 2022a. Final Operable Unit 1 Optimization Deep Groundwater – Phase II Geophysics Field Summary Report. January.

———. 2022b. TCAAP OU2 Source Control Well Installation Field Report. Final. January.

U.S. Army Center for Health Promotion and Prevention Medicine (USACHPPM). 2004. Tier II Ecological Risk Assessment Report. December.

U.S. Army, U.S. Environmental Protection Agency, and Minnesota Pollution Control Agency. 1992. Twin Cities Army Ammunition Plant, New Brighton/Arden Hills Superfund Site, Operable Unit 3 Record of Decision. September.

———. 1993. Twin Cities Army Ammunition Plant, New Brighton/Arden Hills Superfund Site, Operable Unit 1 Record of Decision. September.

———. 1997. Twin Cities Army Ammunition Plant, New Brighton/Arden Hills Superfund Site, Operable Unit 2 Record of Decision. December.

———. 2006a. Record of Decision Amendment [#1] for Operable Unit 1 (OU1). New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota. May.

———. 2006b. Record of Decision Amendment [#1] for Operable Unit 3 (OU3). New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota. August.

———. 2007. Record of Decision Amendment [#1] for Operable Unit 2 (OU2), Site C-2. New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota. July.

———. 2012. Record of Decision Amendment #4 for Operable Unit 2 (OU2), New Brighton/Arden Hills Superfund Site, Arden Hills, Minnesota. January.

U.S. Environmental Protection Agency (EPA). 1987. Interim Response Action Plan.

Wenck and Keres Consulting, Inc. (Wenck). 2006. Groundwater Investigation Report for Building 102, Twin Cities Army Ammunition Plant. January.

———. 2008a. Site A Shallow Groundwater 10-year Evaluation Report. July.

———. 2008b. Site A Shallow Groundwater: Monitoring and Contingency Plan. September.

———. 2008c. Site C Groundwater Extraction System Evaluation Report. November.

———. 2013a. Supplemental Remedial Investigation and Feasibility Study for Round Lake.

———. 2013b. Remedial Action Completion and Close Out Report, Pond G. November.

———. 2014. Site A Vapor Intrusion Investigation Report. February.

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Figures

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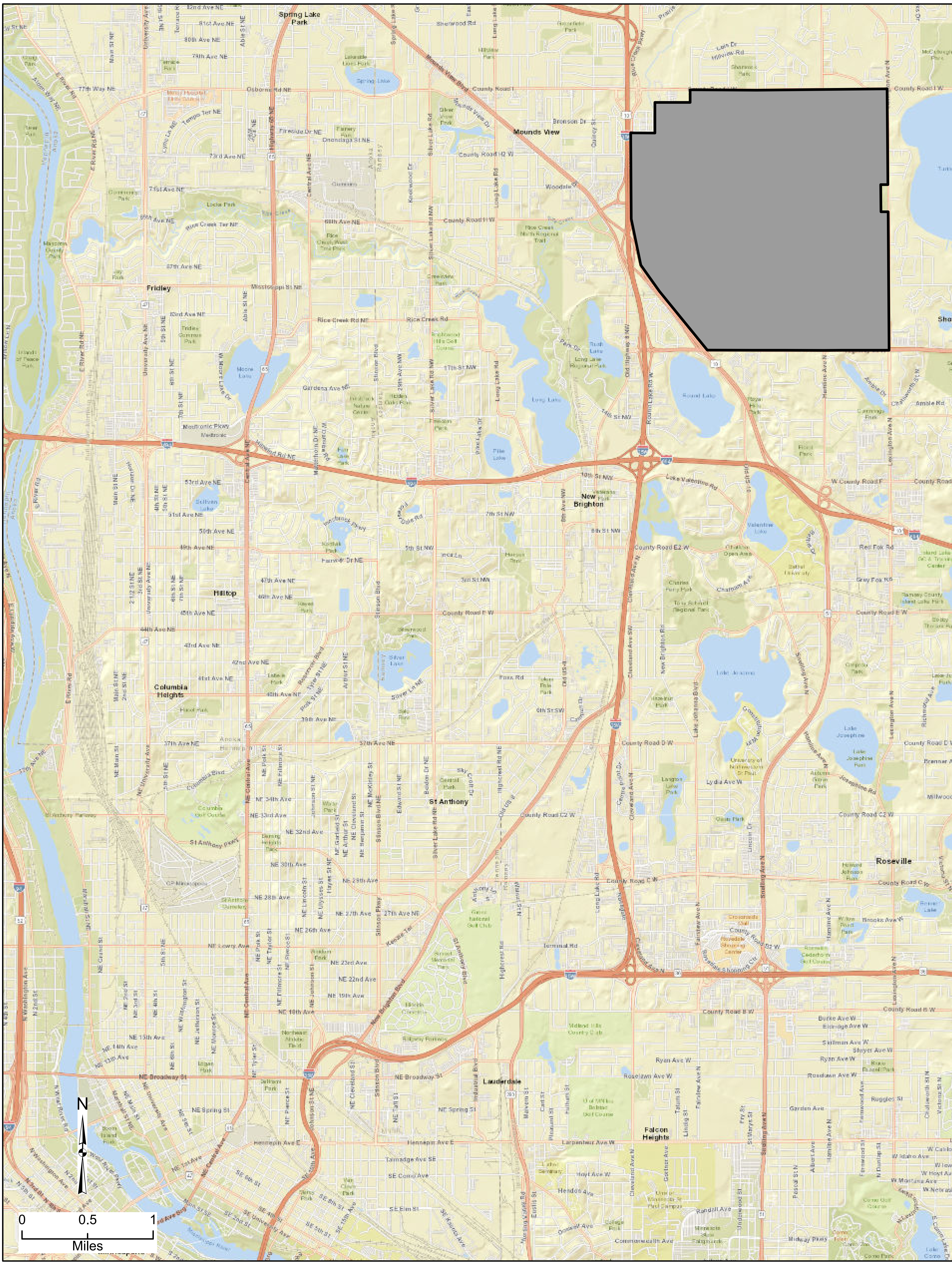

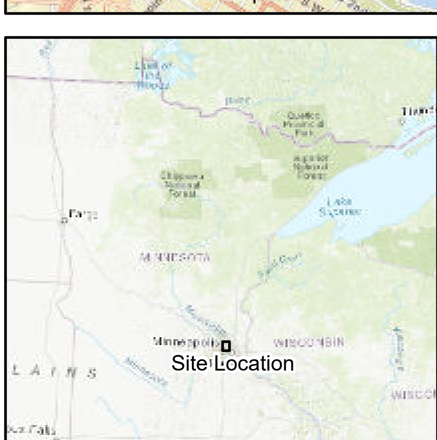

Legend

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.)

Figure 1-1
Site Location Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 2/10/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
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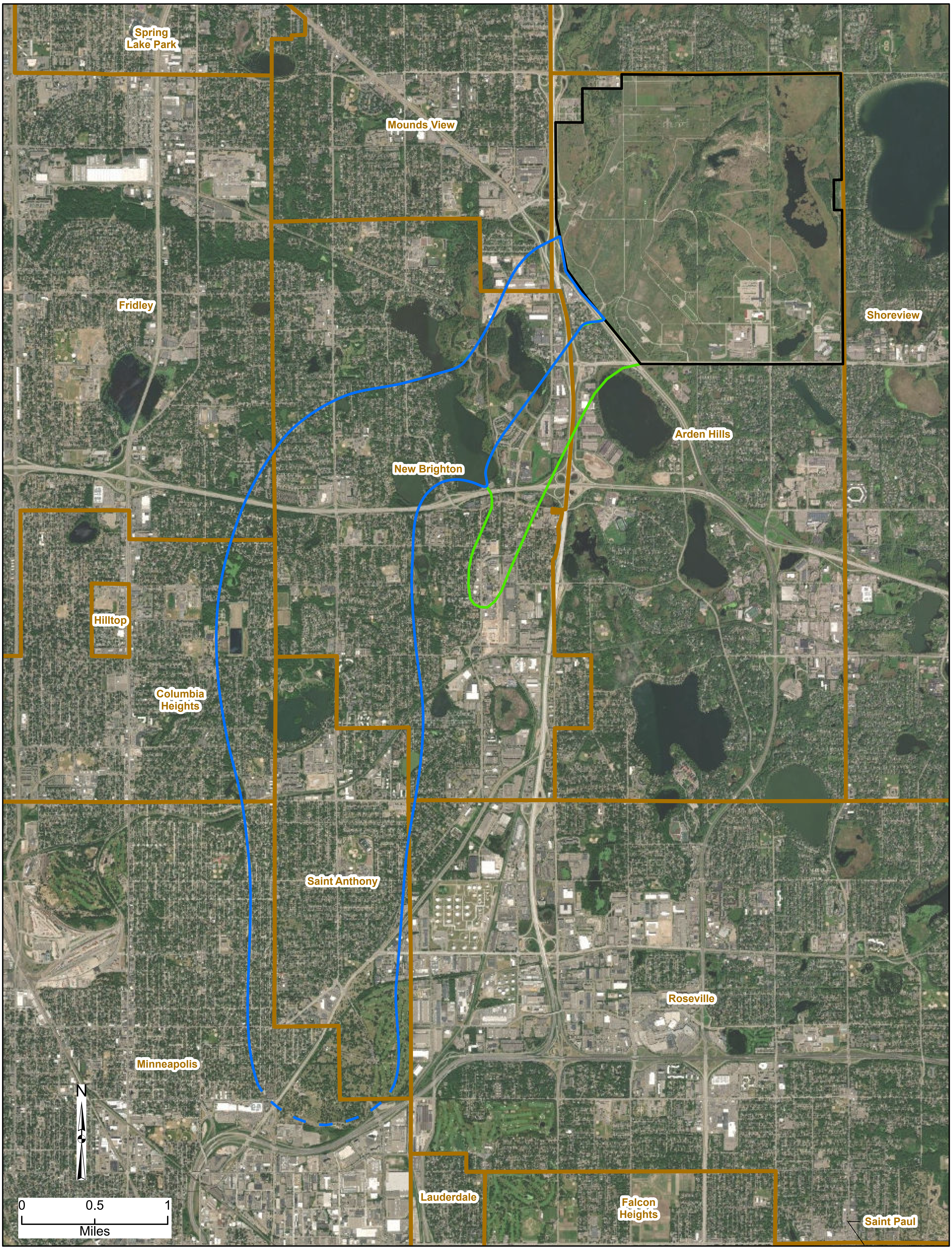

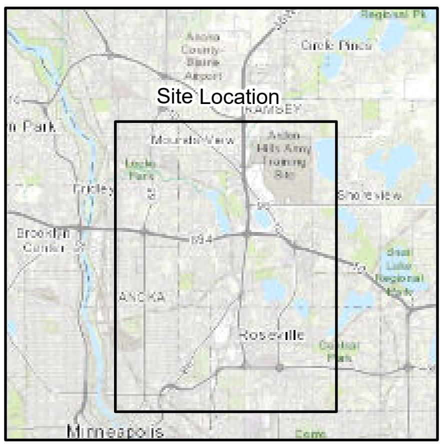

Legend

- Operable Unit 1 (North Plume) (Dashed Where Inferred)
- 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

Date: 2/10/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
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Figure 1-2
Conceptual Illustration of OUs 1, 2, and 3
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Legend

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.)

General NPL Site Boundary

Figure 1-3
OU2 Site Boundaries
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 2/10/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
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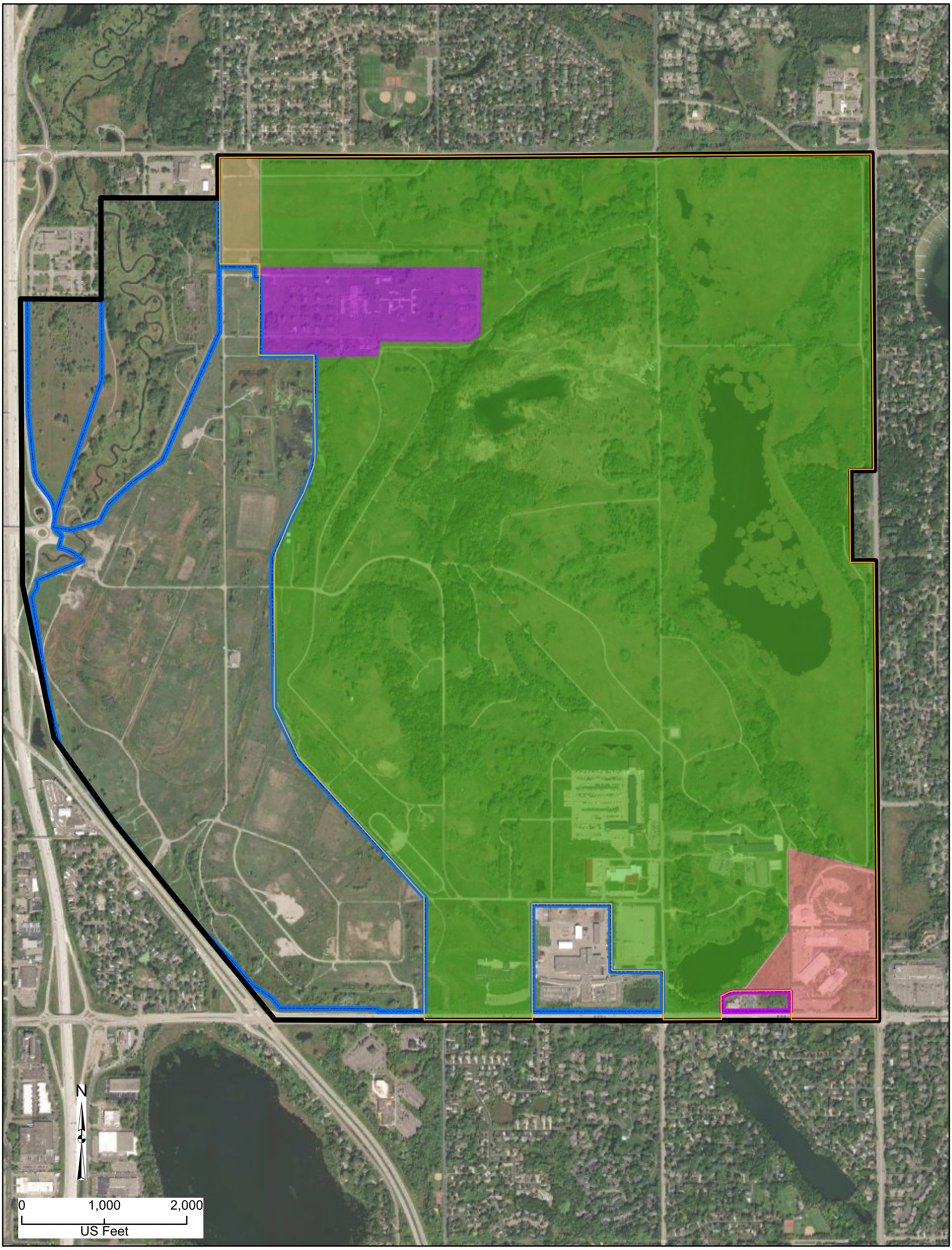

Legend

- Operable Unit 2 Boundary
- City of Arden Hills - Owned Property
- Ramsey County Owned
- 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

Figure 1-4
Operable Unit 2 Site Boundary
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 2/16/2023
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
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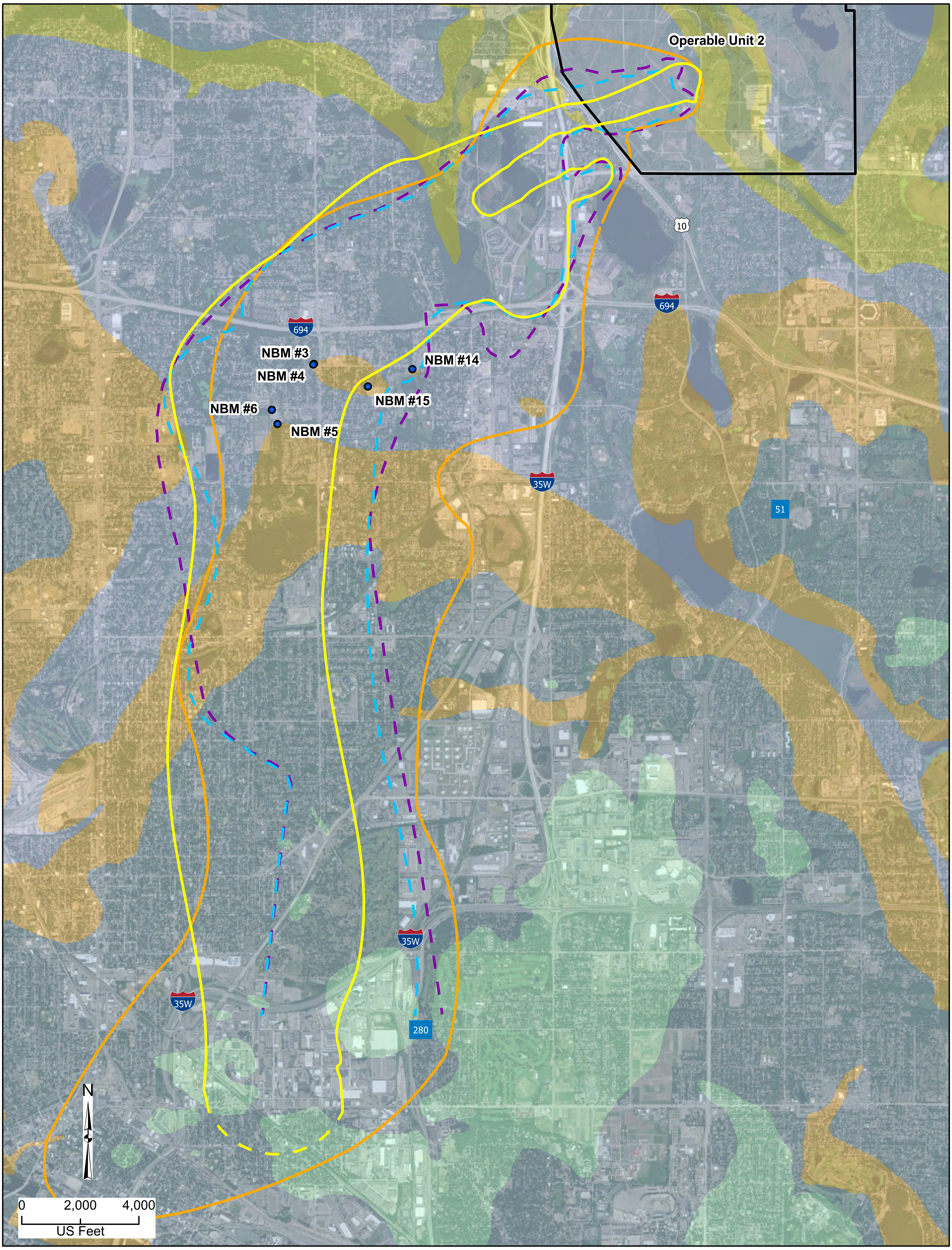

Legend

- New Brighton Municipal Wells
- 2021 5 µg/L
- 2021 Inferred 5 µg/L
- 2009 1 µg/L
- 1999 1 µg/L
- 1990 1 µg/L
- 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

Date: 5/17/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
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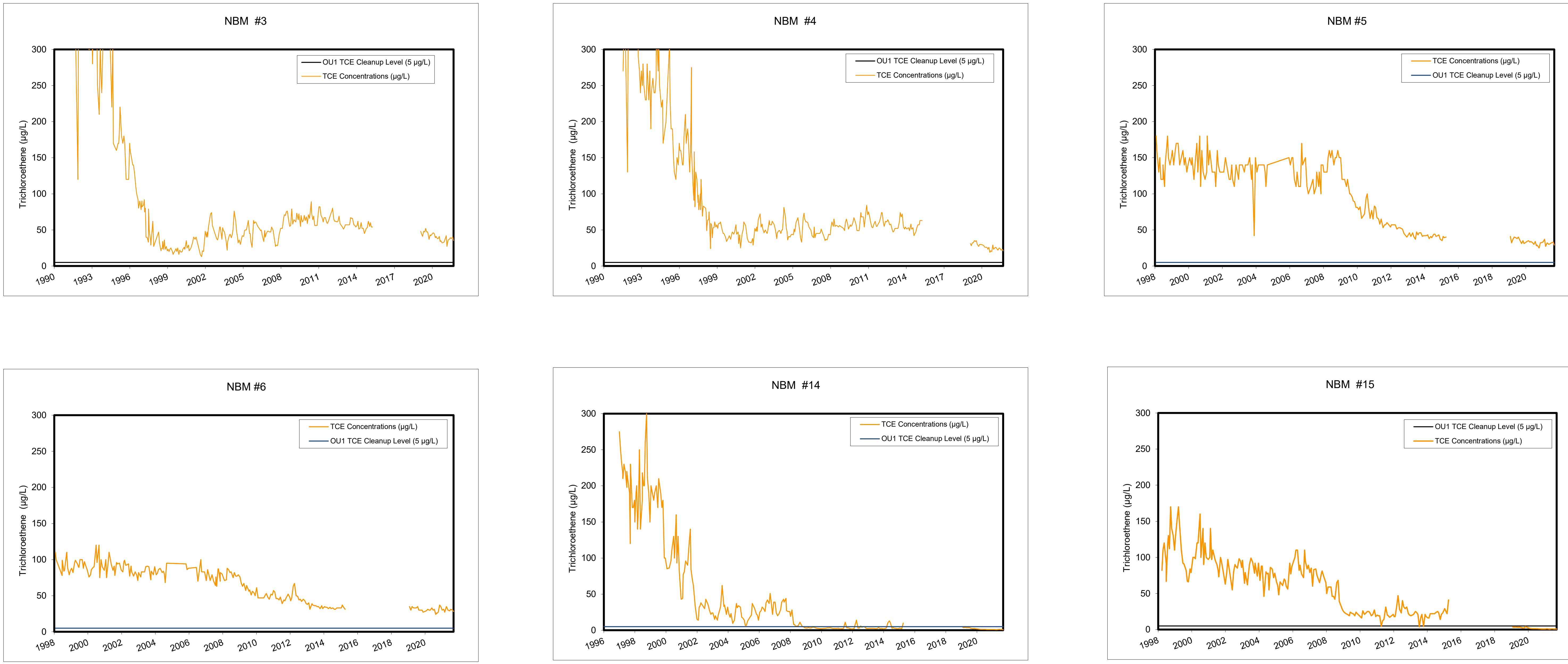
Figure 2-1
Annual Performance Report
Upper Unit 4, 5 µg/L Trichloroethene
Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

FIGURE 2-2

NEW BRIGHTON MUNICIPAL WELLS: TRICHLOROETHENE WATER QUALITY TRENDS

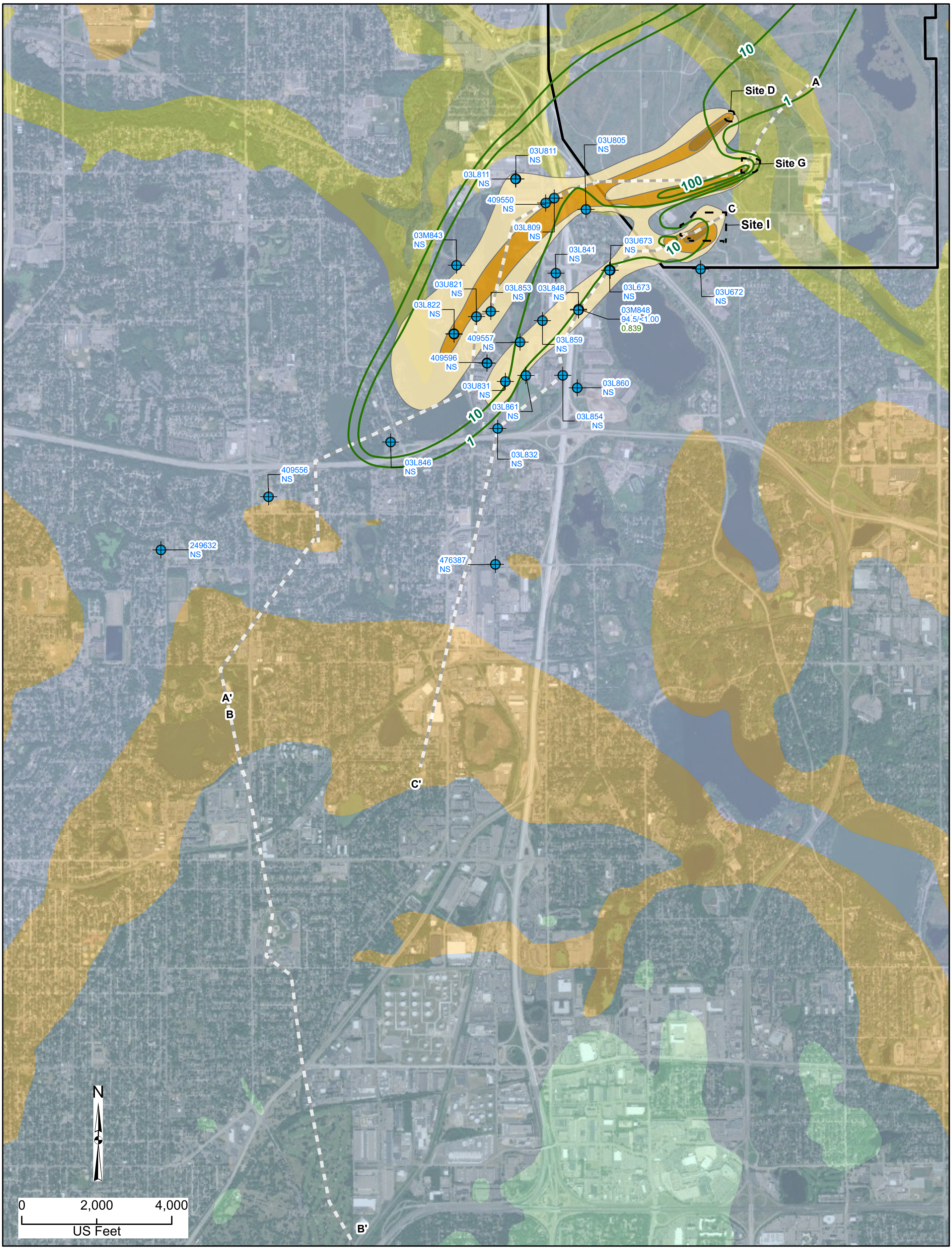
Twin Cities Army Ammunition Plant

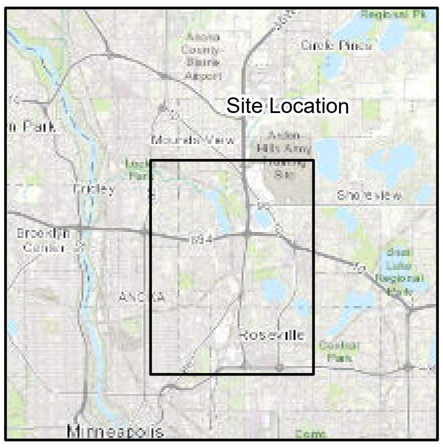
Arden Hills, Minnesota



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

Update: The routine pumping of the NBCGRS began again in 2019 following the implementation of a treatment system for 1,4-dioxane.





Legend

- Monitoring Well Locations
- 03M848 Monitoring Well ID
- 94.5 Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
- 0.839 1,4-Dioxane Concentration (µg/L)
- Cross-Section Line
- Site Boundary
- 2021 1,4 Dioxane Concentration Contour (µg/L

2021 Trichloroethene Concentrations

- 5-100 µg/L
- 100-1,000 µg/L
- 1,000+ µg/L
- 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

Date: 5/17/2022
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Spatial Reference: NAD 1983 UTM Zone 15N
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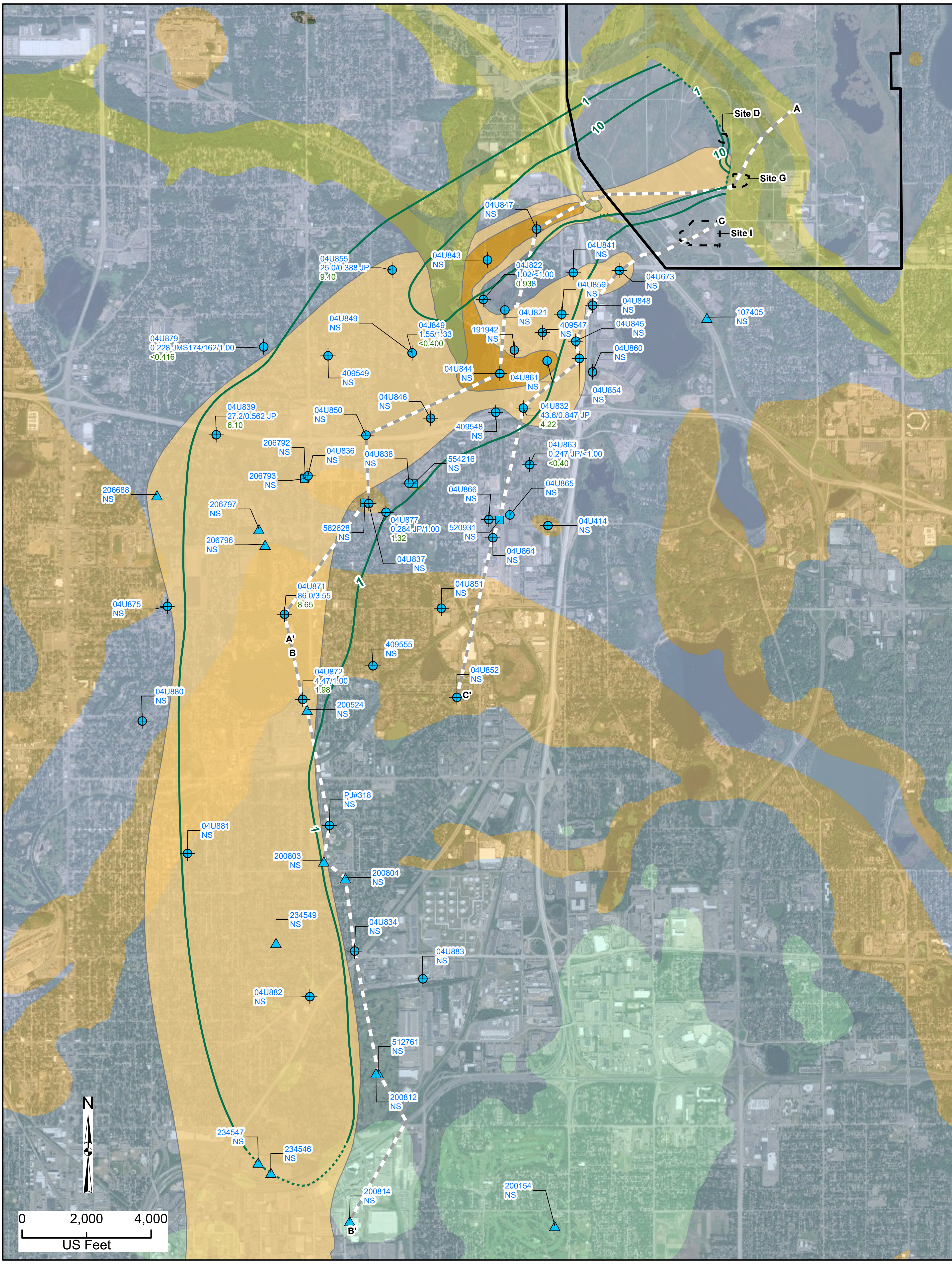
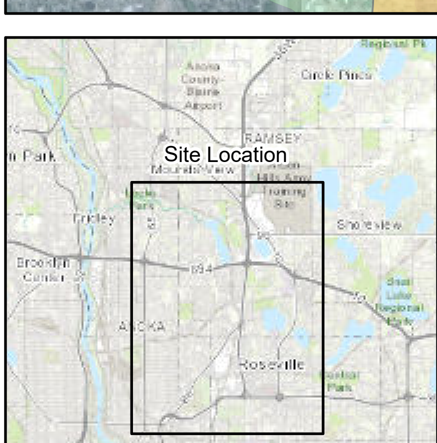
Figure 2-3
Annual Performance Report
OU1 and OU3,
Upper and Lower Unit 3
Trichloroethene and 1, 4-Dioxane
Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota





Legend

Monitoring Well

04U871 Monitoring Well ID

86.0 Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)

8.65 1,4-Dioxane Concentration (µg/L)

Extraction Well

Private Well

Cross-Section Line

Site Boundary

2021 1,4 Dioxane Concentration Contour (µg/L)

2021 1,4 Dioxane Concentration Inferred Contour (µg/L)

2021 Trichloroethene Concentrations (µg/L)

5-100 µg/L

100-1,000 µg/L

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

Date: 12/22/2022
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Spatial Reference: NAD 1983 UTM Zone 15N
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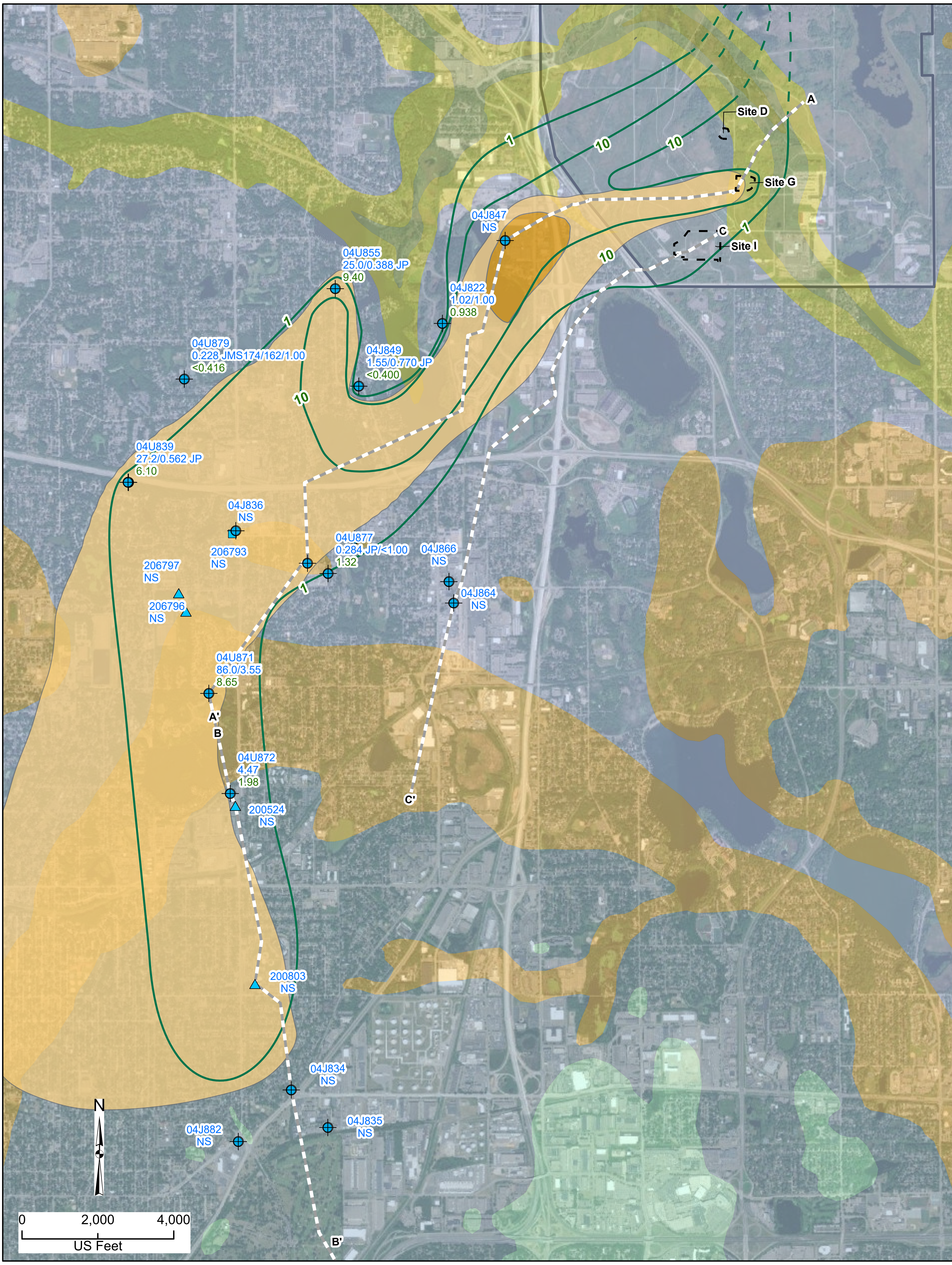
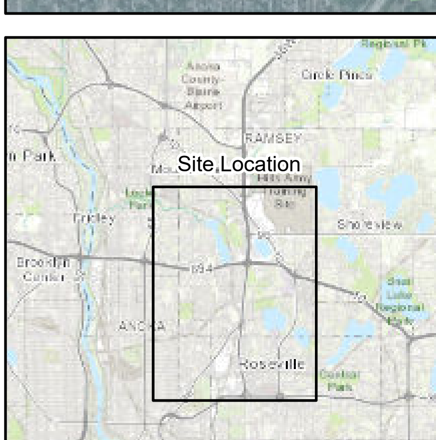
Figure 2-4
Annual Performance Report
OU1 and OU3, Upper Unit 4
Trichloroethene and 1, 4-Dioxane
Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota





Legend

- Monitoring Well
- 04U871 Monitoring Well ID
- 13/0.52 J Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
- 1.6 1,4-Dioxane Concentration (µg/L)
- Extraction Well
- Private Well
- Cross-Section Line
- Site Boundary
- 2021 1,4 Dioxane Concentration Contour (µg/L)
- 2021 1,4 Dioxane Concentration Inferred Contour (µg/L)

2021 Trichloroethene Concentrations (µg/L)

- 100-1,000 µg/L
- 5-100 µg/L
- 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

Date: 5/17/2022
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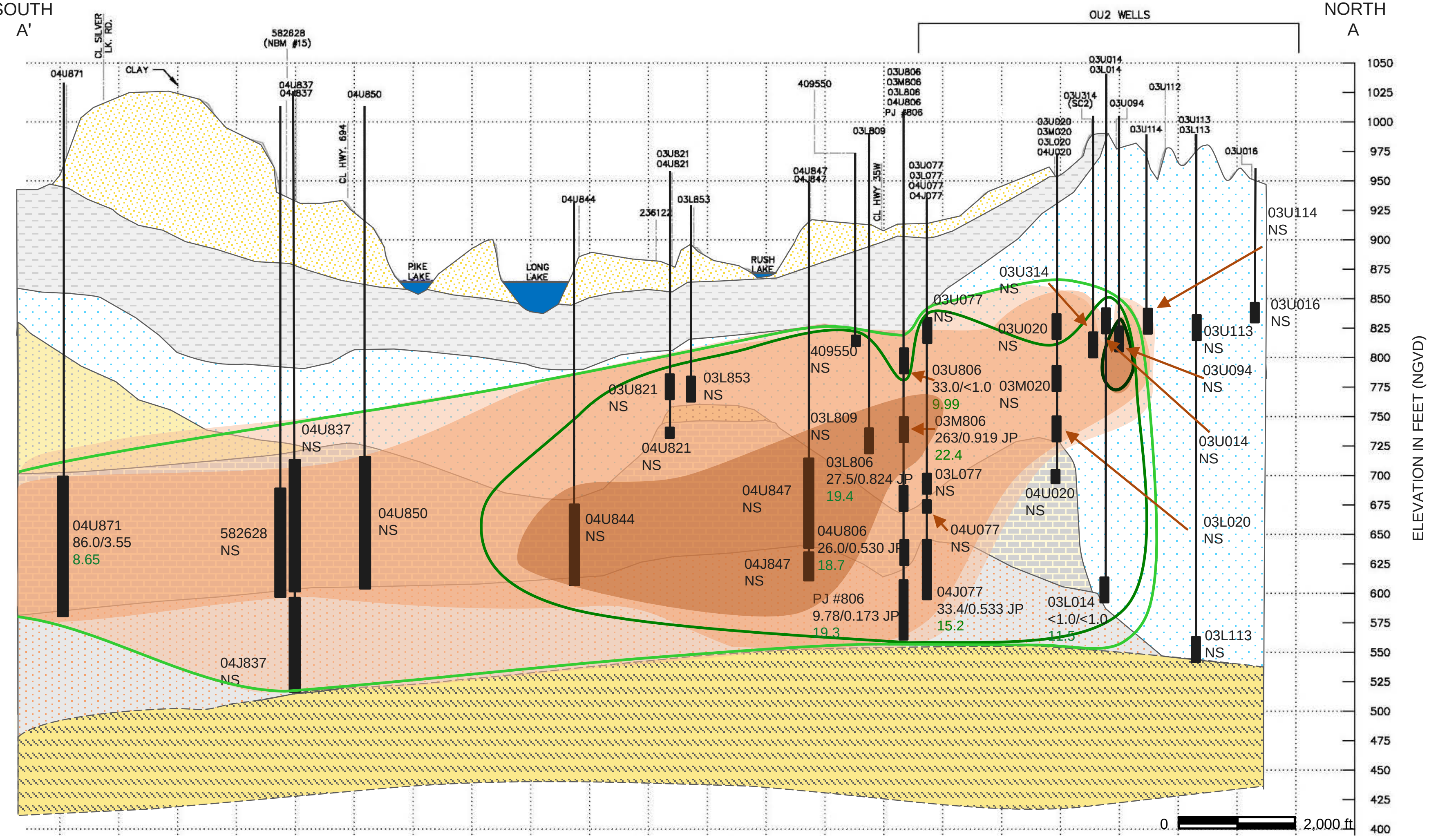
Figure 2-5
Annual Performance Report
OU1 and OU3, Lower Unit 4
Trichloroethene and 1,4-Dioxane
Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

FY 2021 Annual Performance Report
Figure 2-6
OU2-OU1 Trichloroethene Cross Section A-A'

U.S Army - TCAAP
Arden Hills, Minnesota



Legend

04J077 Well ID

NS Not Sampled

µg/L Micrograms per Liter

NGVD National Geodetic Vertical Datum

69/1.5 Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)

36.9 1,4-Dioxane concentration (µg/L)

J Reported value is between the method detection limit and reporting limit

Geologic Contact (inferred where dashed)

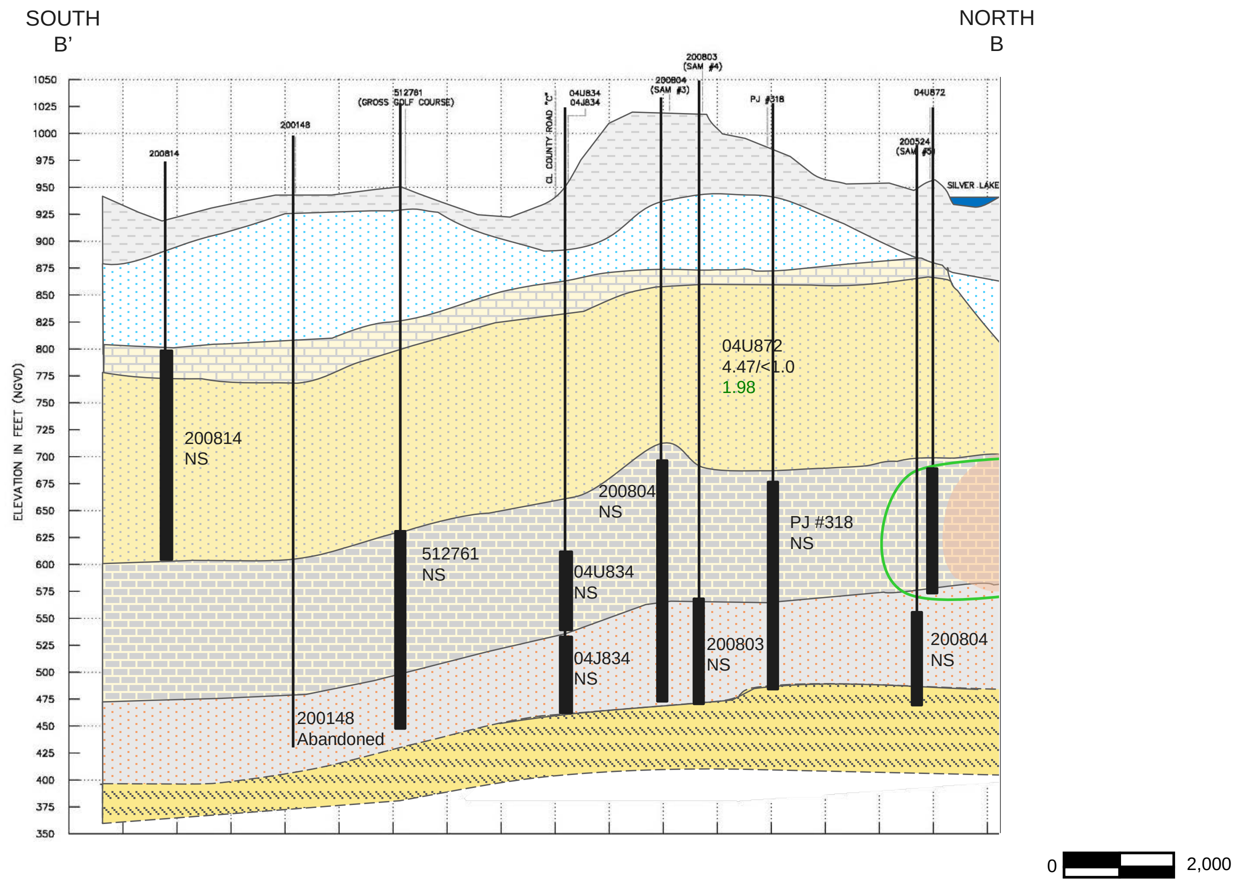
Screened Interval

Trichloroethene Concentration (µg/L)
- 5-10
- 10-100
- >100

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

FY 2021 Annual Performance Report
Figure 2-7
OU2-OU1 Trichloroethene Cross Section B-B’
U.S Army - TCAAP
Arden Hills, Minnesota



Legend

512761	Well ID
NS	Not Sampled
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)
3.4	1,4-Dioxane concentration* (µg/L)
—	Geologic Contact (inferred where dashed)
▌	Screened Interval

Trichloroethene Concentration (µg/L)

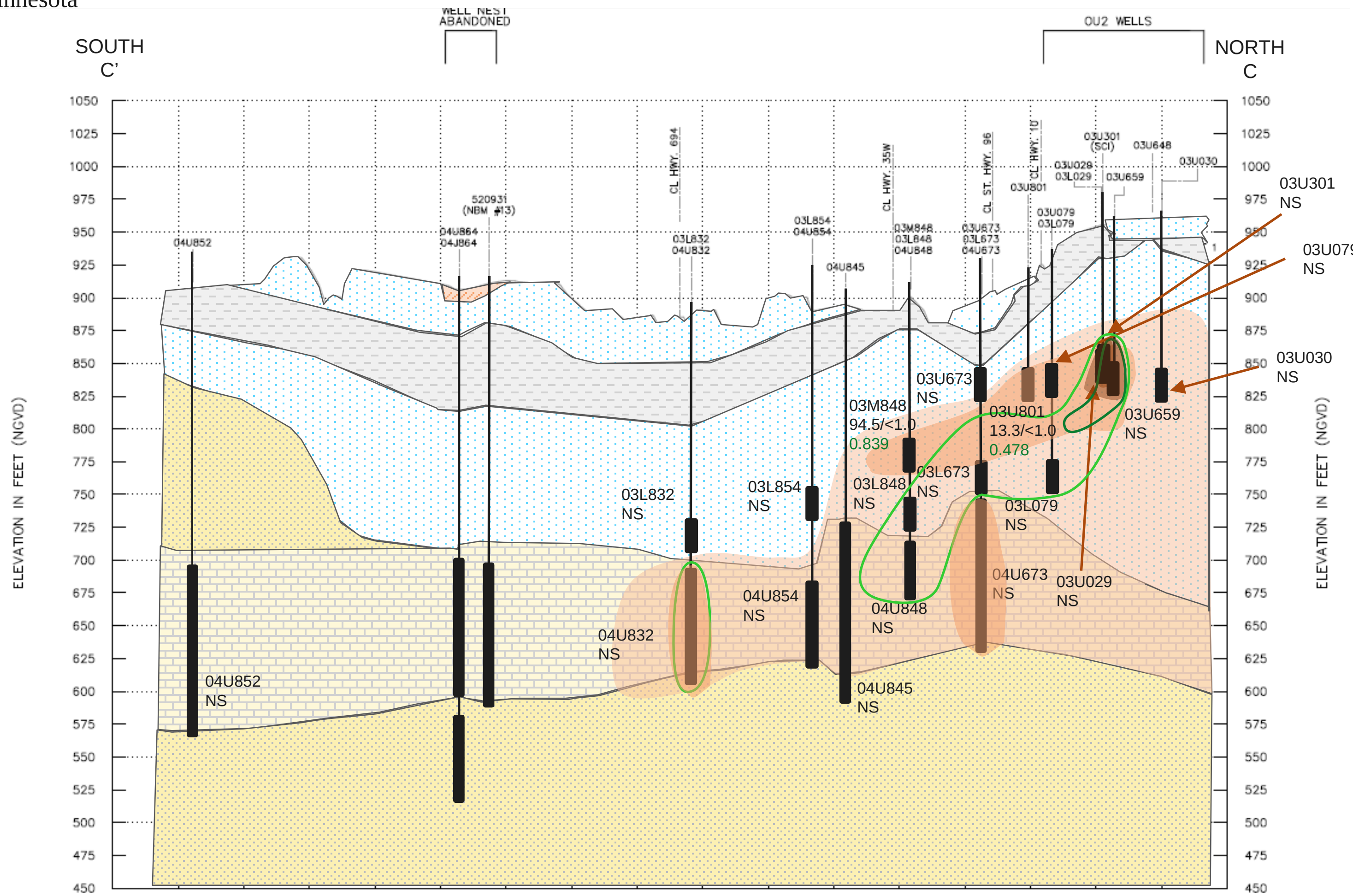
- 5-10
- 10-100

1,4-Dioxane Concentration (µg/L)

- 1-10

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

FY 2021 Annual Performance Report
Figure 2-8
OU2-OU3 Trichloroethene Cross Section C-C’
U.S Army - TCAAP
Arden Hills, Minnesota



Legend

03U079 Well ID
NS Not Sampled
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)
- 5-10
- 10-100
- > 100

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

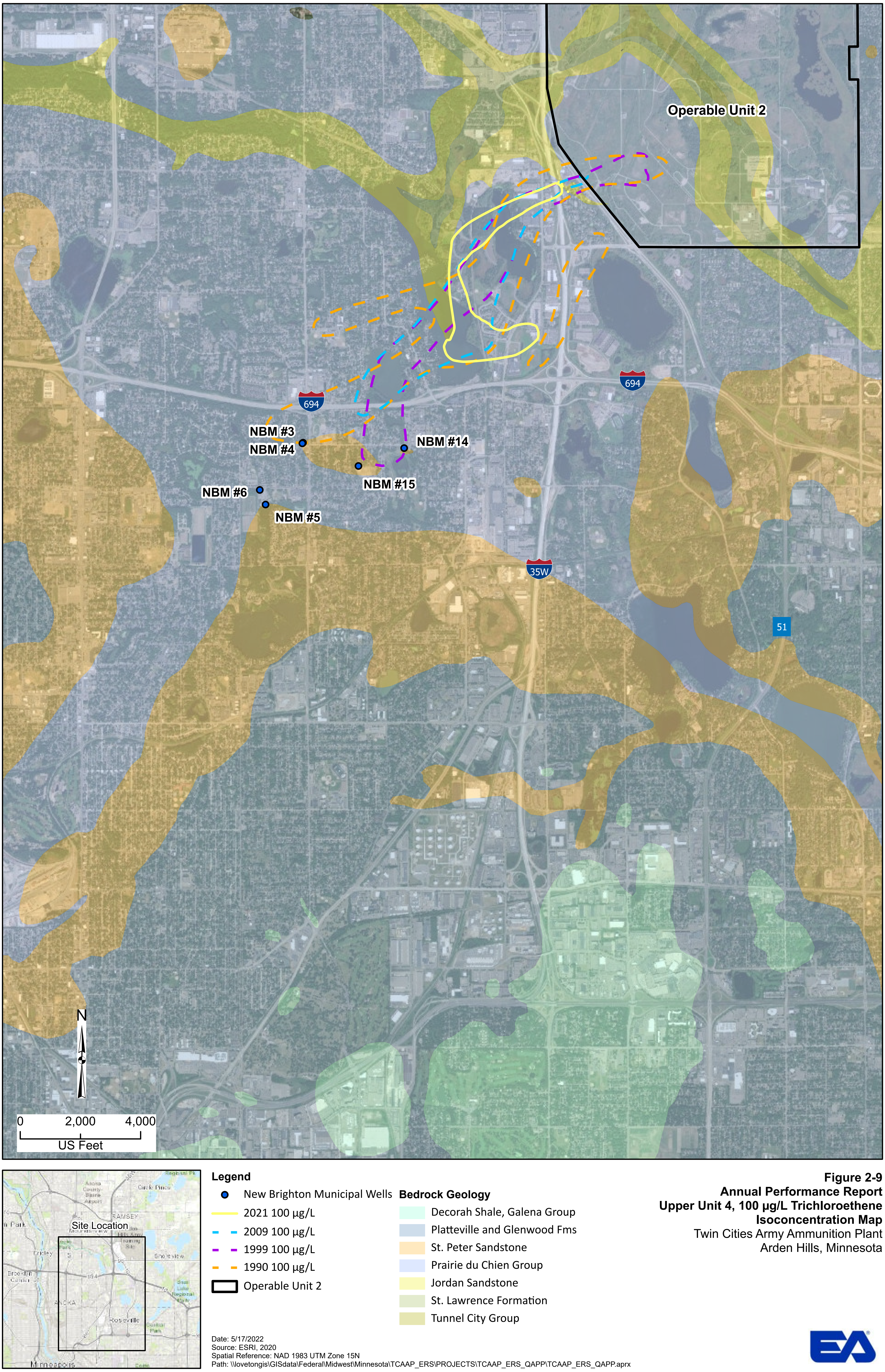
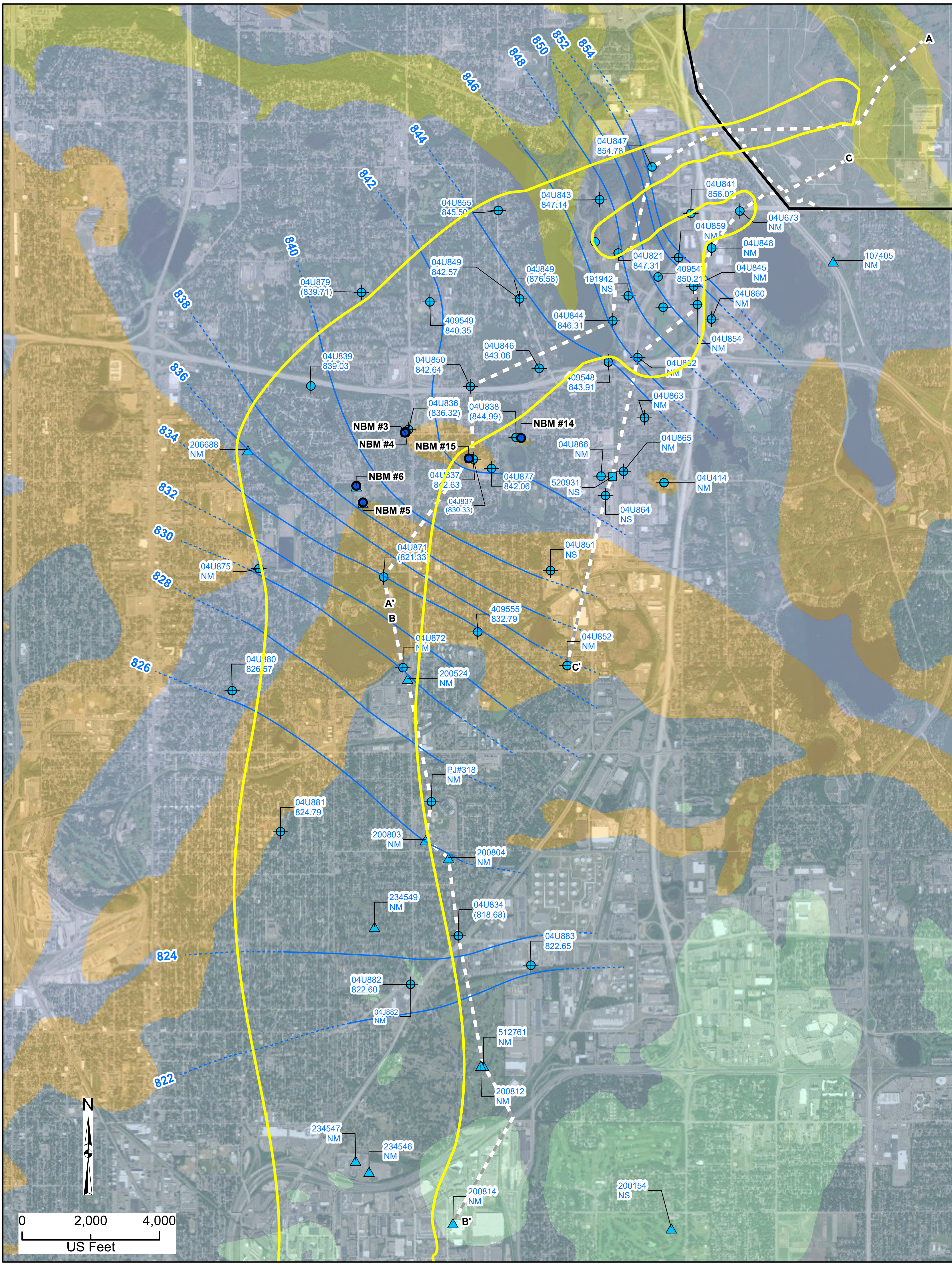
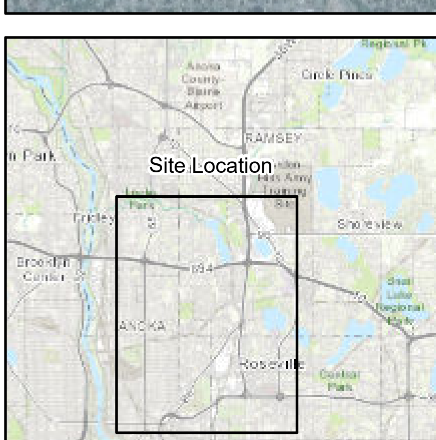


Figure 2-9
Annual Performance Report
Upper Unit 4, 100 µg/L Trichloroethene Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota





Legend

- Monitoring Well
- Extraction Well
- Private Well
- (NM) Not Measured
- 840 Groundwater Elevation
- New Brighton Municipal Wells
- Cross-Section Line
- Groundwater Elevation Contour
- Inferred Groundwater Elevation Contour
- 2021 5 ug/L Trichloroethene Contour in Upper Unit 4

Note: Values in parentheses were not used for contouring.

Bedrock Geology

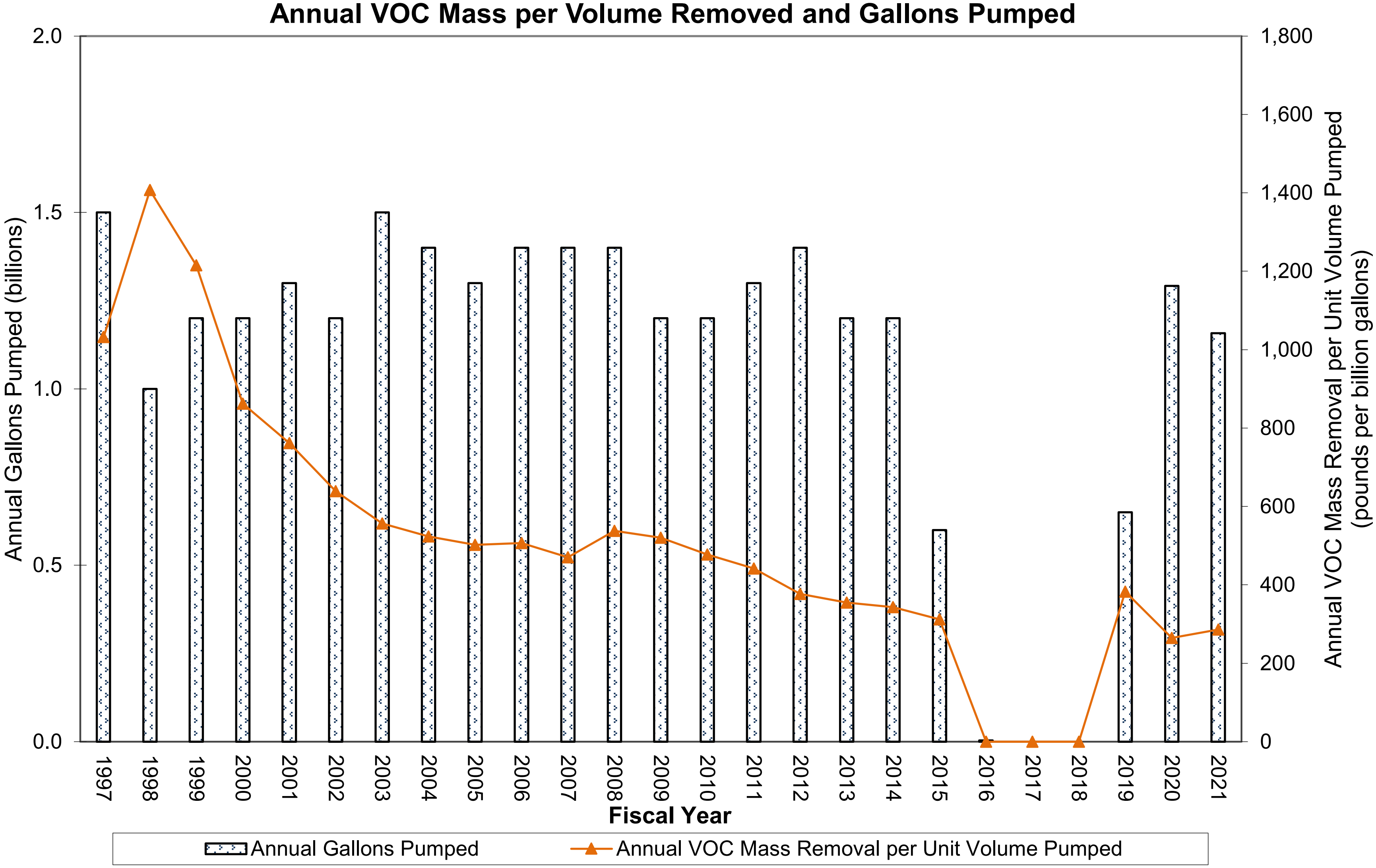
- Decorah Shale, Galena Group
- Platteville and Glenwood Fms
- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Tunnel City Group
- Operable Unit 2 of the New Brighton/ Arden Hills Superfund Site (the same area occupied by The Twin Cities Army Ammunition Plant in 1983, when the Site was placed on the NPL.)

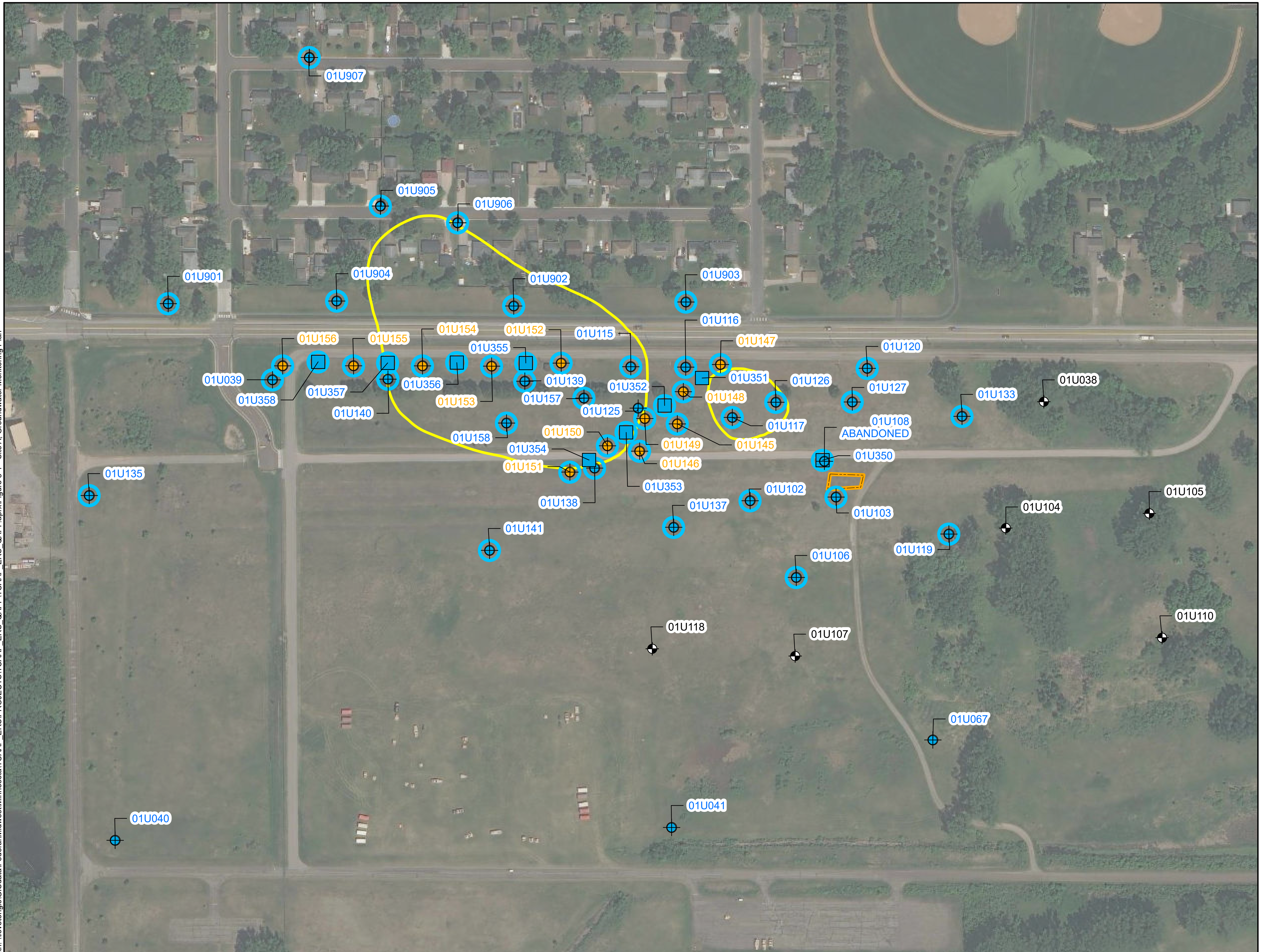
Date: 5/17/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx

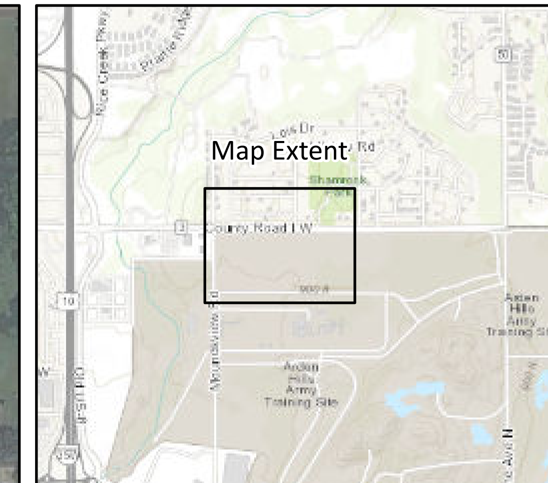
Figure 2-10
Annual Performance Report
OU1 and OU3, Upper Unit 4
Potentiometric Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

FIGURE 2-11
OU1, NBCGRS VOC MASS REMOVAL HISTORY

FY 2021 Annual Performance Report







Legend

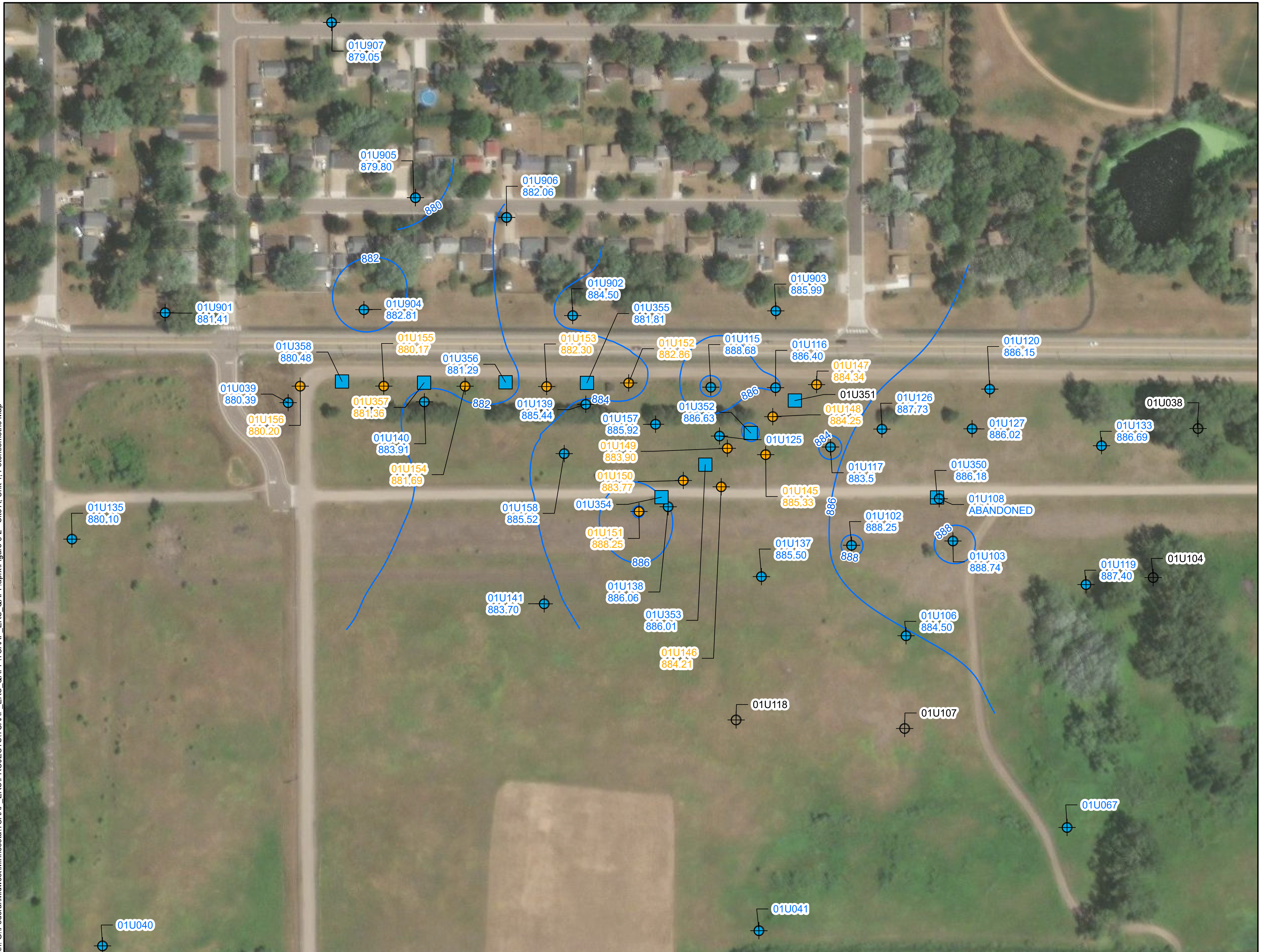
- Monitoring Well Location
- Piezometer Location
- Extraction Well Location
- Sealed Well Location
- Annual Water Quality
- 1 µg/L cis-1,2-Dichloroethene Contour (2021)
- 1945 Trench

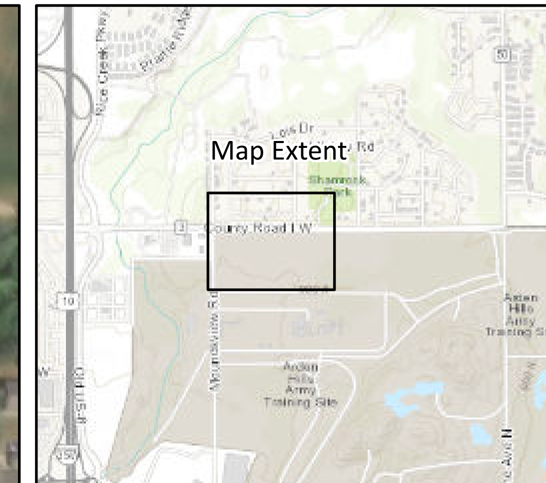
Map Date: 5/17/2022
Source: ESRI 2020
Projection: NAD 1983 UTM Zone 15N

0 100 200
US Feet

Figure 5-1
Site A, Groundwater Monitoring Plan
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx\Figure 5-1 - Site A, Groundwater Monitoring Plan





Legend

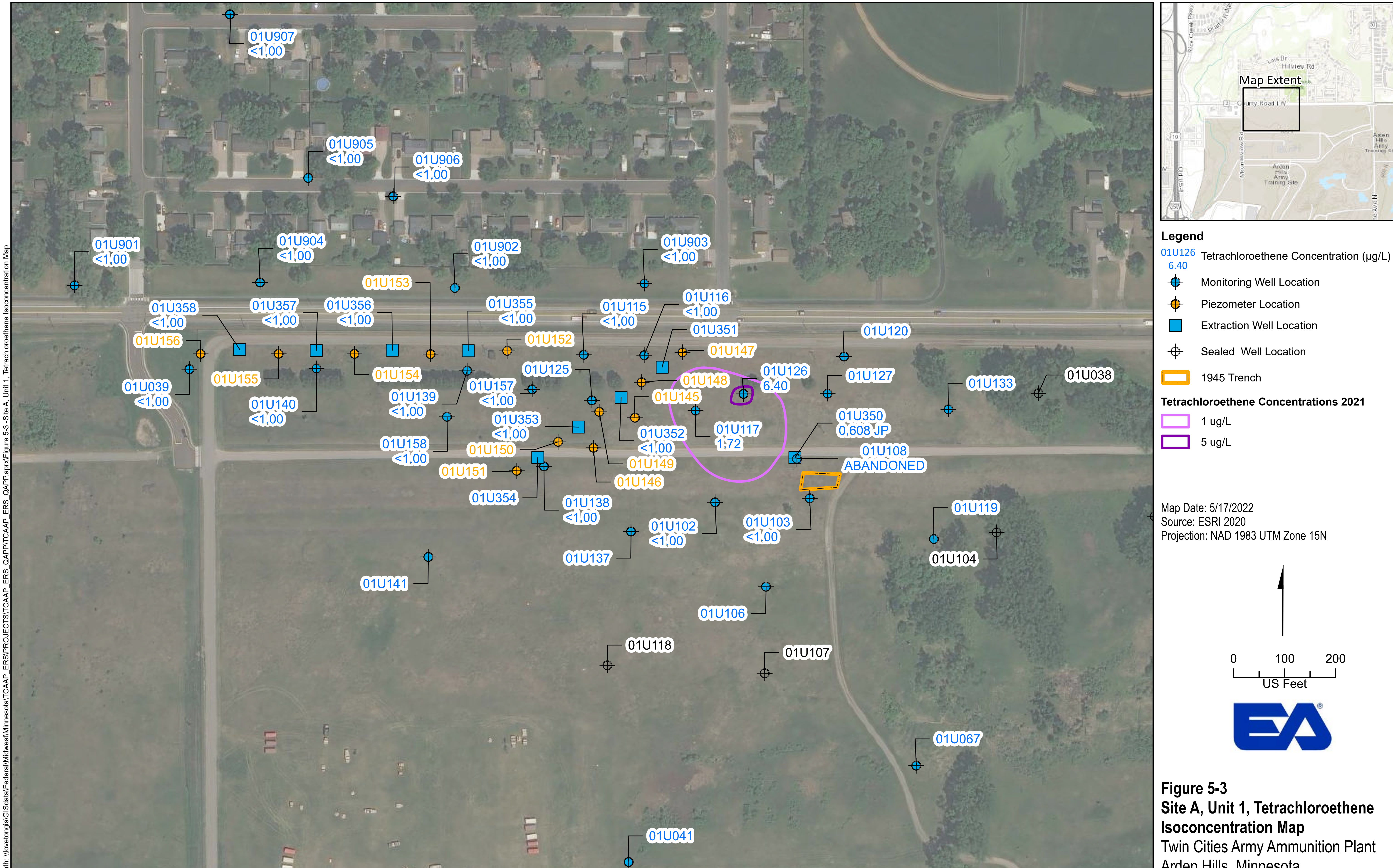
- Sealed Well Location
- Monitoring Well Location (01U127 886.02) Groundwater Elevation (ft amsl)
- Piezometer Location (01U145 885.33) Groundwater Elevation (ft amsl)
- Extraction Well Location (01U350 886.02) Groundwater Elevation (ft amsl)
- 2' Groundwater Contour - 2021

Map Date: 12/22/2022
Source: ESRI 2020
Projection: NAD 1983 UTM Zone 15N

0 100 200
US Feet

Figure 5-2
Site A, Unit 1, Potentiometric Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: G:\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPPapx\Figure 5-2 - Site A, Unit 1, Potentiometric Map



Legend

01U126 6.40 Tetrachloroethene Concentration (µg/L)

Monitoring Well Location

Piezometer Location

Extraction Well Location

Sealed Well Location

1945 Trench

Tetrachloroethene Concentrations 2021

1 ug/L

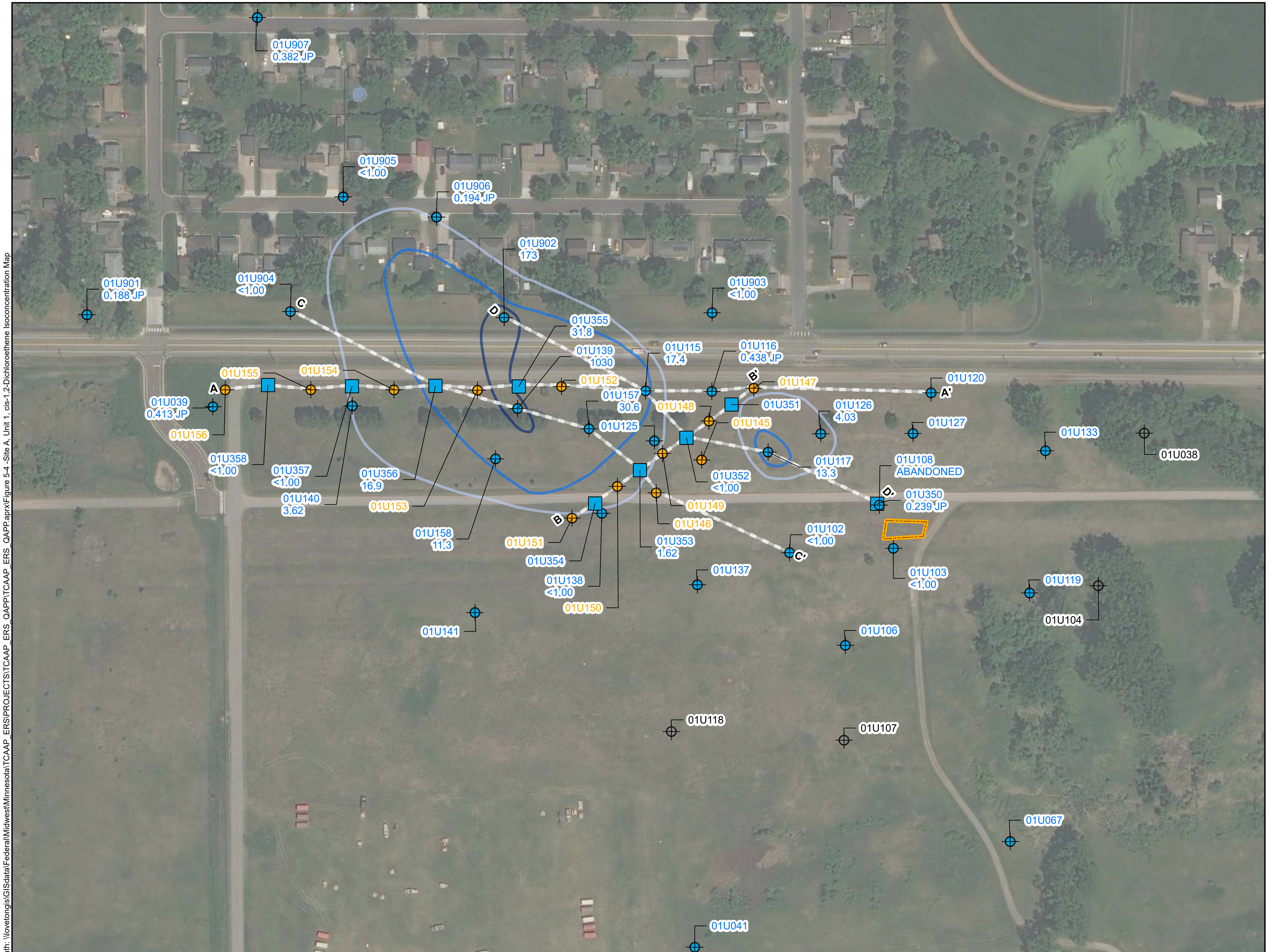
5 ug/L

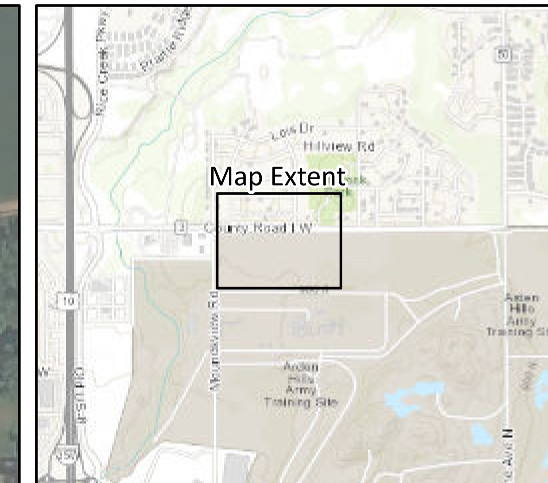
Map Date: 5/17/2022
Source: ESRI 2020
Projection: NAD 1983 UTM Zone 15N

0 100 200
US Feet

Figure 5-3
Site A, Unit 1, Tetrachloroethene Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: \\loveton\gis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx\Figure 5-3 -Site A, Unit 1, Tetrachloroethene Isoconcentration Map





Legend

01U126 4.03 cis-1,2-Dichloroethene Concentration (µg/L)

Monitoring Well Location

Piezometer Location

Extraction Well Location

Sealed Well Location

1945 Trench

Cross Section

cis-1,2-Dichloroethene Concentrations - 2021

1 ug/l

10 ug/l

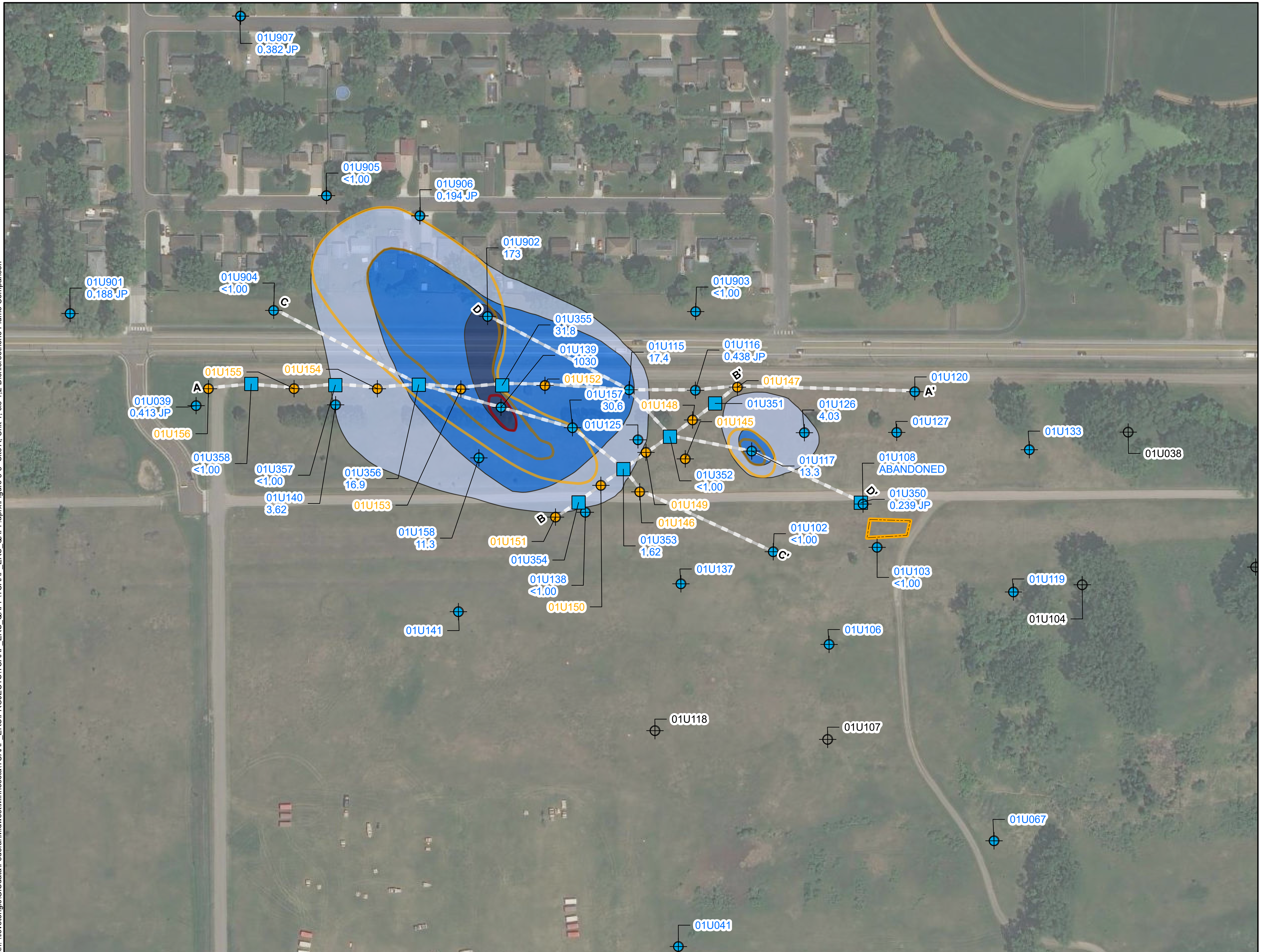
100 ug/l

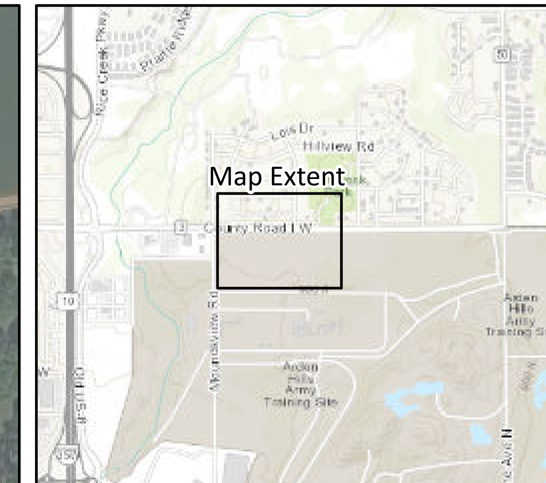
Map Date: 5/17/2022
Source: ESRI 2020
Projection: NAD 1983 UTM Zone 15N

0 100 200
US Feet

Figure 5-4
Site A, Unit 1, cis-1,2-Dichloroethene Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: \\lovetongis\GIS\data\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx\Figure 5-4 Site A, Unit 1, cis-1,2-Dichloroethene Isoconcentration Map





Legend

- Monitoring Well Location
- Piezometer Location
- Extraction Well Location
- Sealed Well Location
- 1945 Trench
- Cross Section

cis-1,2-Dichloroethene Concentrations - 2021

- 1-10 ug/l
- 10-100 ug/l
- > 100 ug/l

cis-1,2-Dichloroethene Concentrations - 2020

- 1-10 ug/l
- 10-100 ug/l
- > 100 ug/l

Map Date: 5/17/2022
Source: ESRI 2020
Projection: NAD 1983 UTM Zone 15N

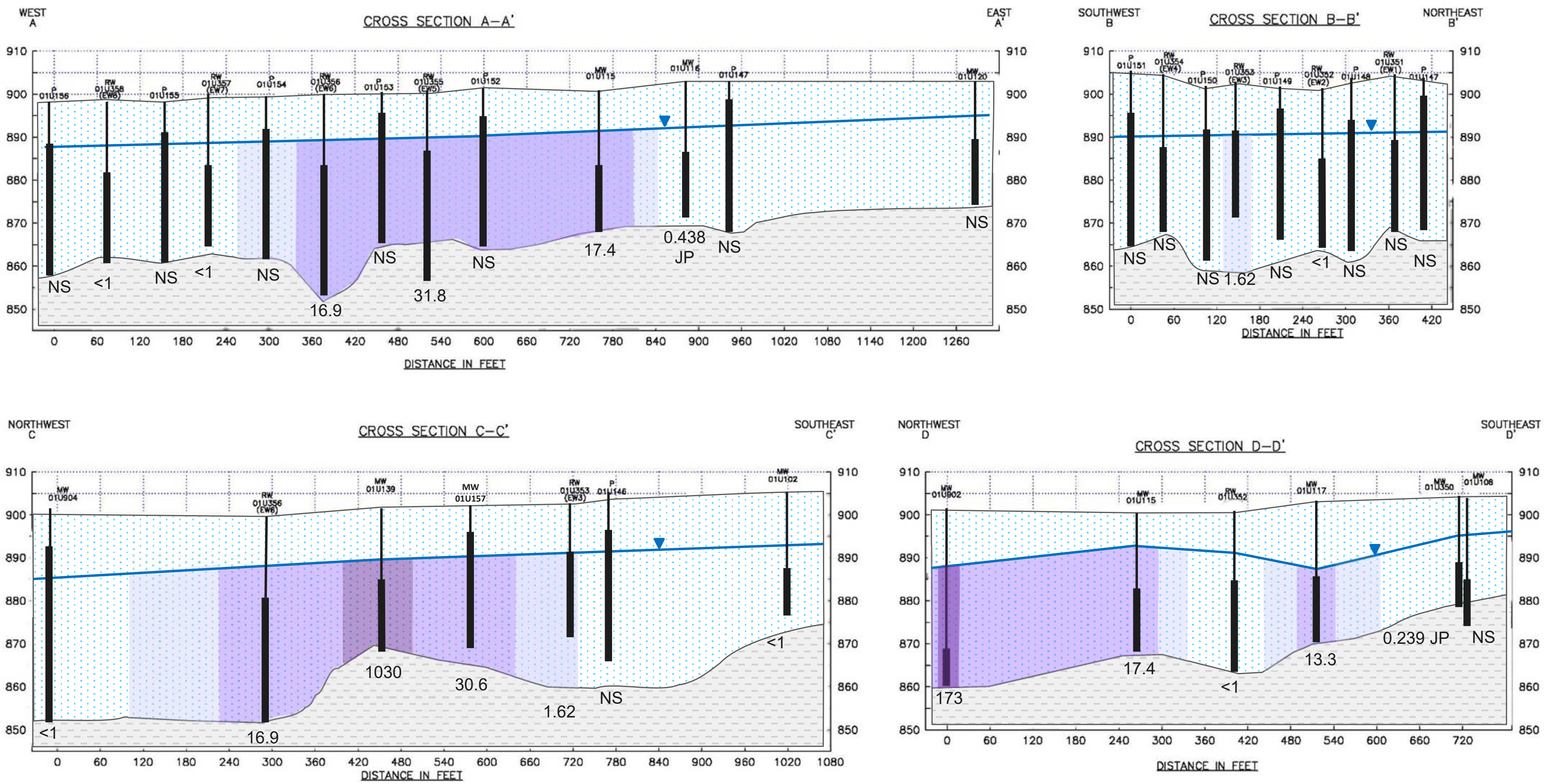
0 100 200
US Feet

Figure 5-5
Site A, Unit 1, cis-1,2-Dichloroethene Plume Comparison
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: \\loveton\gis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx\Figure 5-5 -Site A, Unit 1, cis-1,2-Dichloroethene Plume Comparison

FY 2021 Annual Performance Report
Figure 5-6
Site A cis-1,2-Dichloroethene Cross Sections A, B, C, D

U.S Army - TCAAP
Arden Hills, Minnesota



Legend

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

- 1-10
- 10-100
- > 100

µg/L Micrograms per Liter

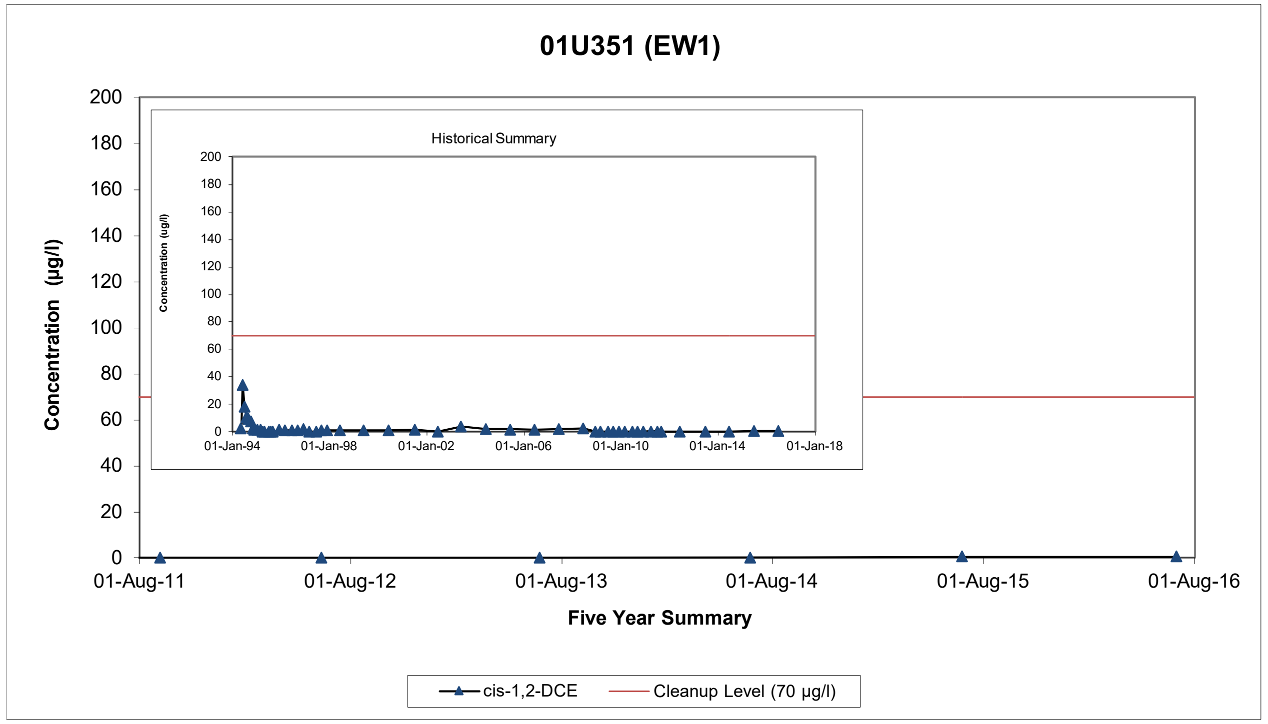
24 cis-1,2-Dichloroethene Concentration (µg/L) – June-July 2020

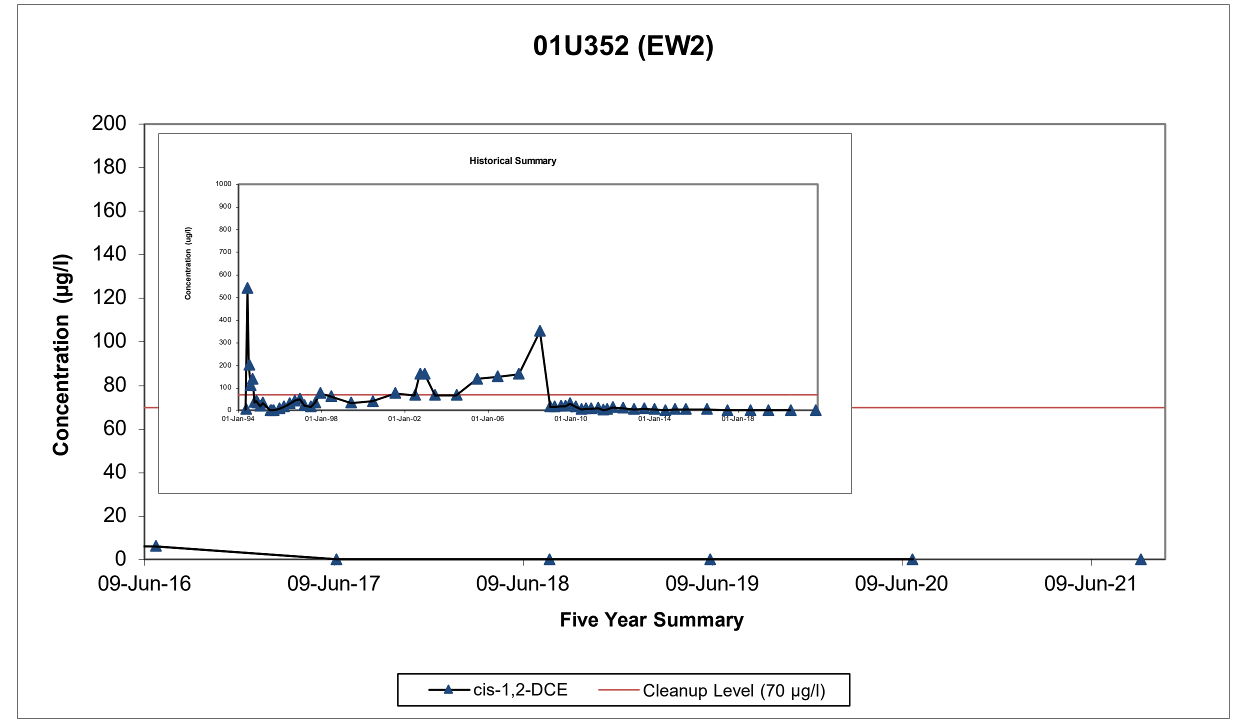
Water Table

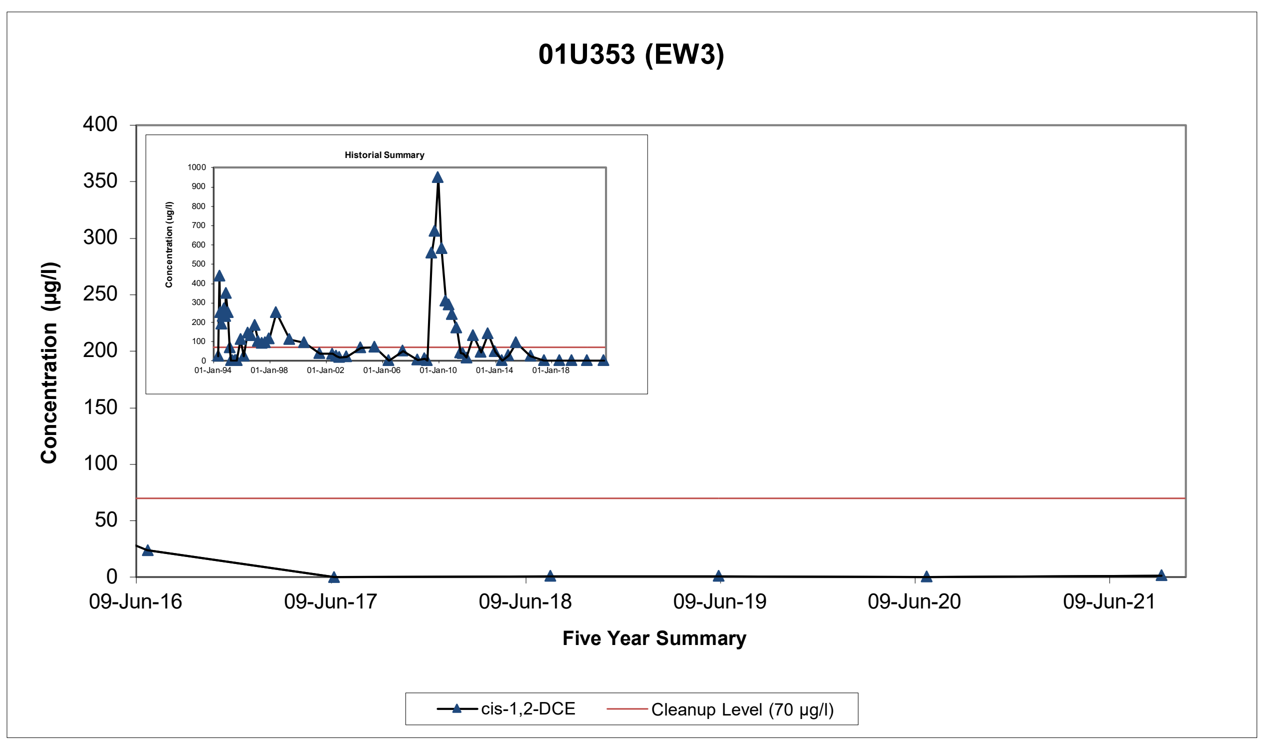
Screened Interval

FIGURE 5-7
SITE A, cis-1,2-DICHLOROETHENE WATER QUALITY TRENDS: EXTRACTION WELLS 1 - 4

FY 2021 ANNUAL PERFORMANCE REPORT







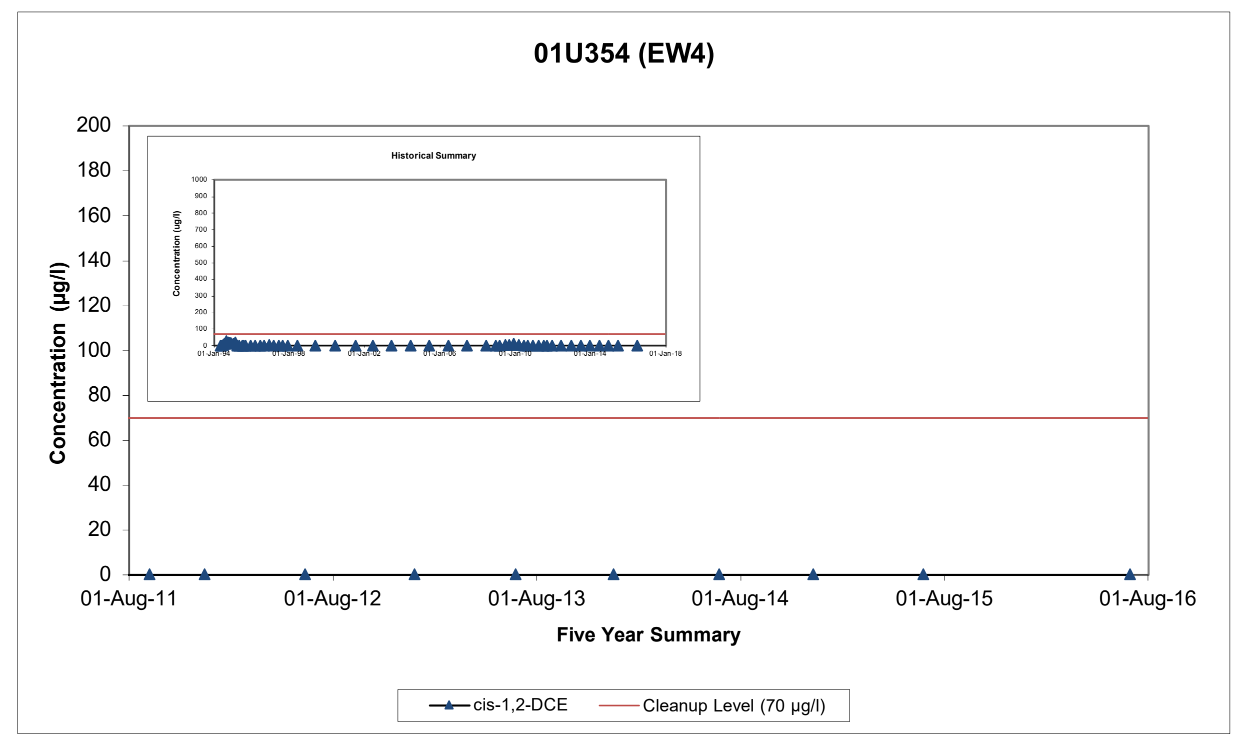
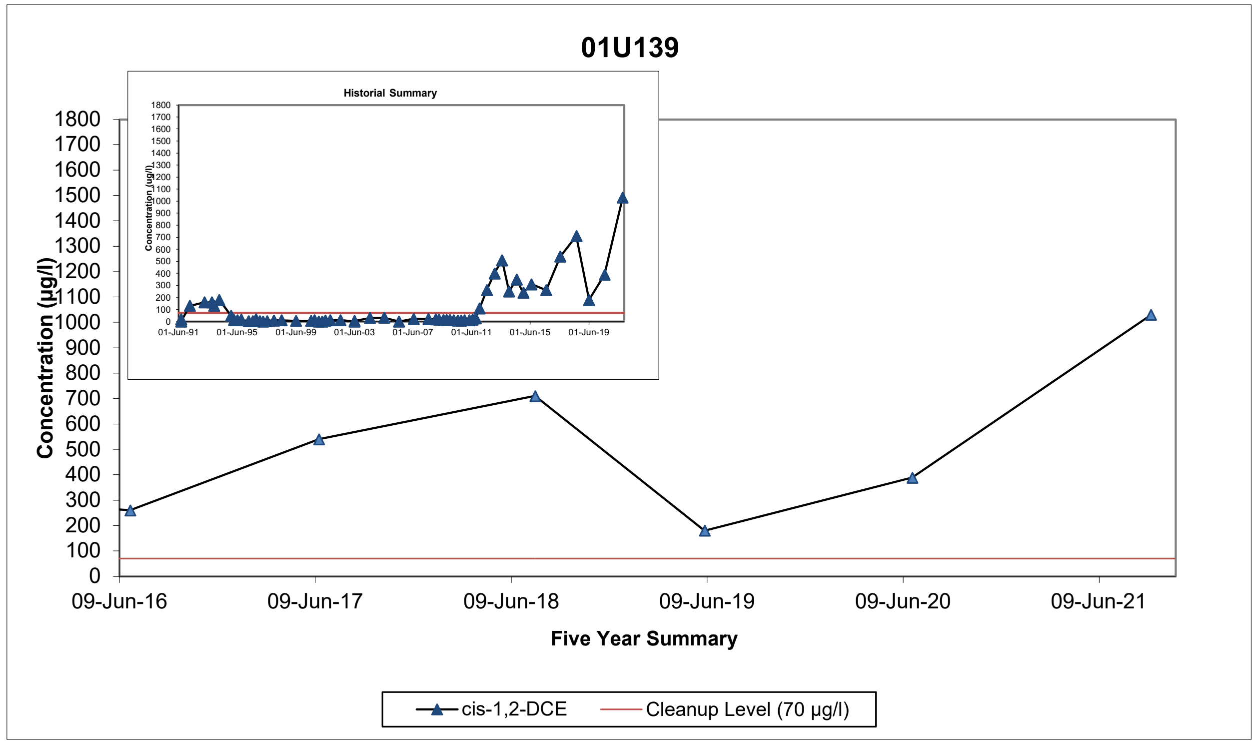
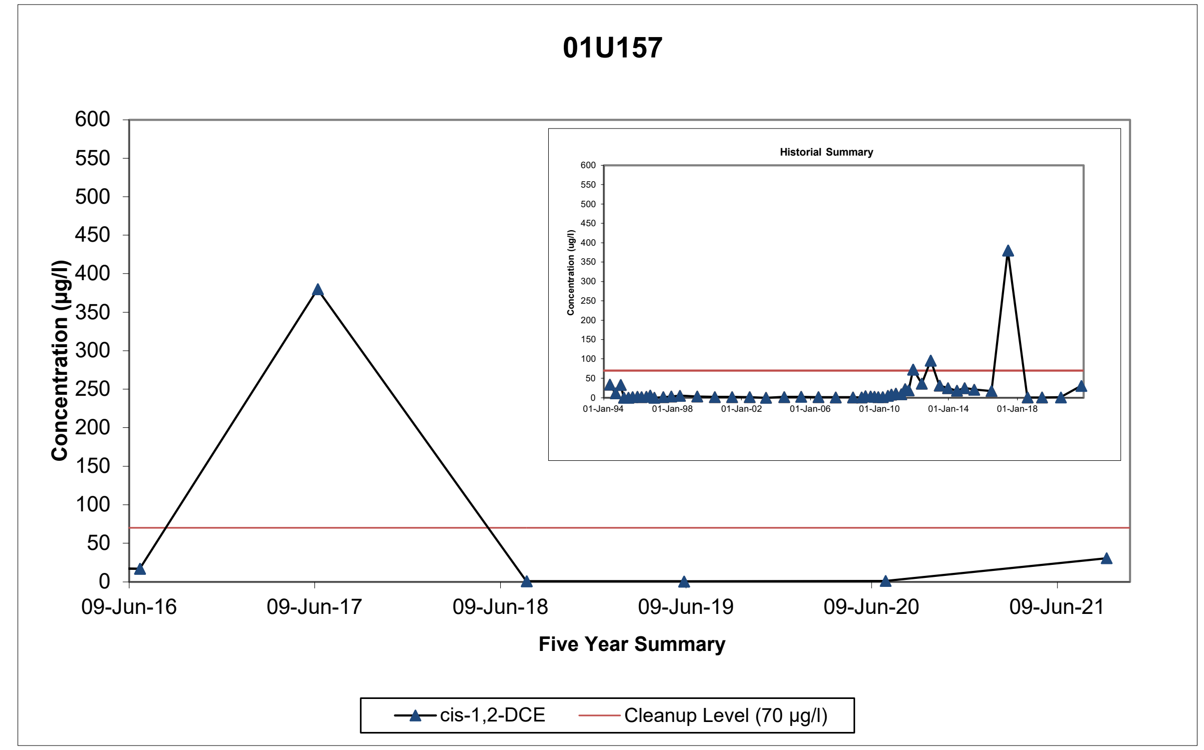
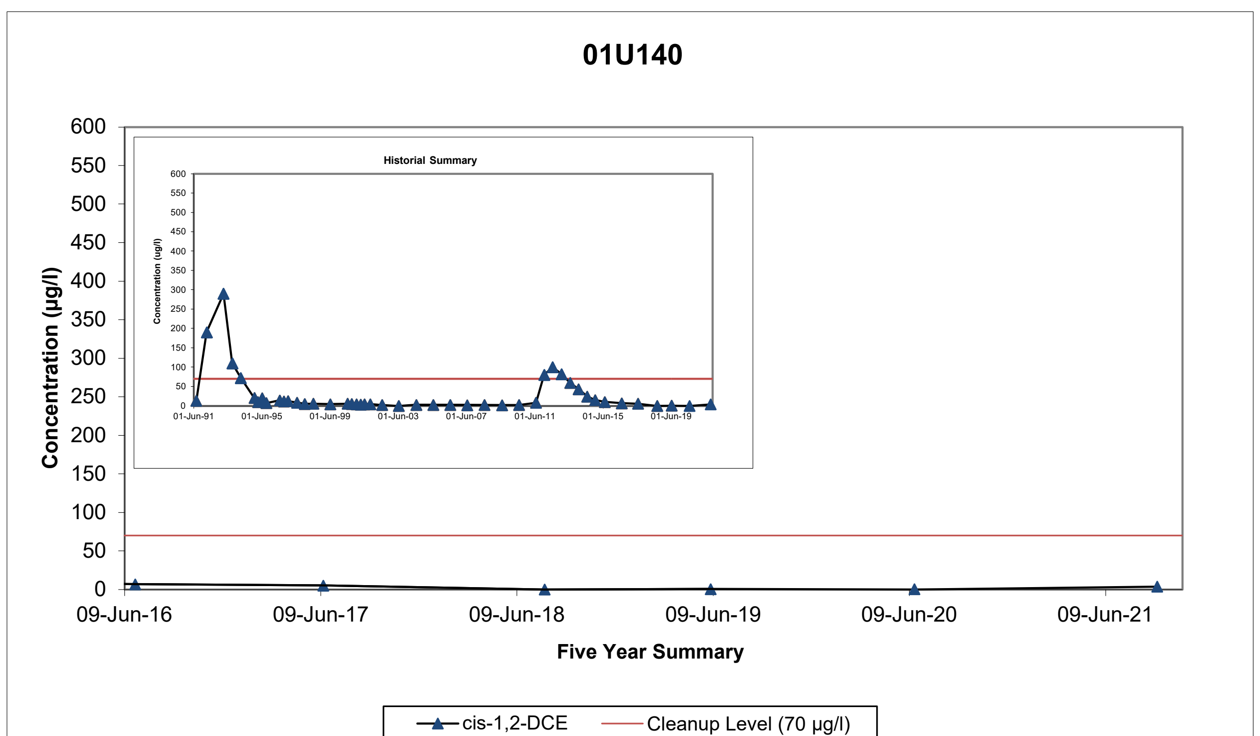


FIGURE 5-8
SITE A, cis-1,2-DICHLOROETHENE WATER QUALITY TRENDS: MONITORING WELLS

FY 2021 ANNUAL PERFORMANCE REPORT







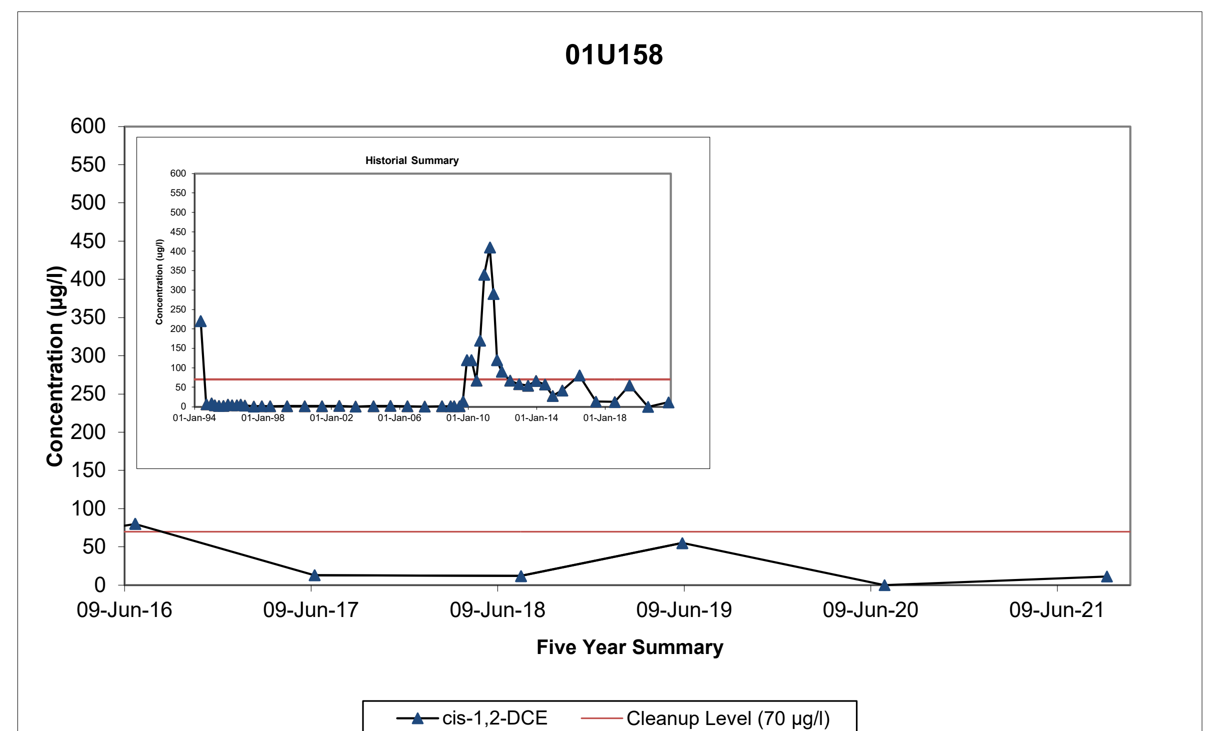
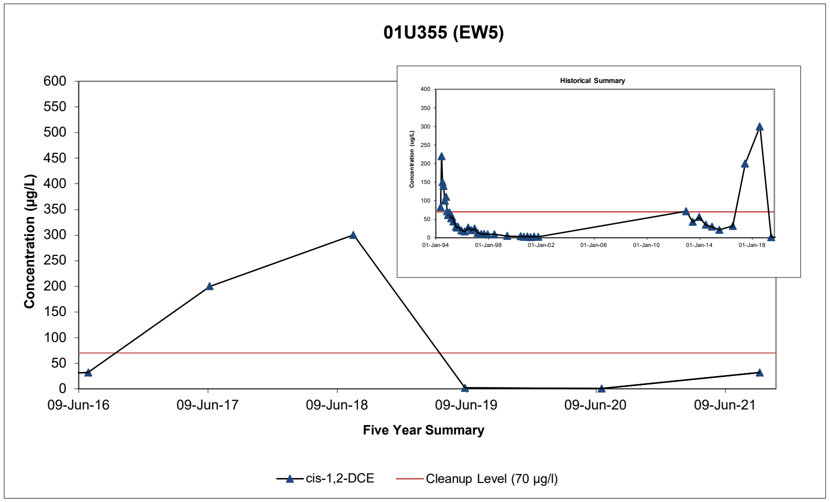
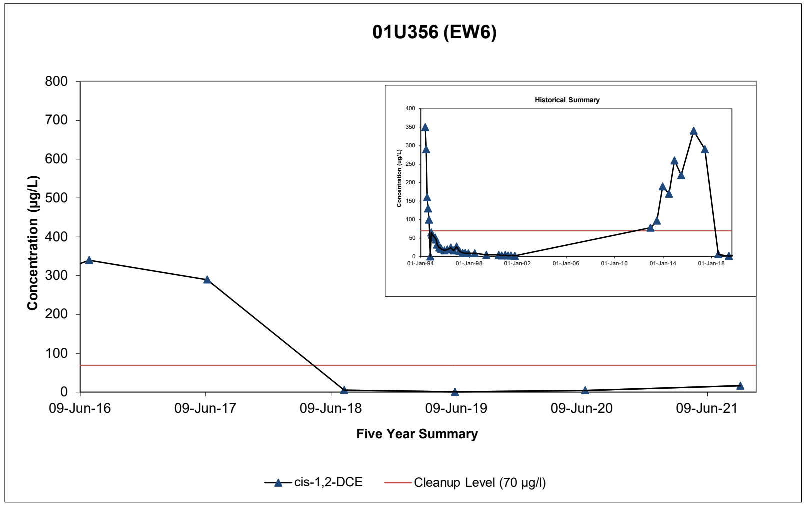
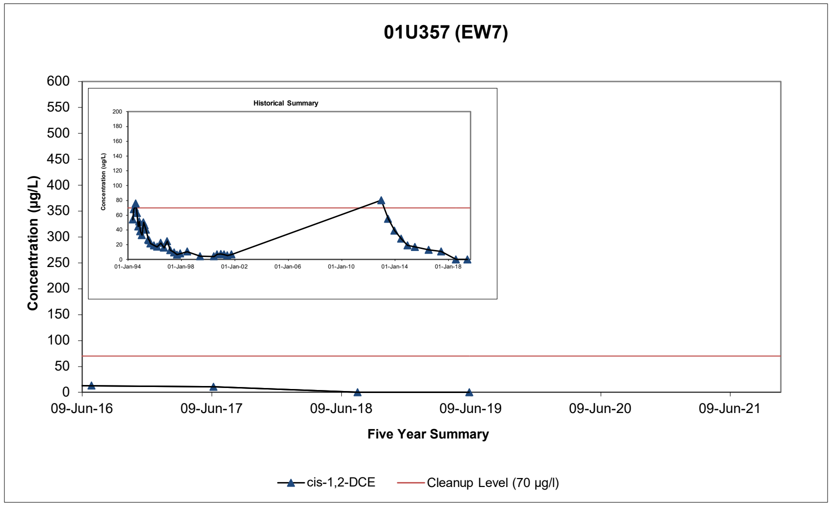


FIGURE 5-9
SITE A, cis-1,2-DICHLOROETHENE WATER QUALITY TRENDS: EXTRACTION WELLS 5 - 8

FY 2021 ANNUAL PERFORMANCE REPORT







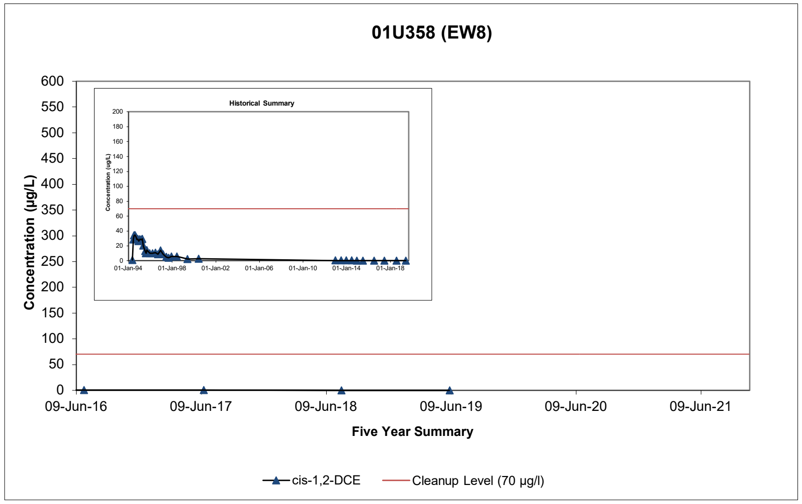
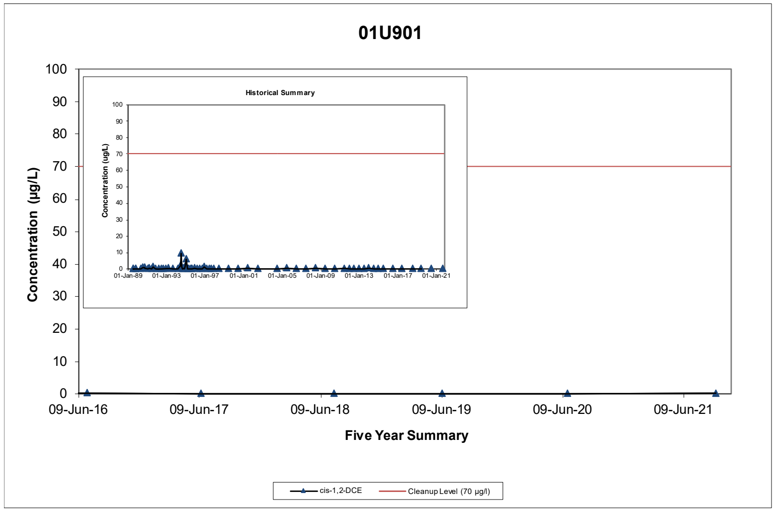
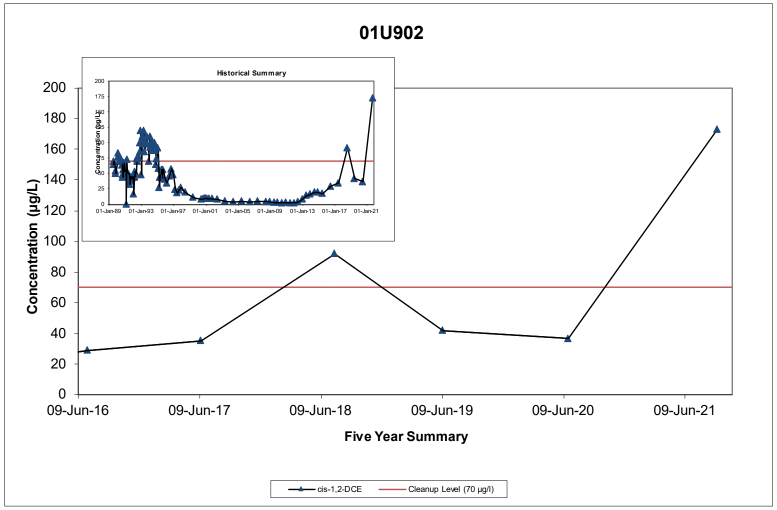


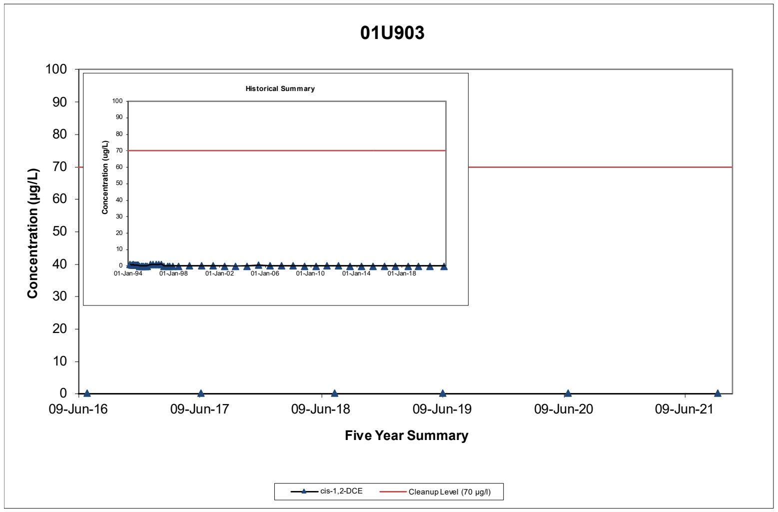
FIGURE 5-10

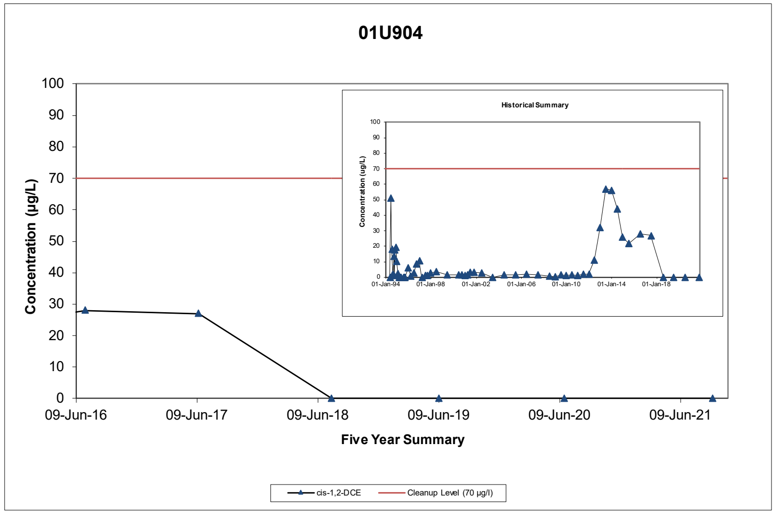
SITE A, cis-1,2-DICHLOROETHENE WATER QUALITY TRENDS: CONTINGENCY LOCATIONS

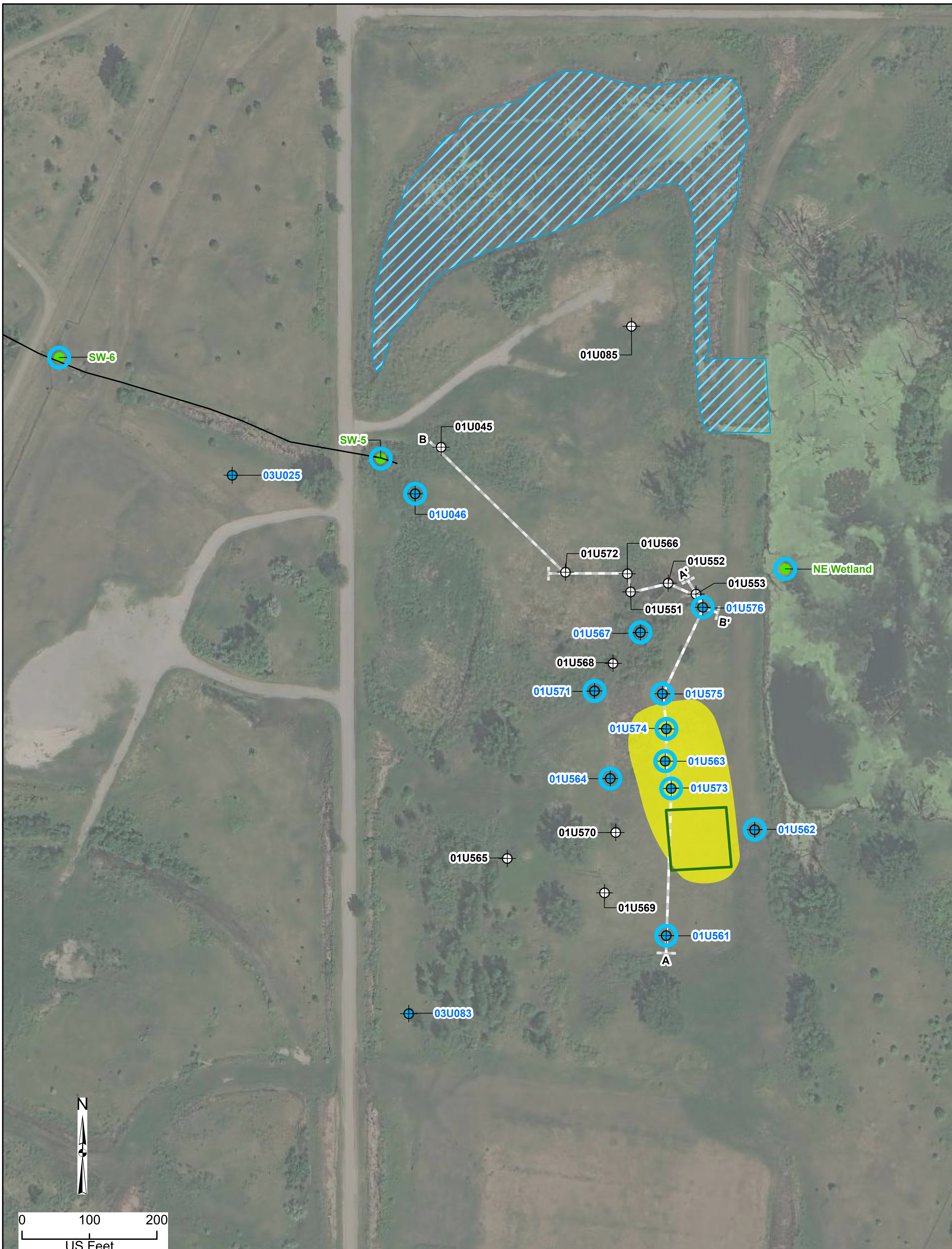
FY 2021 ANNUAL PERFORMANCE REPORT

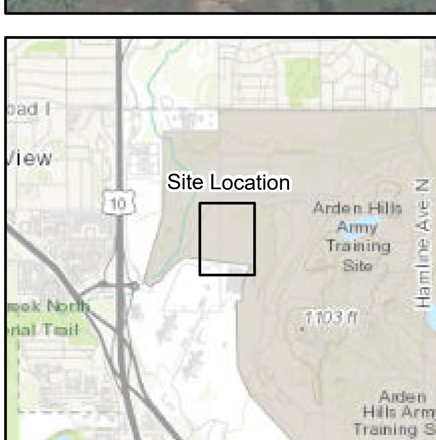












Legend

- Monitoring Well Location
- Sealed Well Location
- Surface Water Sampling Locations
- Annual Monitoring Locations
- Ditch
- Location of Plot for Phytoremediation Demonstration
- Approximate Boundary of Wetland Constructed in 2007
- Cross Section
- 15 ug/L Lead Contour (2019)

Figure 6-1
Site C Monitoring Plan
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

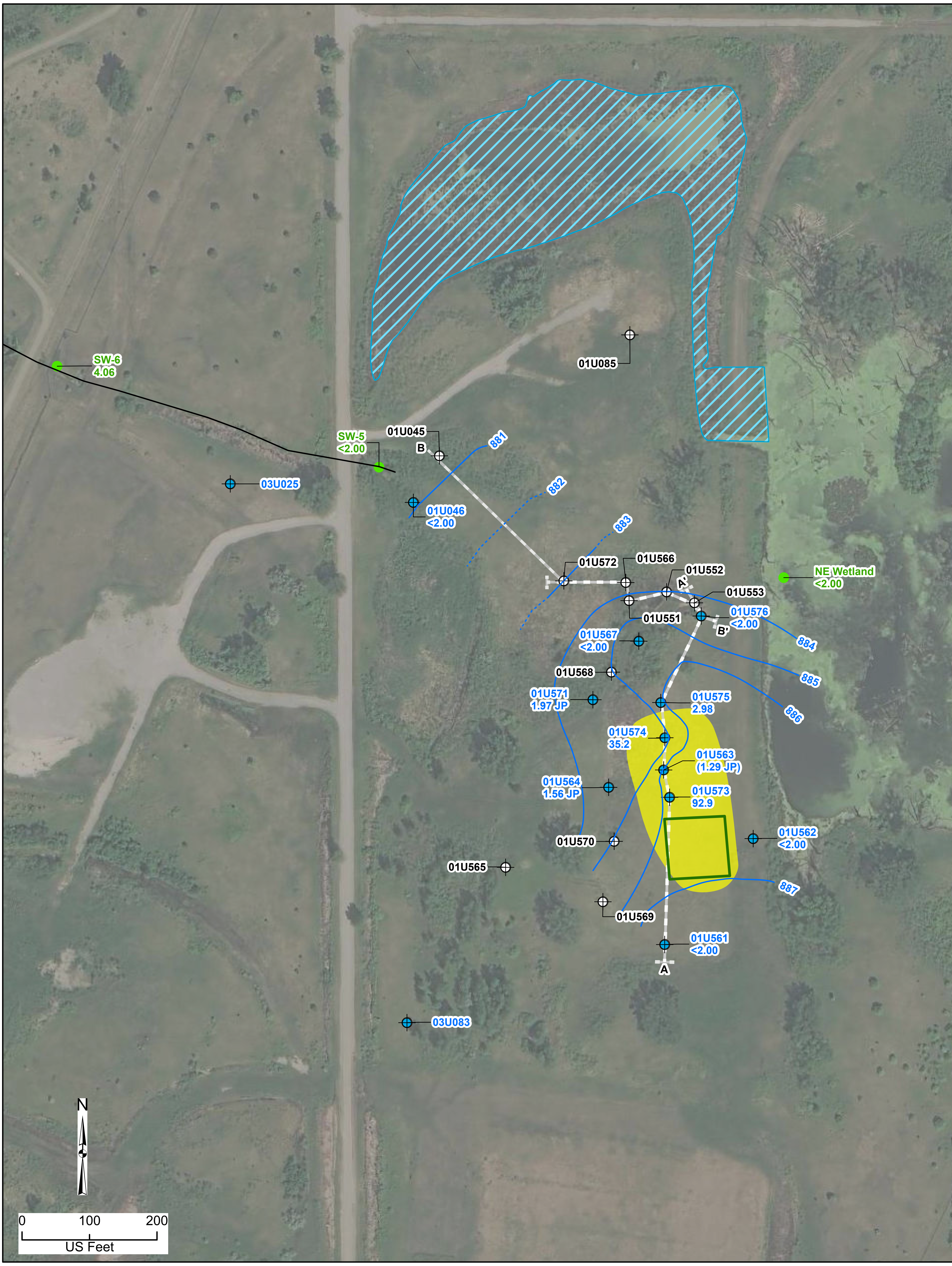
Date: 5/17/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx

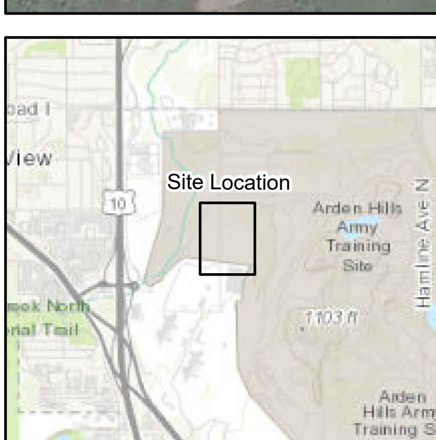
Legend

- 01U569 Sealed Well Location
- 01U561 887.80 Monitoring Well Groundwater Elevation
- SW-6 Surface Water Sampling Locations
- Ditch
- Groundwater Elevation Contours (ft amsl)
- Inferred Groundwater Elevation Contours
- Location of Plot for Phytoremediation Demonstration
- Approximate Boundary of Wetland Constructed in 2007
- Cross Section

Figure 6-2
Site C, Unit 1, Potentiometric Map
Twin Cities
Army Ammunition Plant
Arden Hills, Minnesota

Date: 5/17/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx





Legend

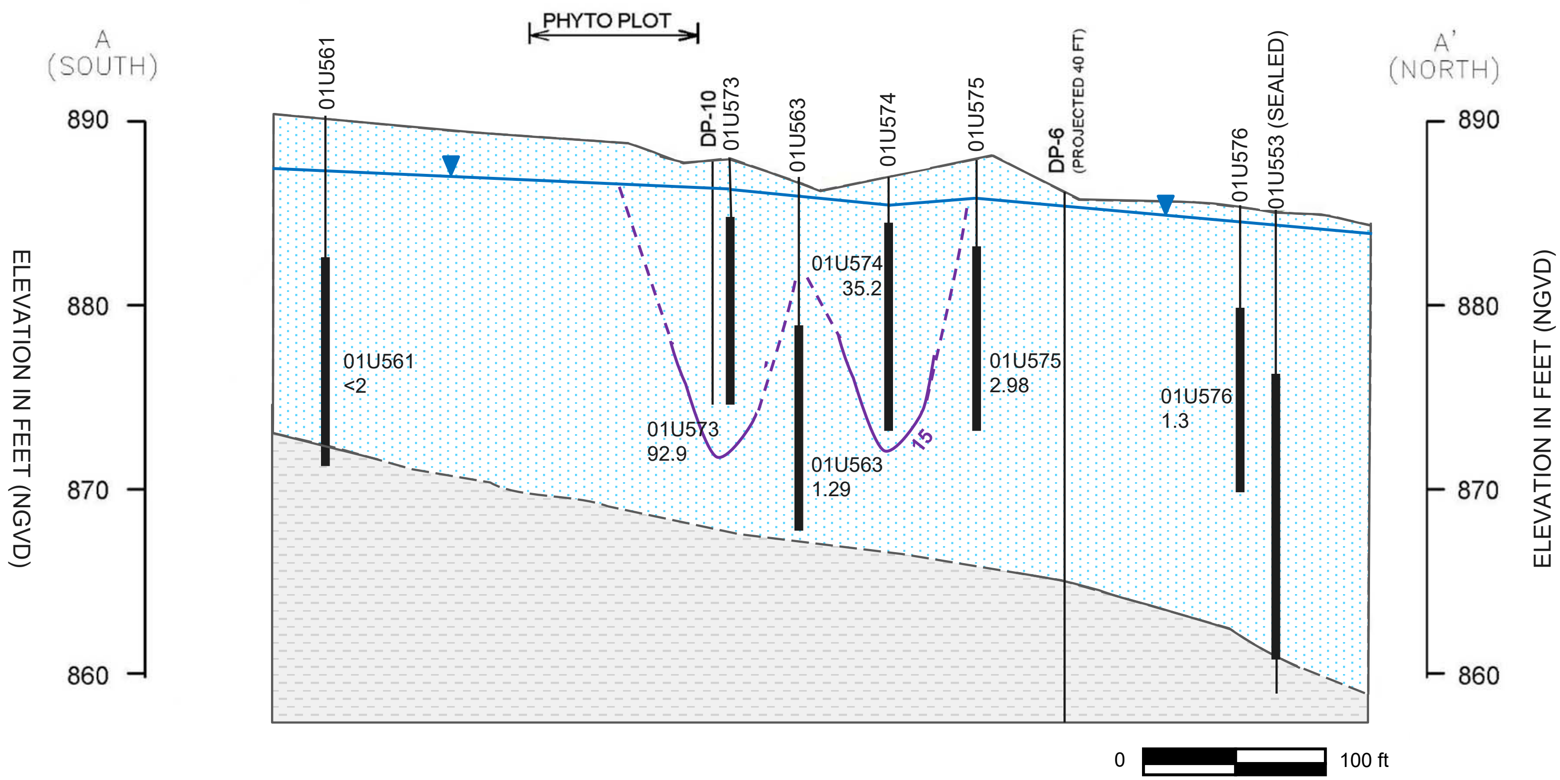
- Monitoring Well Location (01U574 35.2)
- Sealed Well Location (01U569)
- SurfaceWaterSamplingLocations (SW-6)
- Groundwater Elevation Contours (ft amsl)
- Inferred Groundwater Elevation Contours
- Location of Plot for Phytoremediation Demonstration
- Approximate Boundary of Wetland Constructed in 2007
- Exceeds 15 ug/L (Groundwater Cleanup Level) (Values in parentheses were not used for contouring purposes)
- Cross Section
- Ditch

Date: 5/17/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx

Figure 6-3
Site C, Unit 1,
Lead Results
Twin Cities
Army Ammunition Plant
Arden Hills, Minnesota

FY 2021 Annual Performance Report
Figure 6-4
Site C Cross Section A-A'

U.S Army - TCAAP
Arden Hills, Minnesota

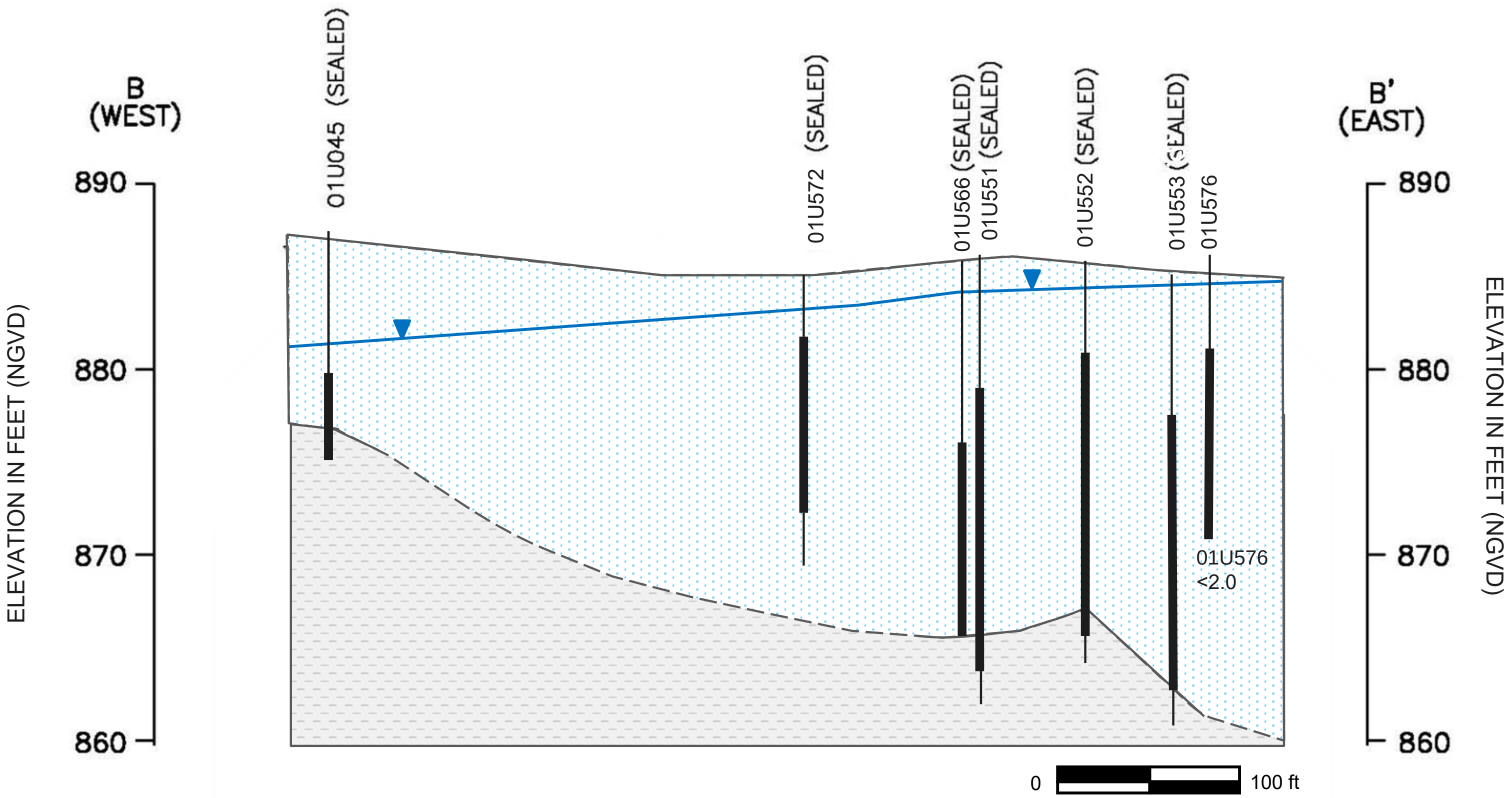


Legend

Upper Unit 1	Geologic Contact (inferred where dashed)
Upper Unit 2	15 µg/L Dissolved Lead Concentration Contour (Groundwater Cleanup Level) dashed where inferred
Water Table	01U573 Well ID
Screened Interval	µg/L Micrograms per Liter
	1.6 Dissolved Lead (µg/L) – June 2020
	NGVD National Geodetic Vertical Datum

FY 2021 Annual Performance Report
Figure 6-5
Site C Cross Section B-B’

U.S Army - TCAAP
Arden Hills, Minnesota

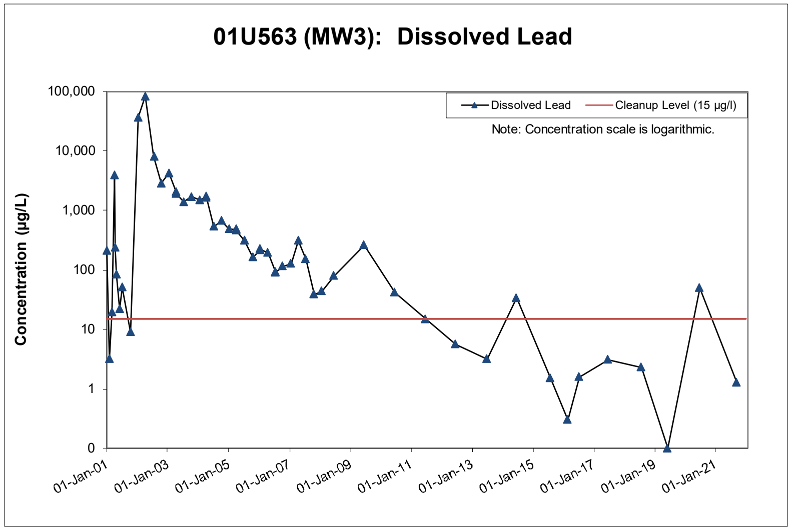


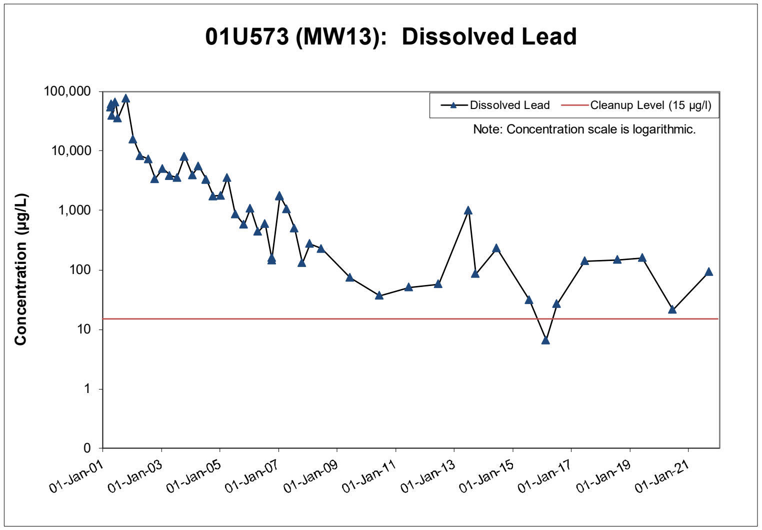
Legend

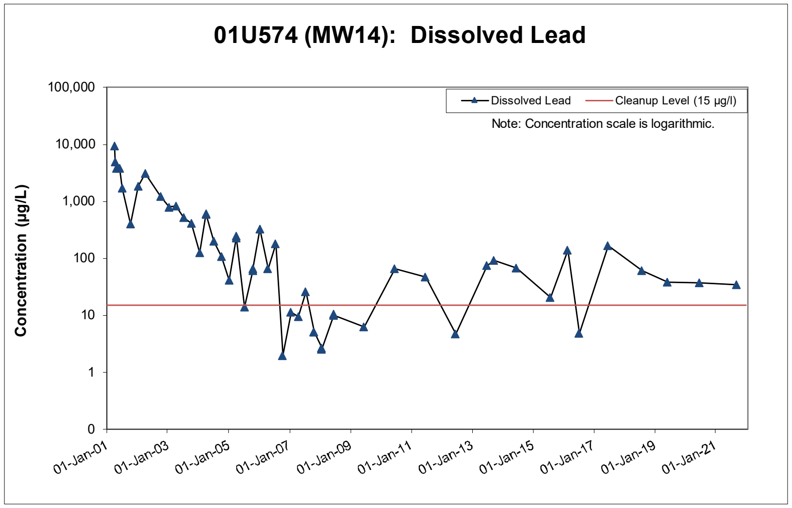
	Upper Unit 1		Geologic Contact (inferred where dashed)	0.30 U	Dissolved Lead (µg/L) – June 2020
	Upper Unit 2			NGVD	National Geodetic Vertical Datum
	Water Table	01U566	Well ID		
	Screened Interval	µg/L	Micrograms per Liter		

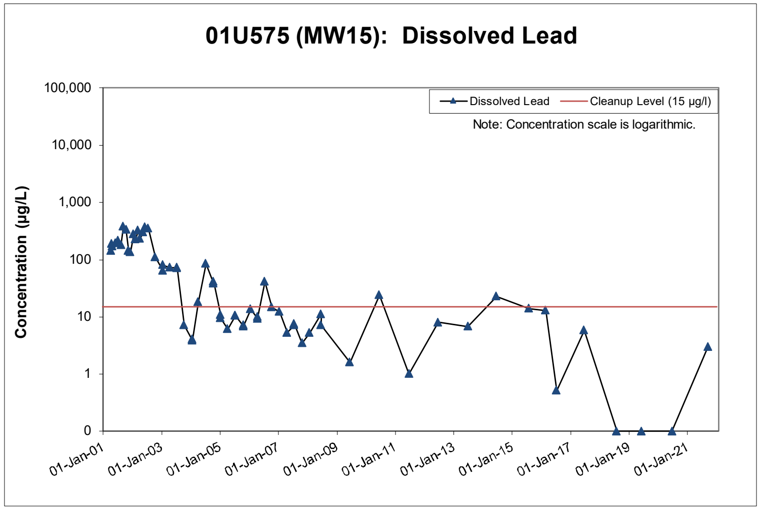
FIGURE 6-6 DISSOLVED LEAD

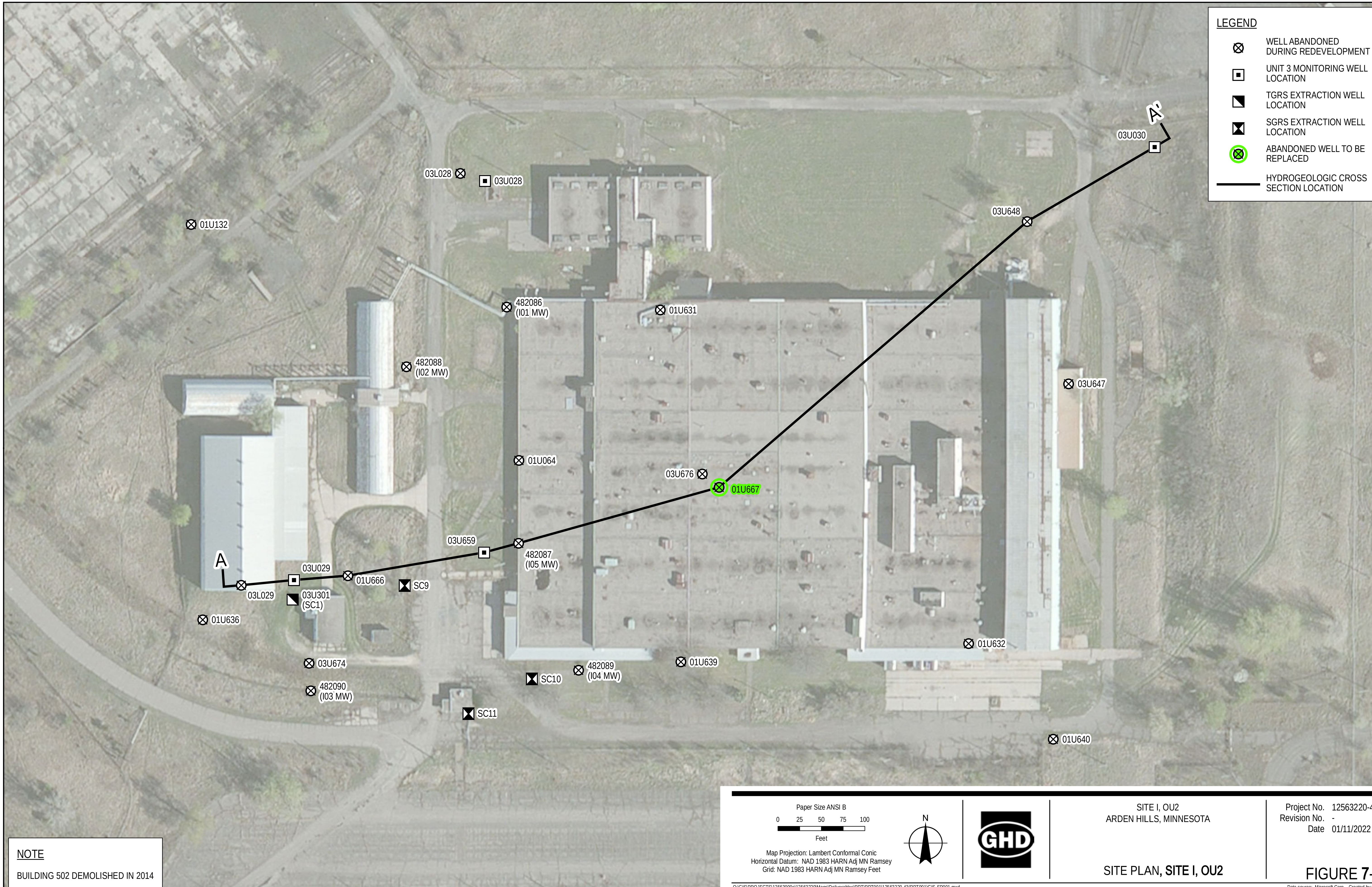
FY 2021 ANNUAL PERFORMANCE REPORT










LEGEND
WELL ABANDONED DURING REDEVELOPMENT
UNIT 3 MONITORING WELL LOCATION
TGRS EXTRACTION WELL LOCATION
SGRS EXTRACTION WELL LOCATION
ABANDONED WELL TO BE REPLACED
HYDROGEOLOGIC CROSS SECTION LOCATION
A
A'
03U030
03U648
03L028
03U028
01U132
482086 (I01 MW)
01U631
482088 (I02 MW)
03U647
01U064
03U676
01U667
03U659
482087 (I05 MW)
03U029
01U666
SC9
03L029
03U301 (SC1)
01U636
01U632
03U674
482089 (I04 MW)
01U639
SC10
482090 (I03 MW)
SC11
01U640
NOTE
BUILDING 502 DEMOLISHED IN 2014
Paper Size ANSI B
0 25 50 75 100
Feet
Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 HARN Adj MN Ramsey
Grid: NAD 1983 HARN Adj MN Ramsey Feet
N
GHD
SITE I, OU2
ARDEN HILLS, MINNESOTA
SITE PLAN, SITE I, OU2
Project No. 12563220-43
Revision No. -
Date 01/11/2022
FIGURE 7-1
Q:\GIS\PROJECTS\12563000s\12563220\Maps\Deliverables\RPT\RPT001\12563220-43(RPT001)GIS-SP001.mxd
Print date: 11 Jan 2022 - 20:39
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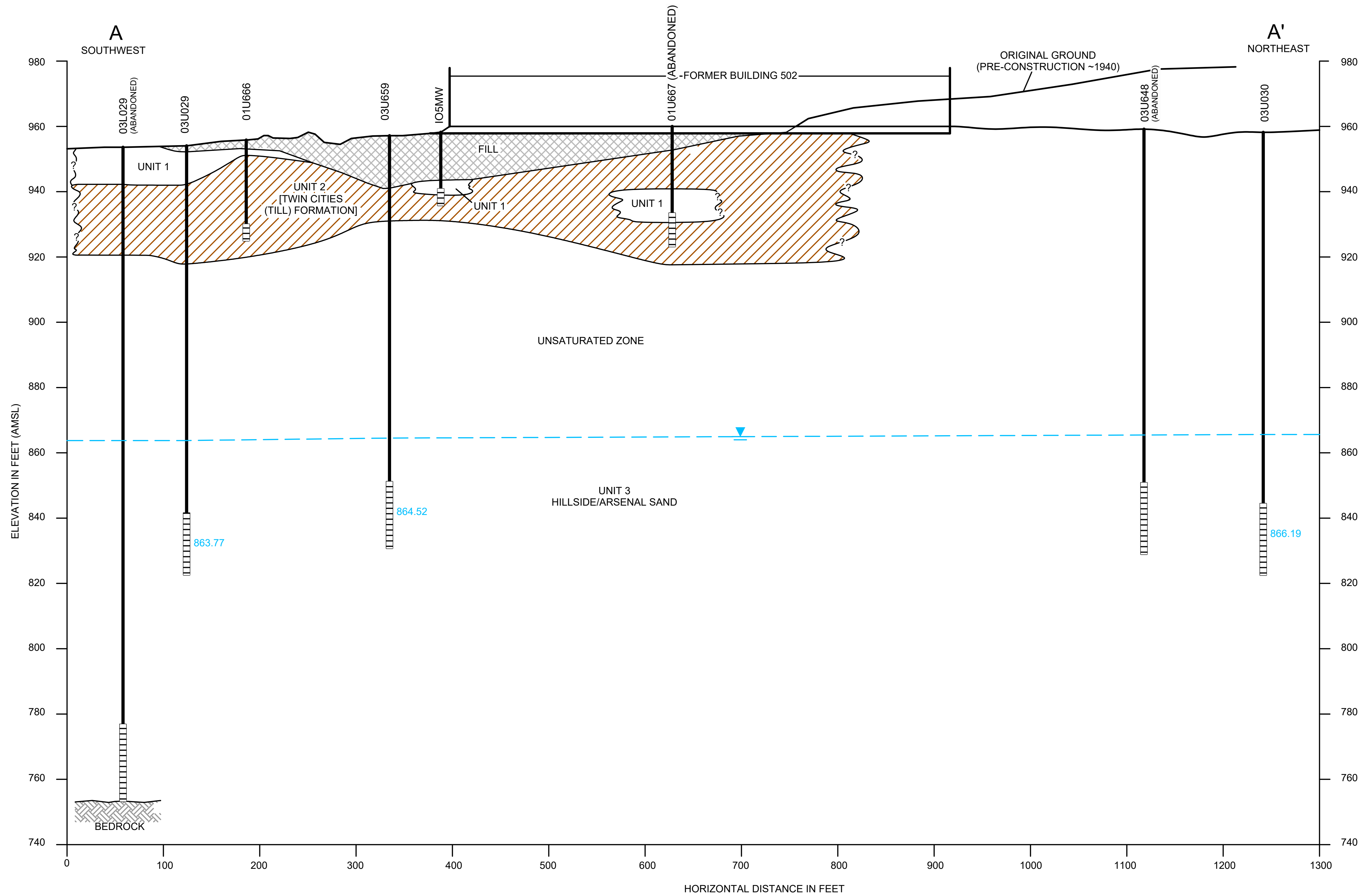


LEGEND

03L029 — WELL DESIGNATION
GROUND SURFACE
WELL INSTALLATION
STRATIGRAPHIC BOUNDARY
WATER TABLE
SCREENED INTERVAL
BOTTOM OF BORING

0 60 120 ft

N

GHD

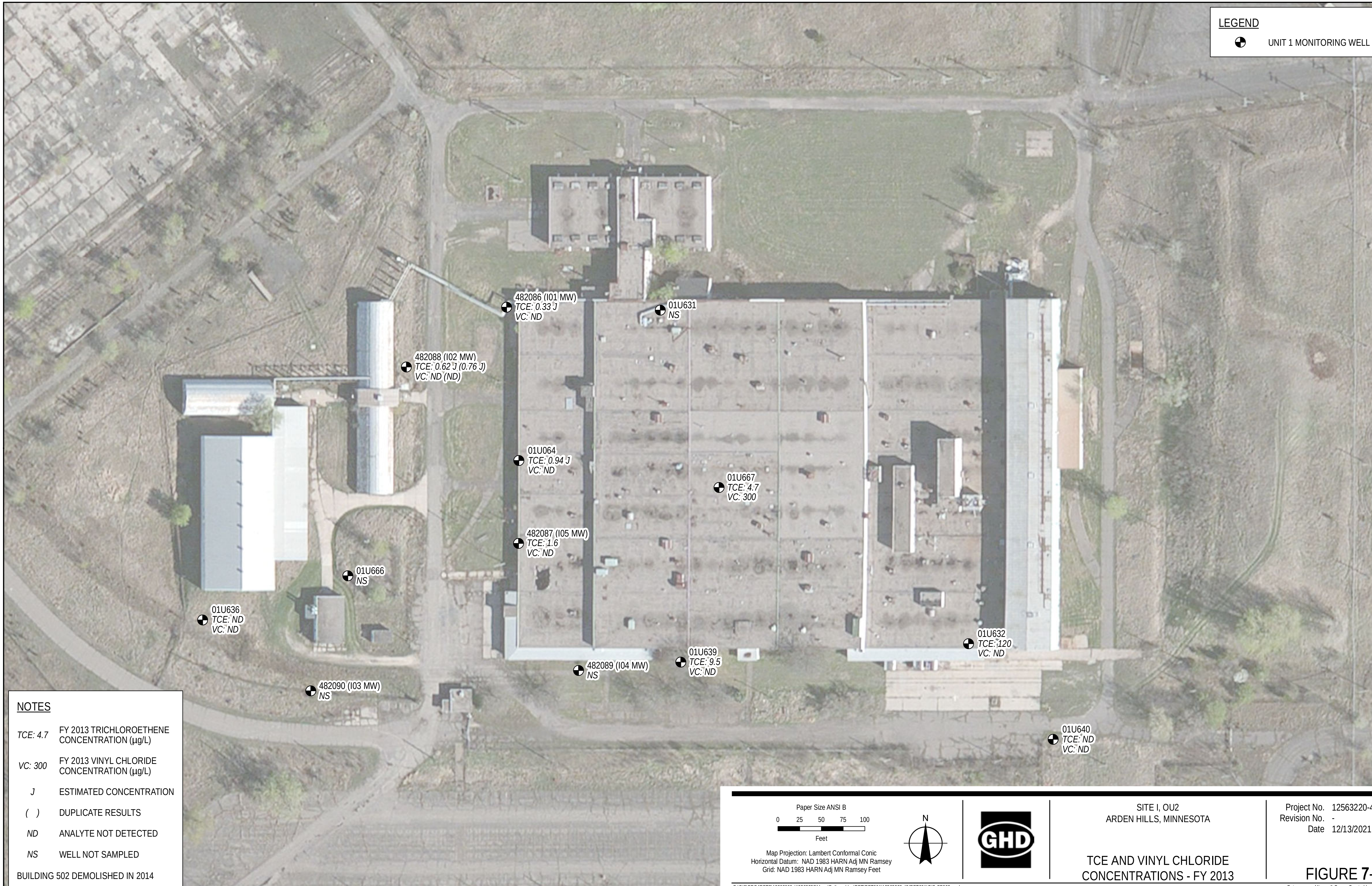
SITE I, OU2
ARDEN HILLS, MINNESOTA

GEOLOGIC CROSS-SECTION A-A'

Project No. 12563220
Date December 2021

FIGURE 7-2

SOURCE: STANTEC SITE I CROSS SECTION DWG FILE
Plot Date: 17 December 2021 3:51 PM



NOTES

TCE: 4.7	FY 2013 TRICHLOROETHENE CONCENTRATION (µg/L)
VC: 300	FY 2013 VINYL CHLORIDE CONCENTRATION (µg/L)
J	ESTIMATED CONCENTRATION
( )	DUPLICATE RESULTS
ND	ANALYTE NOT DETECTED
NS	WELL NOT SAMPLED

BUILDING 502 DEMOLISHED IN 2014

Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 HARN Adj MN Ramsey
Grid: NAD 1983 HARN Adj MN Ramsey Feet

SITE I, OU2
ARDEN HILLS, MINNESOTA

TCE AND VINYL CHLORIDE CONCENTRATIONS - FY 2013

Project No. 12563220-43
Revision No. -
Date 12/13/2021

FIGURE 7-3

Q:\GIS\PROJECTS\12563000s\12563220\Maps\Deliverables\RPT\RPT001\12563220-43(RPT001)GIS-SP002.mxd
Print date: 13 Dec 2021 - 15:42

Data source: Microsoft Corp.. Created by: rjcoy

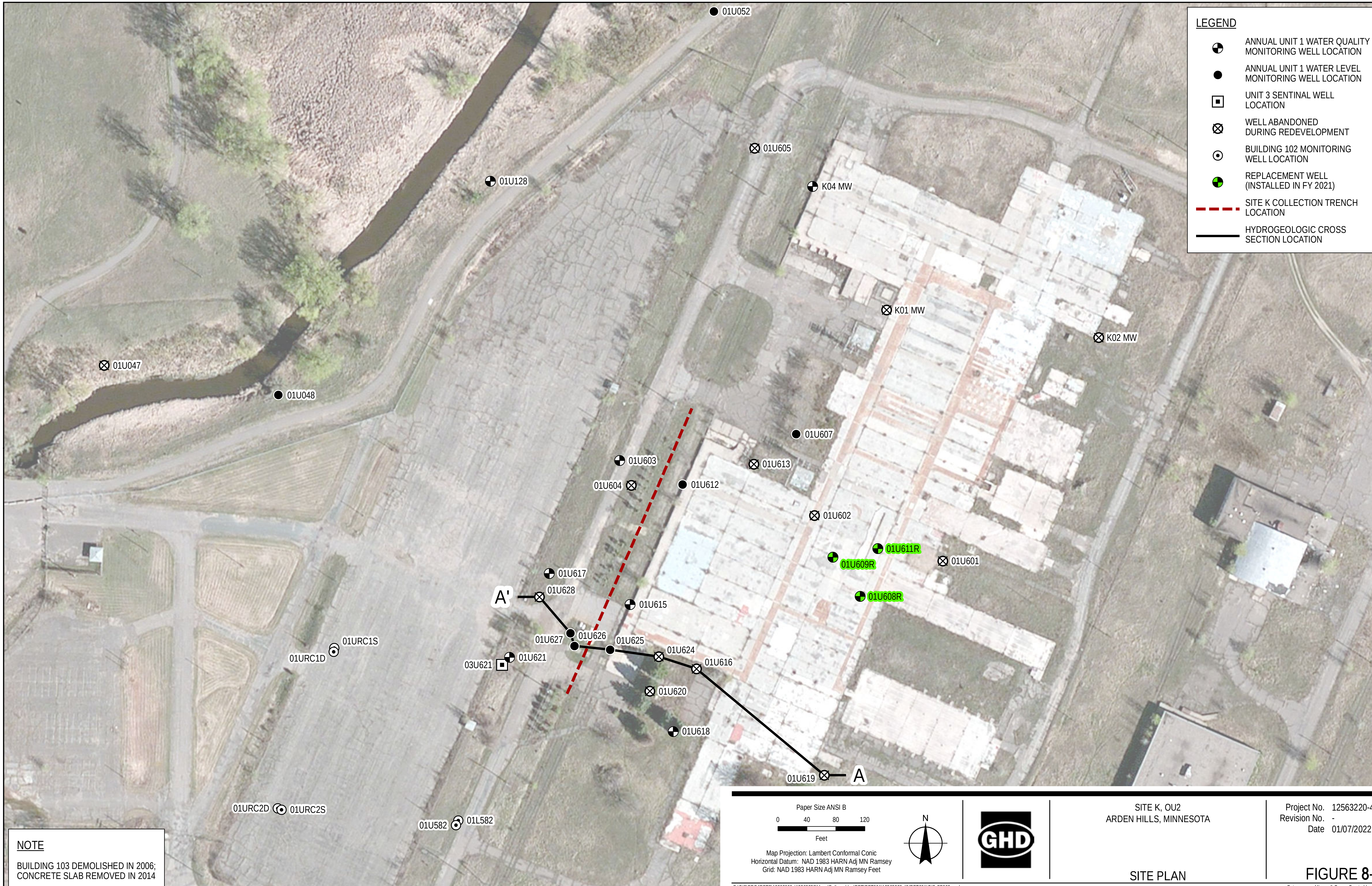
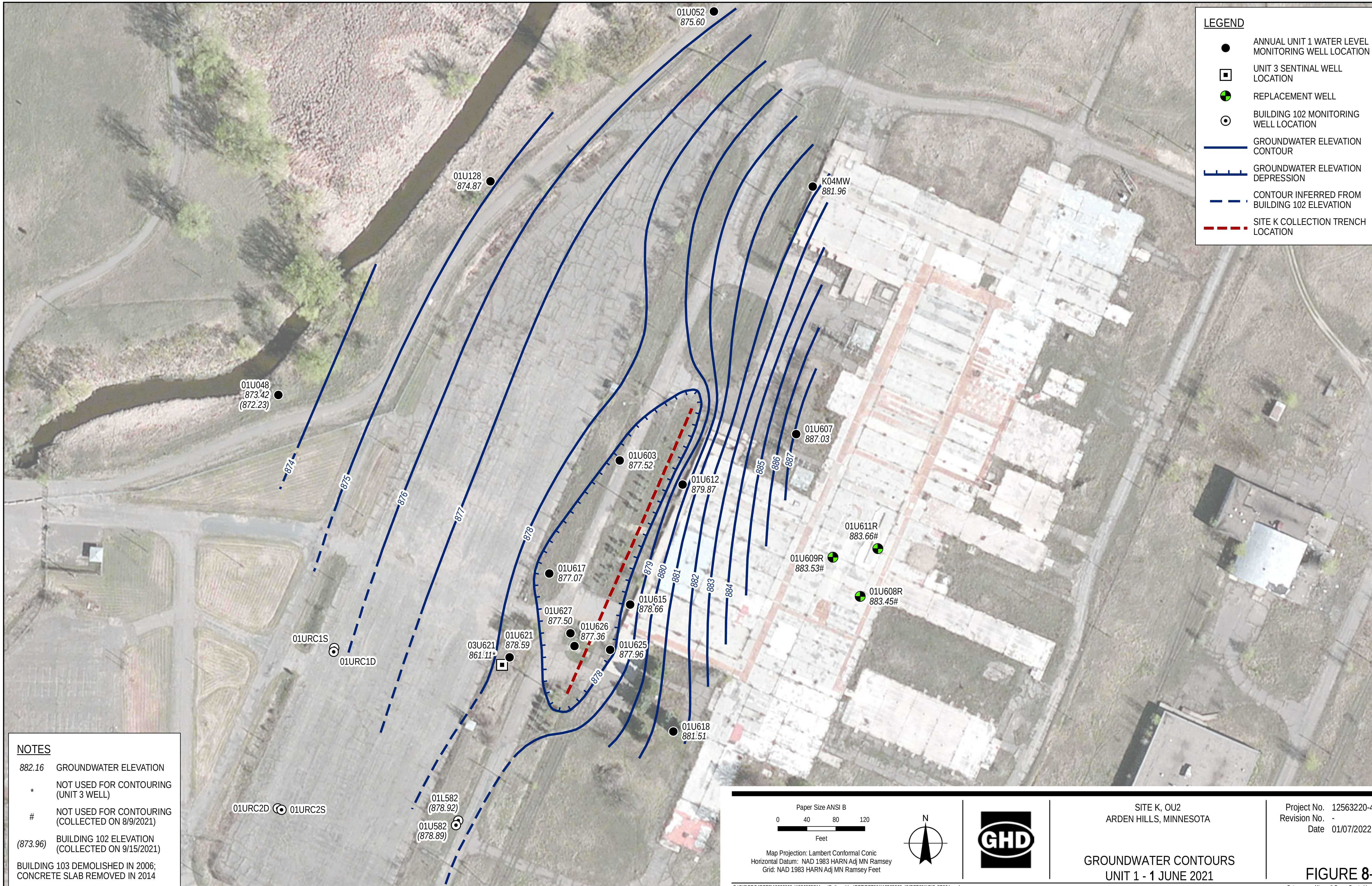

LEGEND
ANNUAL UNIT 1 WATER QUALITY MONITORING WELL LOCATION
ANNUAL UNIT 1 WATER LEVEL MONITORING WELL LOCATION
UNIT 3 SENTINAL WELL LOCATION
WELL ABANDONED DURING REDEVELOPMENT
BUILDING 102 MONITORING WELL LOCATION
REPLACEMENT WELL (INSTALLED IN FY 2021)
SITE K COLLECTION TRENCH LOCATION
HYDROGEOLOGIC CROSS SECTION LOCATION
01U052
01U605
K04 MW
01U128
K01 MW
K02 MW
01U047
01U048
01U607
01U603
01U613
01U604
01U612
01U602
01U611R
01U609R
01U601
01U617
01U608R
A'
01U628
01U615
01U626
01U627
01U625
01U624
01URC1S
01URC1D
01U621
03U621
01U616
01U620
01U618
01U619
A
01URC2D
01URC2S
01U582
01L582
NOTE
BUILDING 103 DEMOLISHED IN 2006; CONCRETE SLAB REMOVED IN 2014
Paper Size ANSI B
0 40 80 120
Feet
Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 HARN Adj MN Ramsey
Grid: NAD 1983 HARN Adj MN Ramsey Feet
N
GHD
SITE K, OU2
ARDEN HILLS, MINNESOTA
Project No. 12563220-43
Revision No. -
Date 01/07/2022
SITE PLAN
Q:\GIS\PROJECTS\12563000s\12563220\Maps\Deliverables\RPT\RPT001\12563220-43(RPT001)GIS-SP003.mxd
Print date: 07 Jan 2022 - 13:57
Data source: Microsoft Corp., Created by: rjcoy

FIGURE 8-1



Paper Size ANSI B

0 40 80 120

Feet

N

Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 HARN Adj MN Ramsey
Grid: NAD 1983 HARN Adj MN Ramsey Feet

GHD

SITE K, OU2
ARDEN HILLS, MINNESOTA

GROUNDWATER CONTOURS
UNIT 1 - 1 JUNE 2021

Project No. 12563220-43
Revision No. -
Date 01/07/2022

FIGURE 8-2

Q:\GIS\PROJECTS\12563000s\12563220\Maps\Deliverables\RPT\RPT001\12563220-43(RPT001)GIS-SP004.mxd
Print date: 07 Jan 2022 - 14:48

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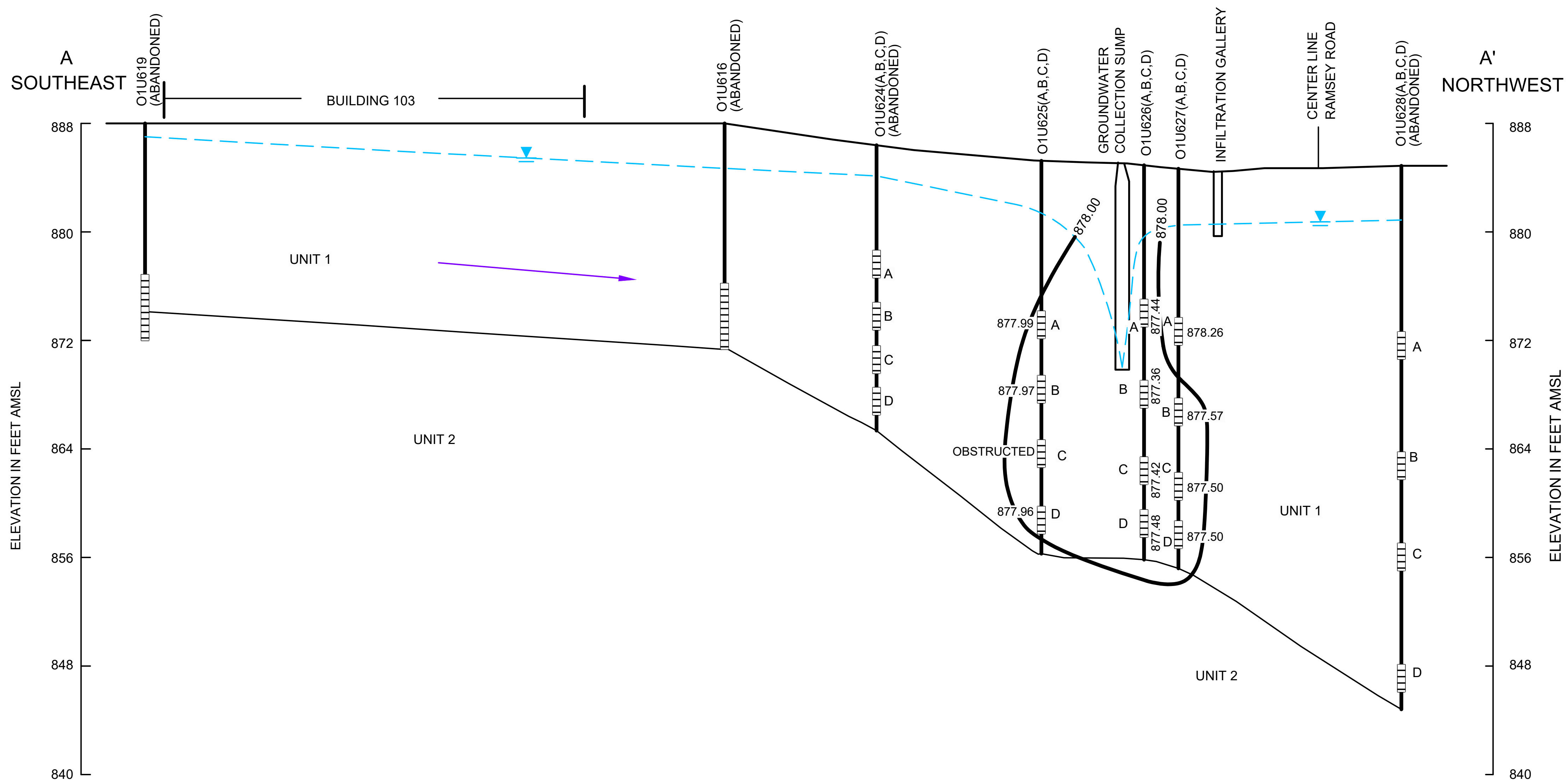
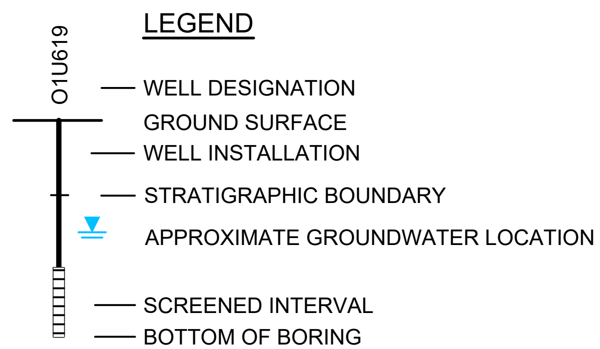


LEGEND



SOURCE: STANTEC, SITE K CROSS SECTION DWG FILE

HORIZONTAL 1" = 10 ft — 0, 5, 10Ft

VERTICAL 1" = 10 ft — 0, 5, 10Ft

GHD

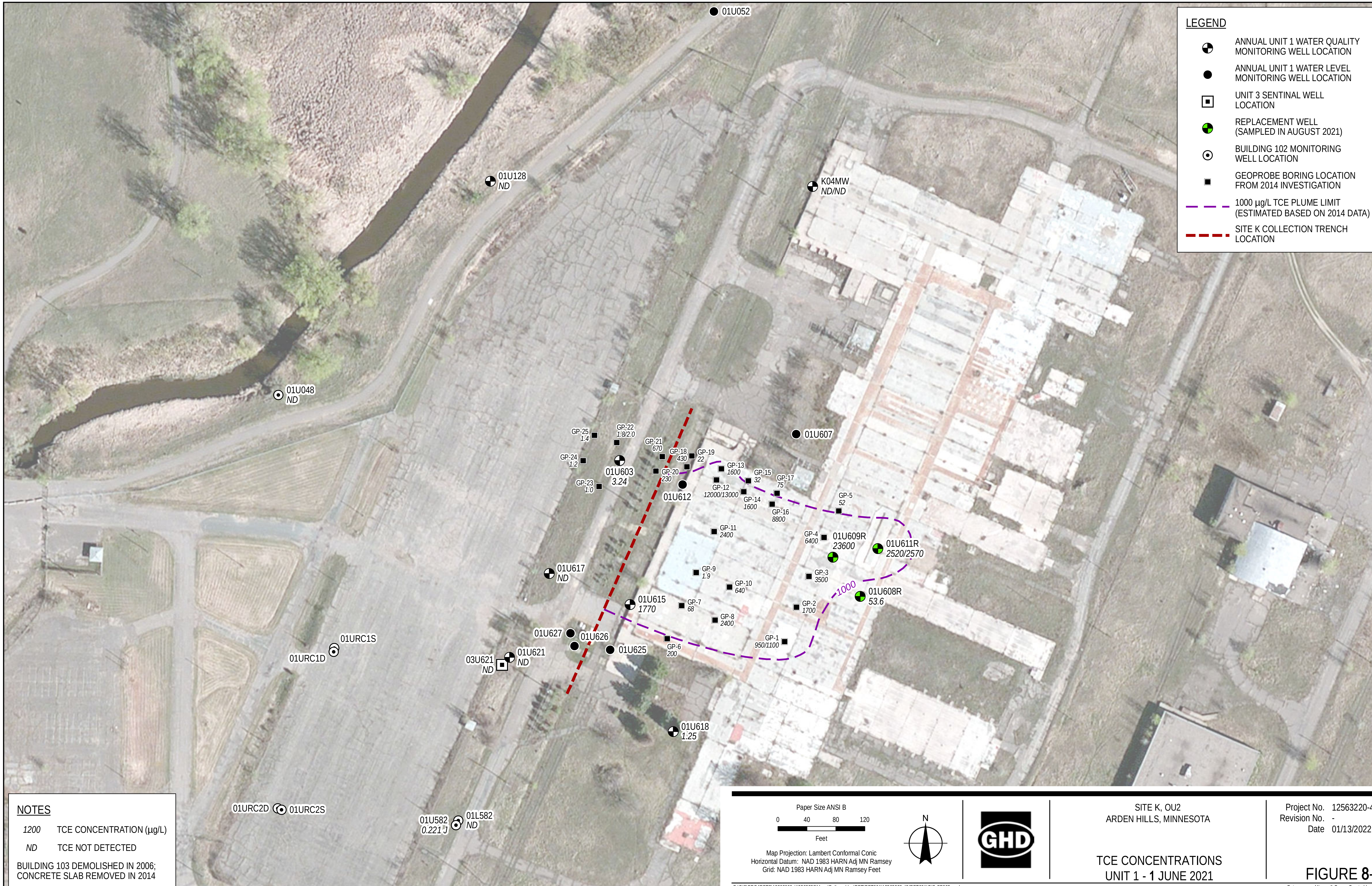
SITE K, OU2
ARDEN HILLS, MINNESOTA

HYDROGEOLOGIC CROSS-SECTION A-A'
1 JUNE 2021

Project No. **12563220**
Date **January 2022**

Figure 8-3

Filename: N:\US\St Paul\Projects\563\12563220\Digital_Design\ACAD\Figures\RPT001\12563220-GHD-0000-RPT-EN-0102_WA-001.DWG
Plot Date: 07 January 2022 10:46 AM



LEGEND

- ANNUAL UNIT 1 WATER QUALITY MONITORING WELL LOCATION
- ANNUAL UNIT 1 WATER LEVEL MONITORING WELL LOCATION
- UNIT 3 SENTINAL WELL LOCATION
- REPLACEMENT WELL (SAMPLED IN AUGUST 2021)
- BUILDING 102 MONITORING WELL LOCATION
- GEOPROBE BORING LOCATION FROM 2014 INVESTIGATION
- 1000 µg/L TCE PLUME LIMIT (ESTIMATED BASED ON 2014 DATA)
- SITE K COLLECTION TRENCH LOCATION

NOTES

1200 TCE CONCENTRATION (µg/L)

ND TCE NOT DETECTED

BUILDING 103 DEMOLISHED IN 2006; CONCRETE SLAB REMOVED IN 2014

Paper Size ANSI B

0 40 80 120

Feet

Map Projection: Lambert Conformal Conic
Horizontal Datum: NAD 1983 HARN Adj MN Ramsey
Grid: NAD 1983 HARN Adj MN Ramsey Feet

N

SITE K, OU2
ARDEN HILLS, MINNESOTA

TCE CONCENTRATIONS
UNIT 1 - 1 JUNE 2021

Project No. 12563220-43
Revision No. -
Date 01/13/2022

FIGURE 8-4

Q:\GIS\PROJECTS\12563000s\12563220\Maps\Deliverables\RPT\RPT001\12563220-43(RPT001)GIS-SP005.mxd
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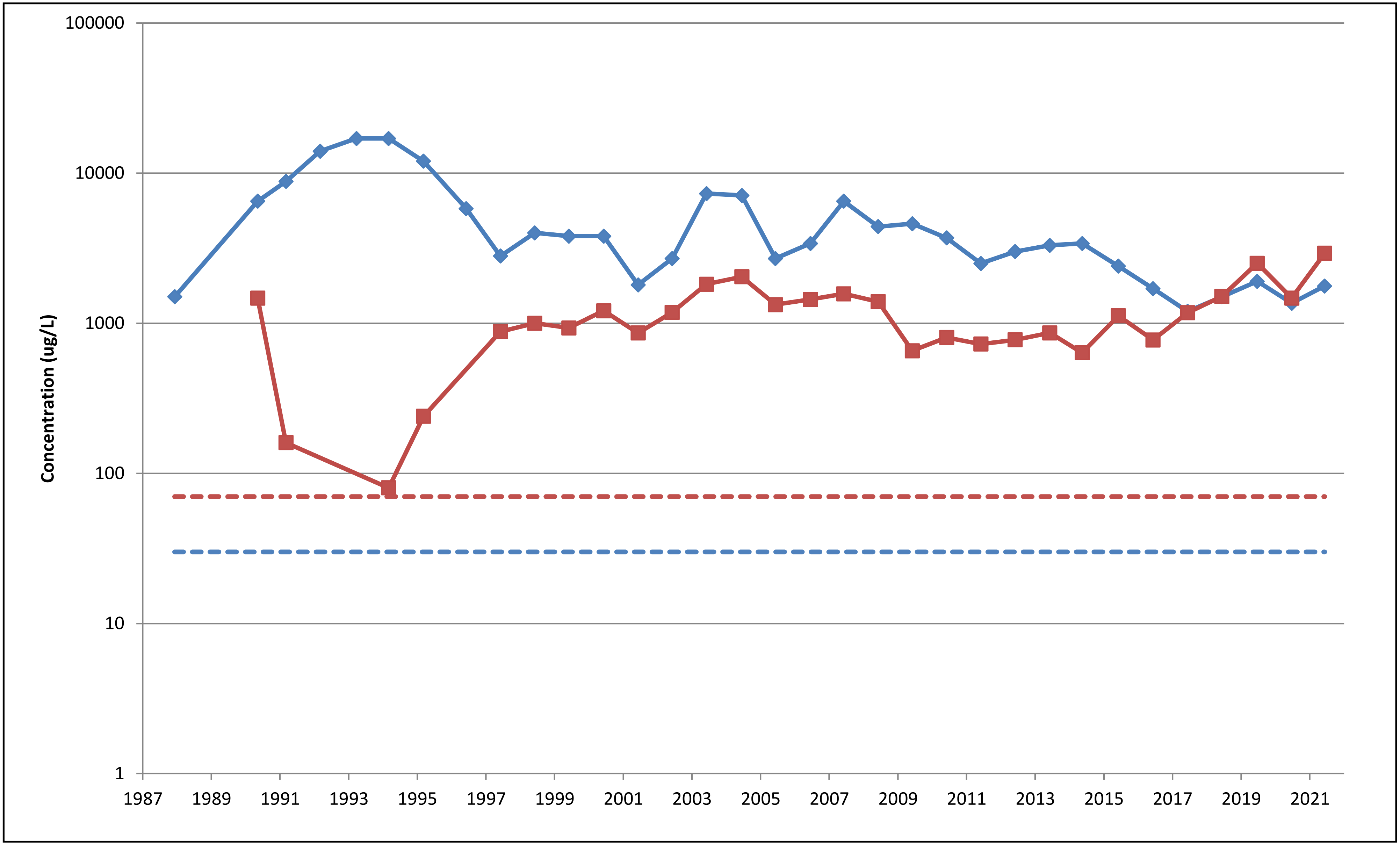
Data source: Microsoft Corp.. Created by: rjcoy



Trichloroethene

Total 1,2-Dichloroethene

Trichloroethene Site K Cleanup Level

Total 1,2-Dichloroethene Site K Cleanup Level

GHD

SITE K, OU2
ARDEN HILLS, MINNESOTA

VOC CONCENTRATIONS OVER TIME
WELL 01U615

Project No. 12563220-43
Revision No. -
Date 01/07/2022

FIGURE 8-5

Q:\GIS\PROJECTS\12563000s\12563220\Maps\Deliverables\RPT\RPT001\12563220-43(RPT001)GIS-SP006.mxd
Print date: 07 Jan 2022 - 10:16

Legend

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.)

Figure 9-1
Location of Building 102
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 5/17/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx

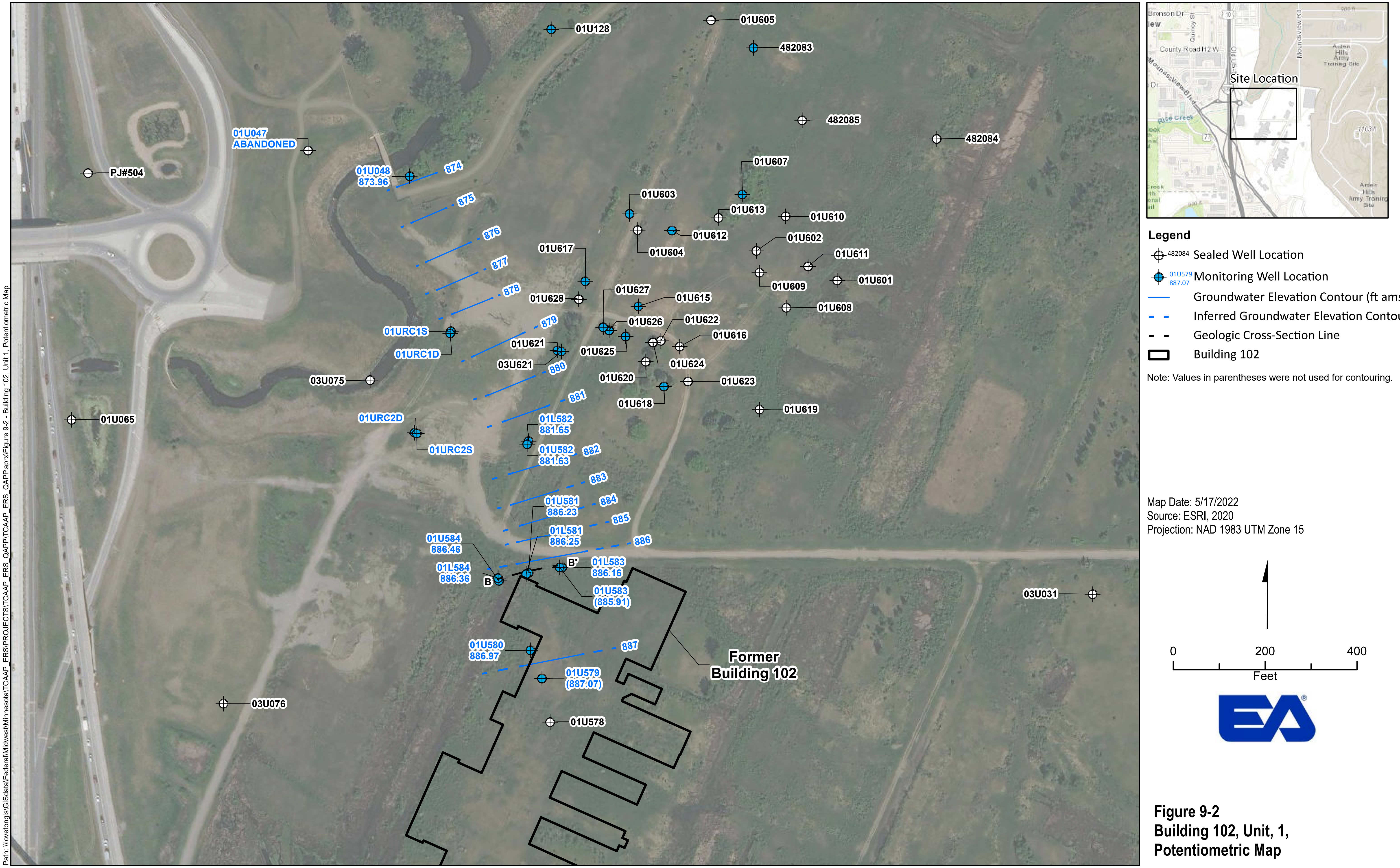
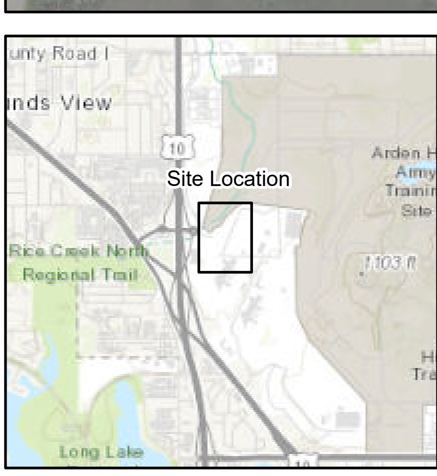


Figure 9-2
Building 102, Unit, 1, Potentiometric Map

Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx\Figure 9-2 - Building 102, Unit 1, Potentiometric Map



Legend

Trichloroethene Concentration Contours (ug/L)

01U580 2.08 Monitoring Well Location

01U578 Sealed Well Location

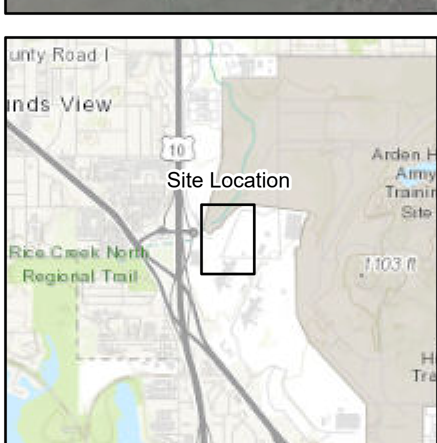
Building 102

Geologic Cross-Section Line

Note: Contour created using "01U" Locations

Date: 5/17/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx

Figure 9-3
Building 102, Unit 1,
Trichloroethene Results
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota



Legend

- cis-1,2-Dichloroethene Concentration Contours (ug/L)
- 01U580 11.3 Monitoring Well Location
- 01U578 Sealed Well Location
- Geologic Cross-Section Line
- Building 102

Note: Contour created using "01U" Locations

Figure 9-4
Building 102, Unit 1,
cis-1,2-Dichloroethene Results
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 5/17/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx

Legend

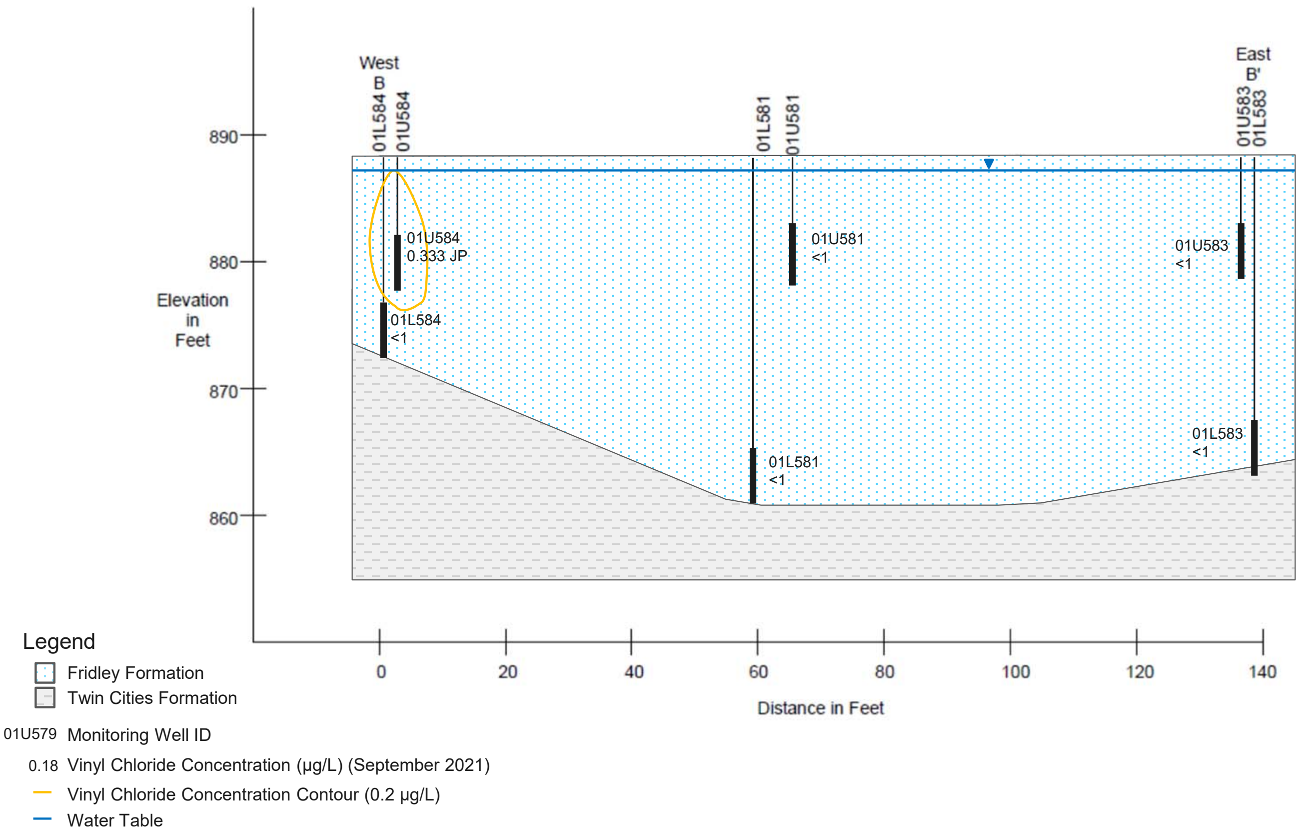
- Vinyl Chloride Concentration Contours (ug/L)
- 01U580 2.61 Monitoring Well Location
- 01U578 Sealed Well Location
- Geologic Cross-Section Line
- Building 102

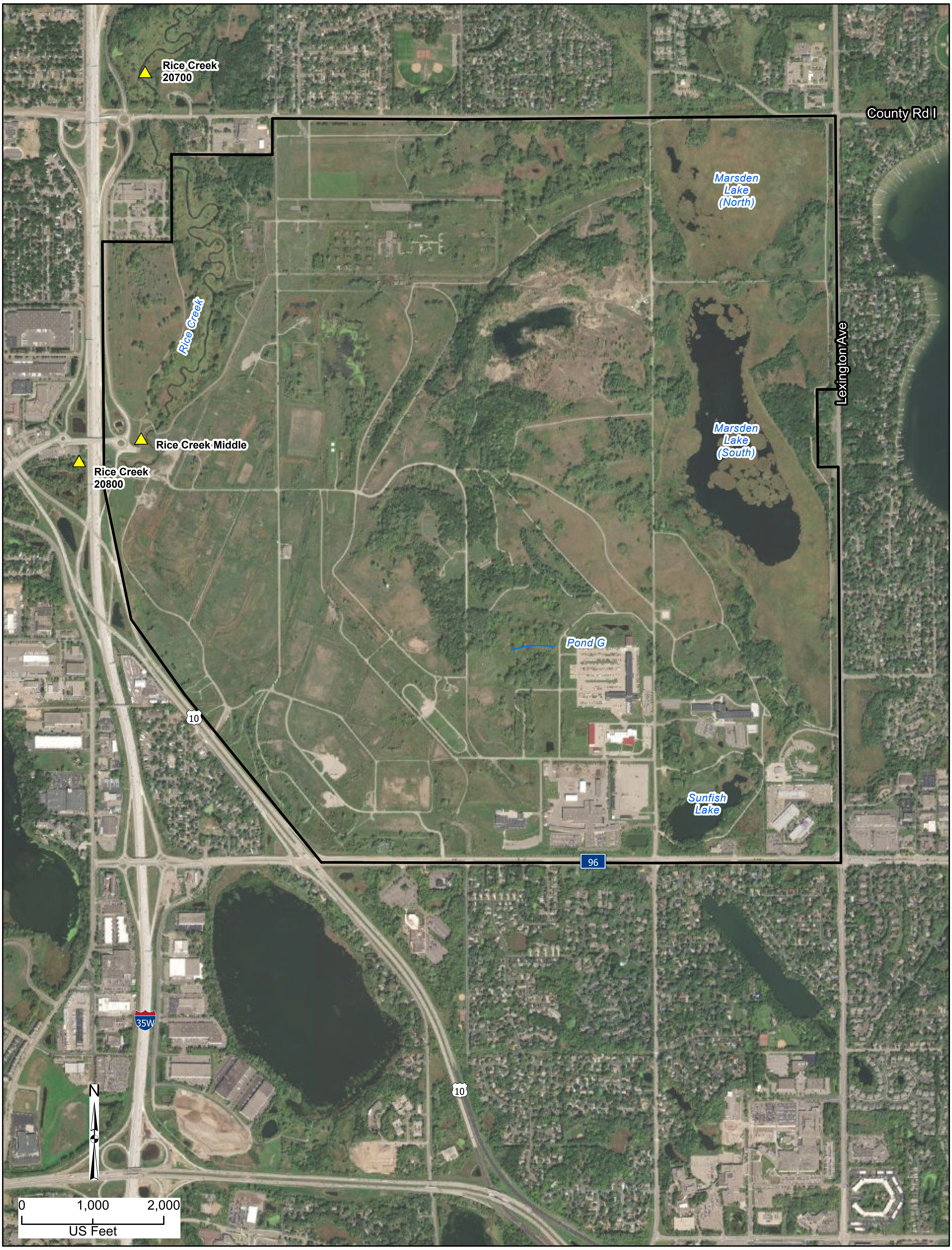
Date: 5/24/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx

Figure 9-5
Building 102, Unit 1,
Vinyl Chloride Results
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

FY 2021 Annual Performance Report
Figure 9-6
Building 102, Vinyl Chloride Cross Section B-B'

U.S Army - TCAAP
Arden Hills, Minnesota





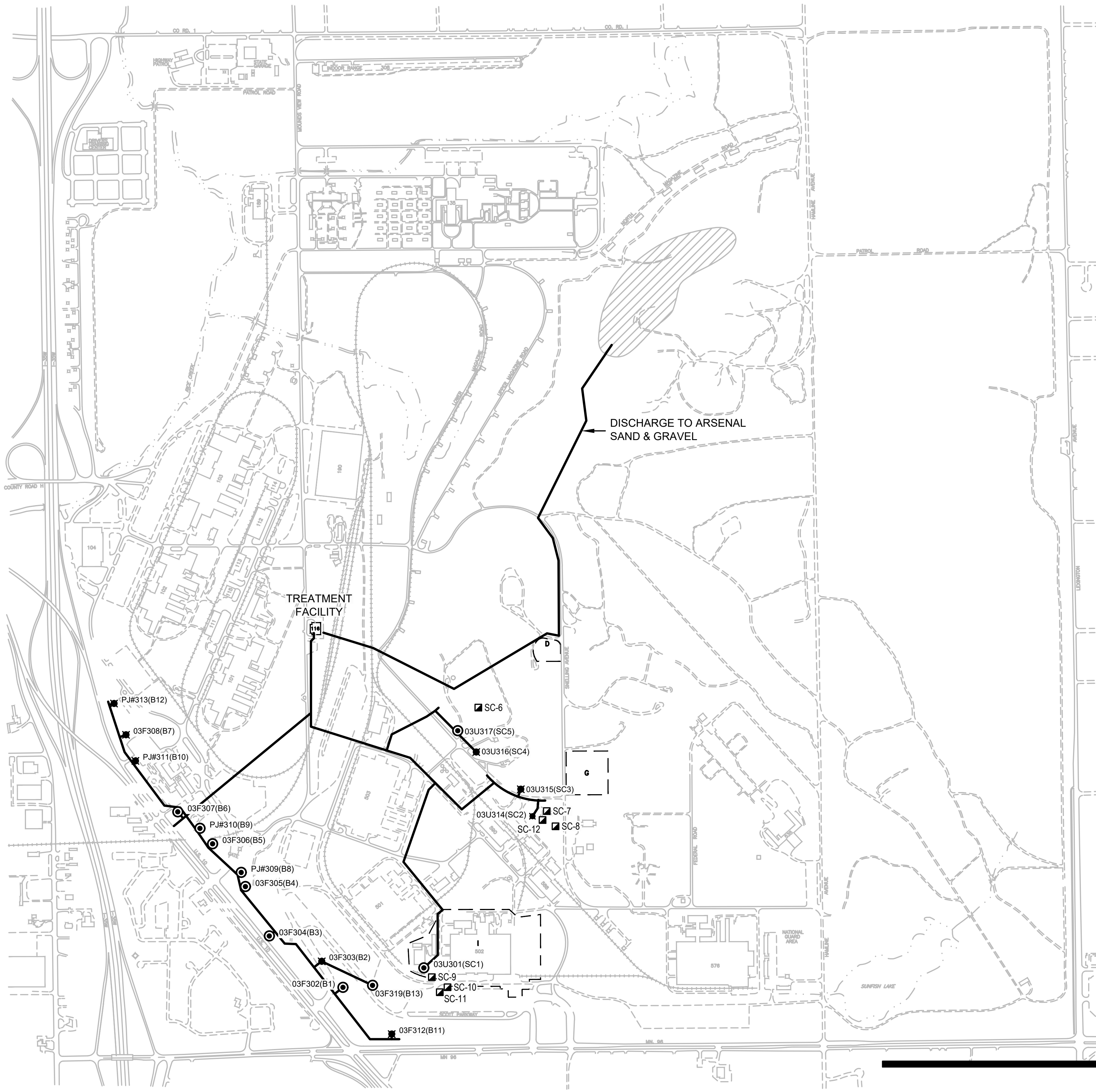
Legend

Rice Creek Sample Location

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.)

Figure 10-1
OU2 Aquatic Sites and Sampling Locations
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 5/17/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx



LEGEND

- PRIMARY ROAD
- SECONDARY ROAD
- RAILROAD
- DRAINAGE
- BUILDING
- BUILDING REMOVED
- SOURCE AREA
- ACTIVE EXTRACTION WELL LOCATION
- INACTIVE EXTRACTION WELL LOCATION
- INACTIVE SGRS 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

0 600 1200 ft
1" = 1200 ft
N

GHD

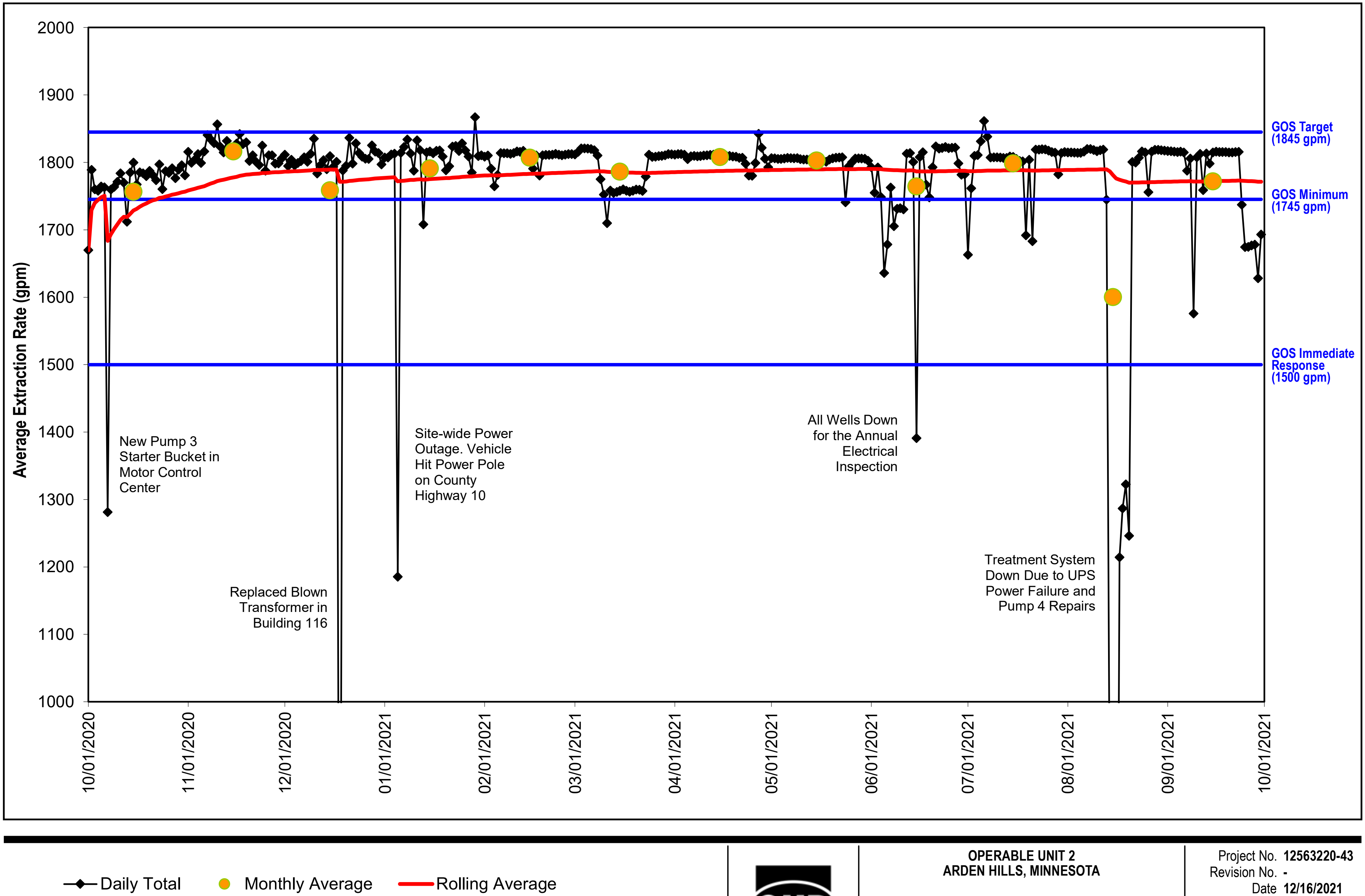
OPERABLE UNIT 2
ARDEN HILLS, MINNESOTA

TGRS LAYOUT

Project No. 12563220
Date January 2022

FIGURE 11-1

Filename: N:\US\St Paul\Projects\563\12563220\Digital_Design\ACAD\Figures\RPT001\12563220-GHD-0000-RPT-EN-0103_WA-001.DWG
Plot Date: 13 January 2022 1:02 PM



OPERABLE UNIT 2
ARDEN HILLS, MINNESOTA

TGRS FY2021 TOTAL
DAILY FLOW RATES

Project No. 12563220-43
Revision No. -
Date 12/16/2021

FIGURE 11-2

Q:\GIS\PROJECTS\12563000s\12563220\Maps\Deliverables\RPT\RPT001\12563220-43(RPT001)GIS-SP007.mxd
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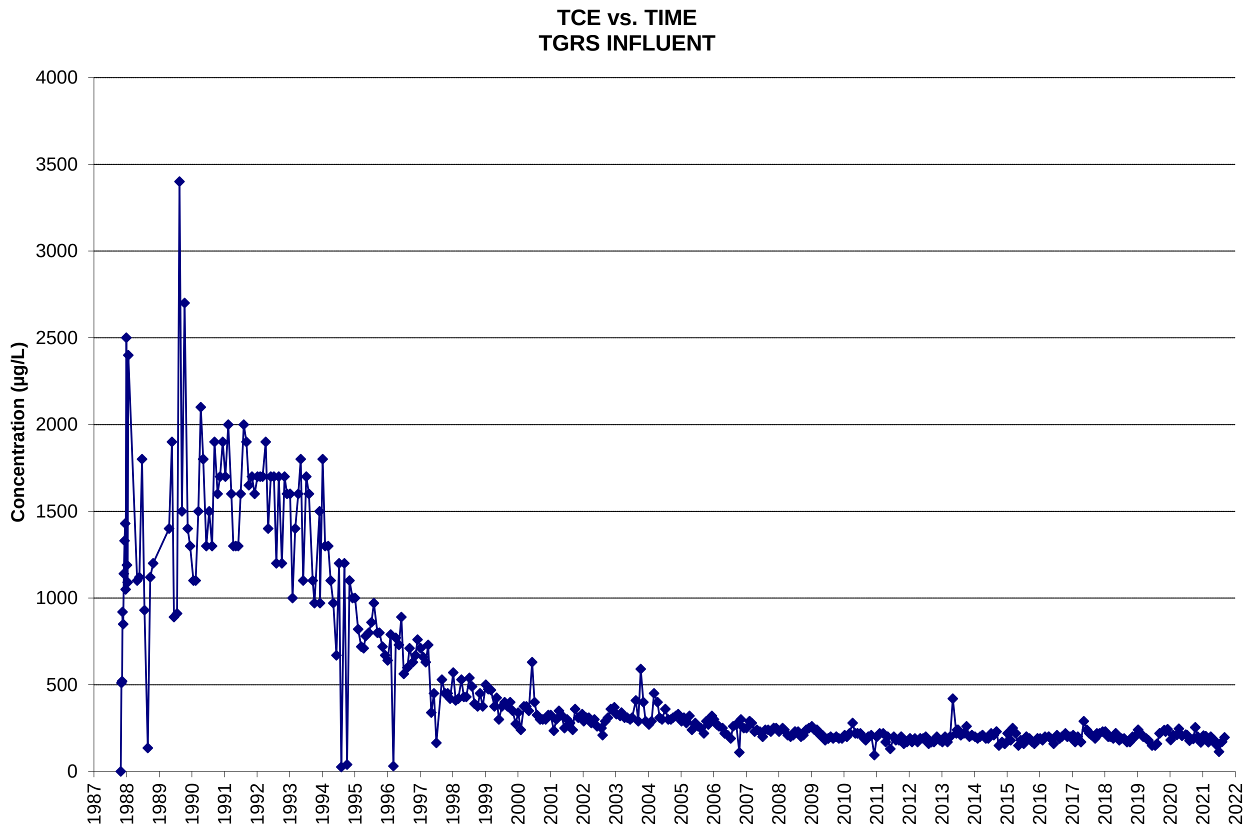

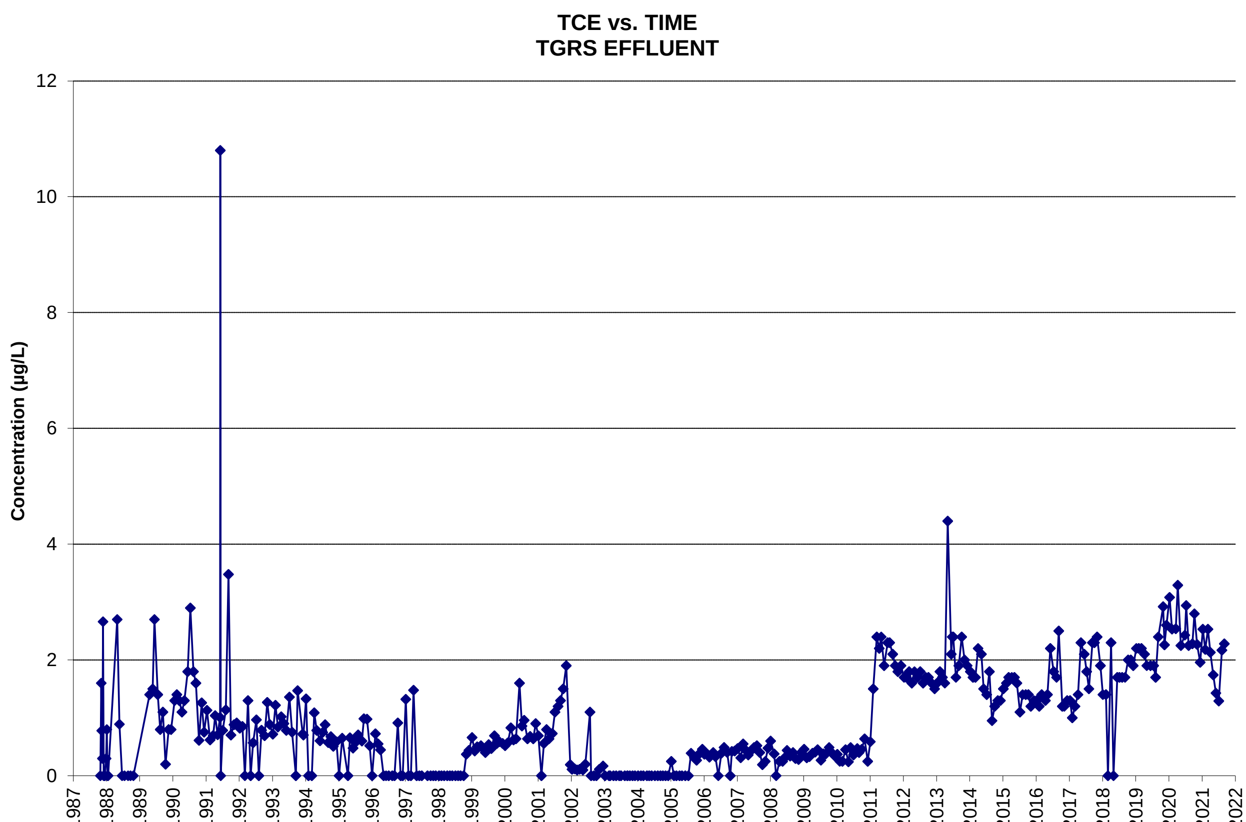

NOTE: SAMPLES REPORTING CONCENTRATIONS OF NON-DETECT WERE PLOTTED AS ZERO. WHEN DUPLICATE SAMPLES WERE COLLECTED, THE HIGHER CONCENTRATION WAS REPORTED.

OPERABLE UNIT 2
ARDEN HILLS, MINNESOTA

TGRS TREATMENT
SYSTEM PERFORMANCE

Project No. 12563220-43
Revision No. -
Date 12/16/2021

FIGURE 11-3

Q:\GIS\PROJECTS\12563000s\12563220\Maps\Deliverables\RPT\RPT001\12563220-43(RPT001)GIS-SP008.mxd
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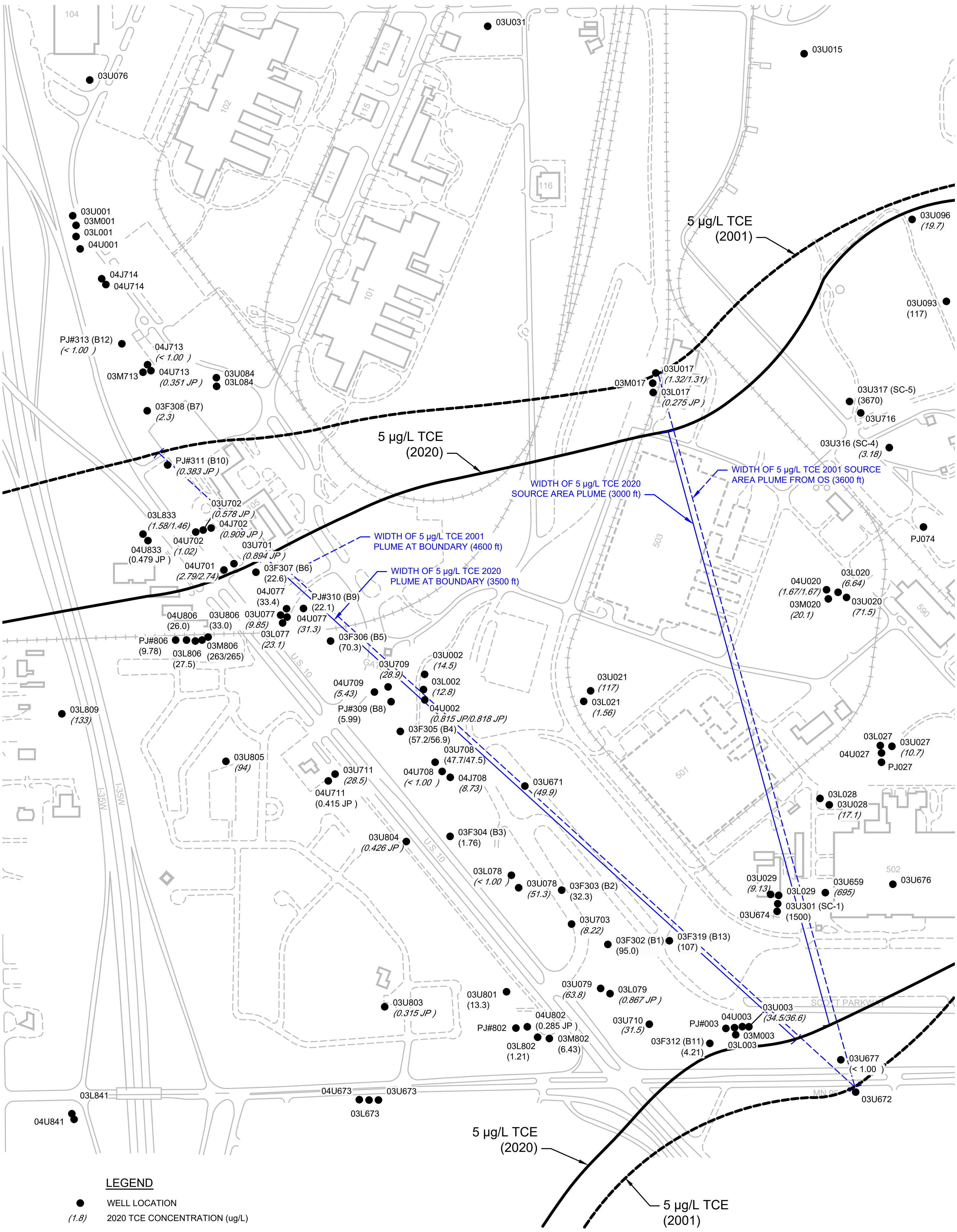
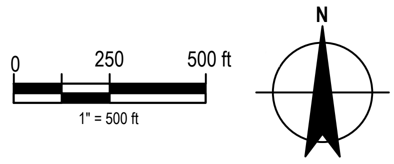




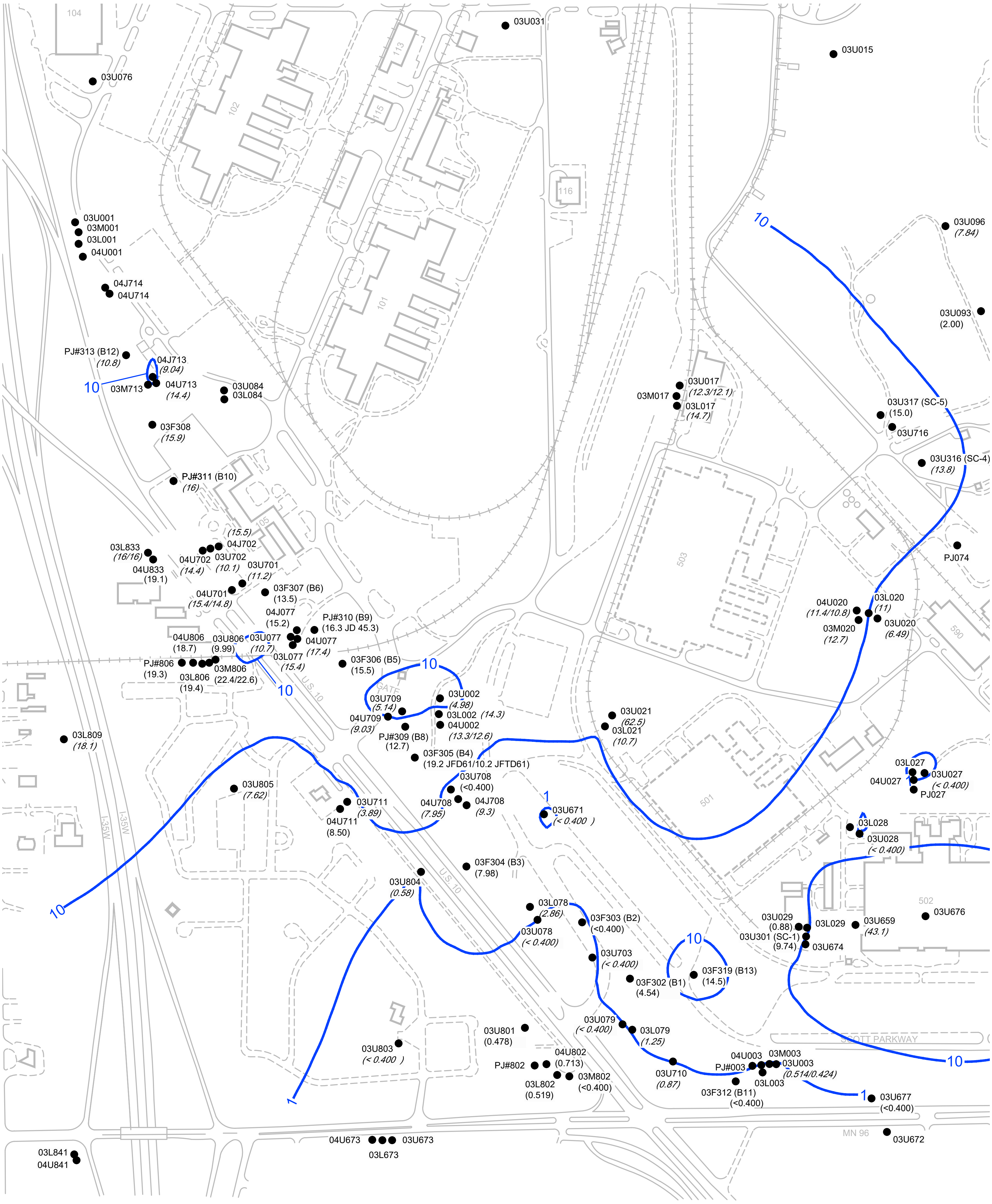
TGRS ANNUAL MONITORING DATA - WEST PORTION

TCE CONCENTRATIONS (µg/L)
JUNE 2021, OPERABLE UNIT 2

Project No. **12563220**
Date **January 2022**

FIGURE 11-4

Filename: N:\US\St Paul\Projects\563\12563220\Digital_Design\ACAD\Figures\RPT001\12563220-GHD-0000-RPT-EN-0109_WA-001.DWG
Plot Date: 04 January 2022 3:40 PM



LEGEND

- WELL LOCATION
- (3.9) 2020 1,4-DIOXANE CONCENTRATION
- 10 1,4-DIOXANE ISOCONCENTRATION CONTOUR

0 250 500 ft
1" = 500 ft

N

GHD

TGRS ANNUAL MONITORING DATA - WEST PORTION

1,4-DIOXANE CONCENTRATIONS (µg/L) JUNE 2021

Project No. **12563220**
Date **May 2022**

FIGURE 11-5

Filename: N:\US\St Paul\Projects\563\12563220\Digital_Design\ACAD\Figures\RPT001\12563220-GHD-0000-RPT-EN-0110_WA-001.DWG
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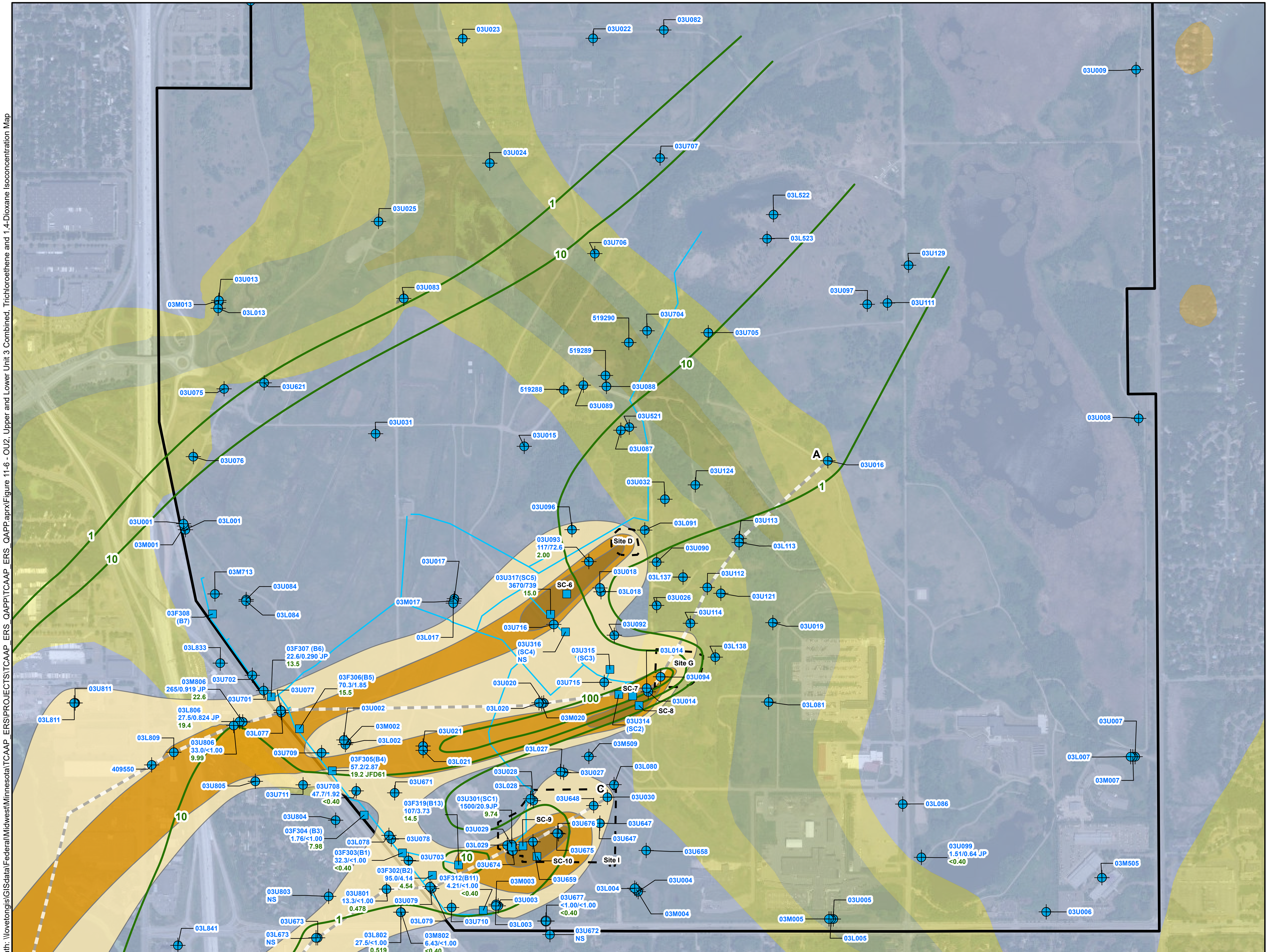
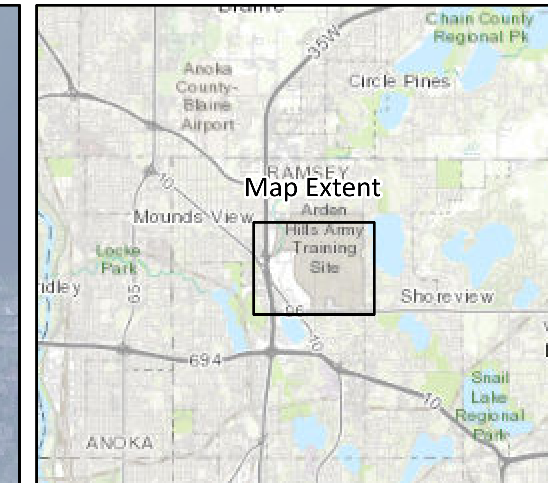




Legend

03U708 Monitoring Well ID
47.7/1.92 Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
0.40 1,4-Dioxane Concentration (µg/L)
Monitoring Well
Extraction Well
Cross-Section Line
Site Boundary
Extraction Well Piping
2021 1,4 Dioxane Concentration Contour (µg/L)

2021 Trichloroethene Concentrations

5-100 µg/L
100-1,000 µg/L
1,000+ µg/L
Operable Unit 2

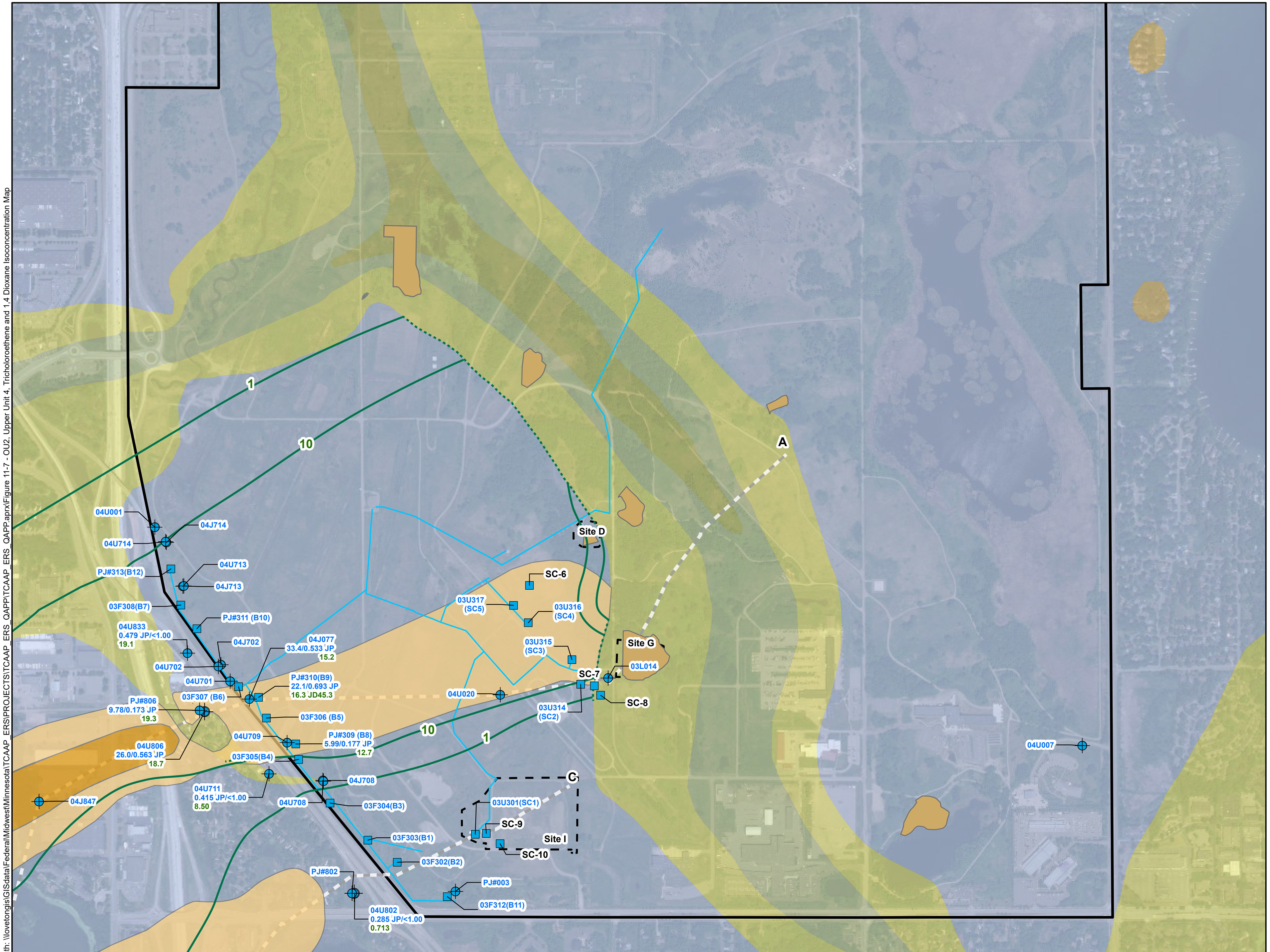
Bedrock Geology

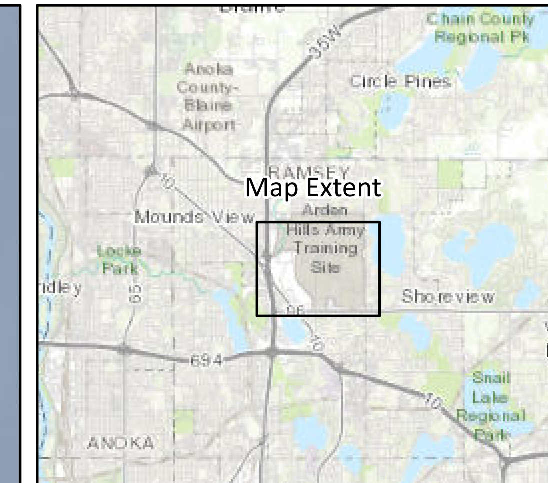
St. Peter Sandstone
Prairie du Chien Group
Jordan Sandstone
St. Lawrence Formation
Tunnel City Group

0 500 1,000
US Feet

Figure 11-6
OU2, Upper and Lower Unit 3 Combined Trichloroethene and 1,4-Dioxane Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx\Figure 11-6 - OU2, Upper and Lower Unit 3 Combined, Trichloroethene and 1,4-Dioxane Isoconcentration Map





Legend

PJ#806 Monitoring Well ID
9.78/0.173 Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
18.7 1,4-Dioxane Concentration (µg/L)
Monitoring Well
Extraction Well
Cross-Section Line
Site Boundary
Extraction Well Piping
2021 1,4 Dioxane Concentration Contour (µg/L)
2021 1,4 Dioxane Concentration Inferred Contour (µg/L)
Soil Covers

2021 Trichloroethene Concentrations (µg/L)

5-100 µg/L
100-1,000 µg/L
Operable Unit 2

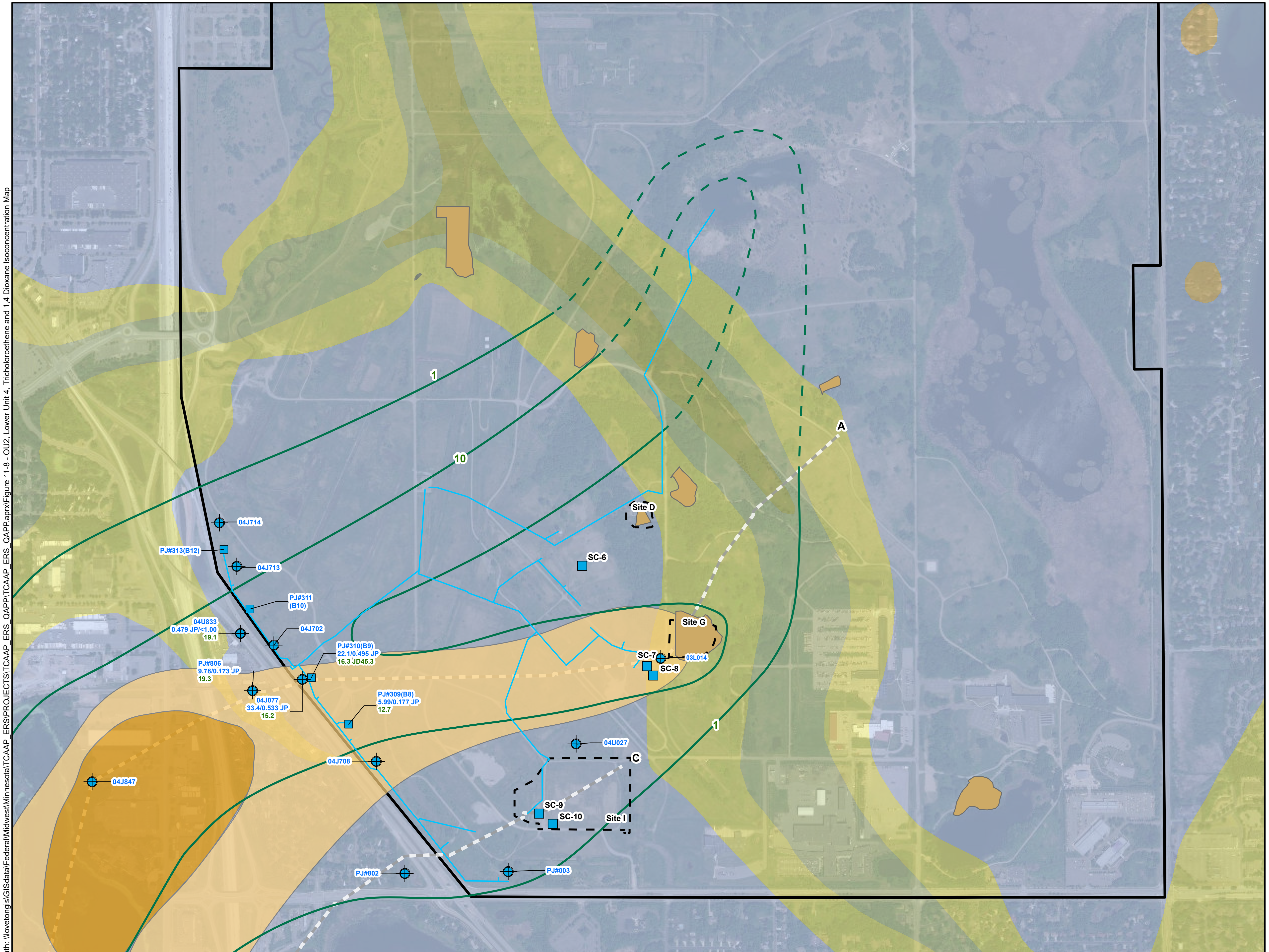
Bedrock Geology

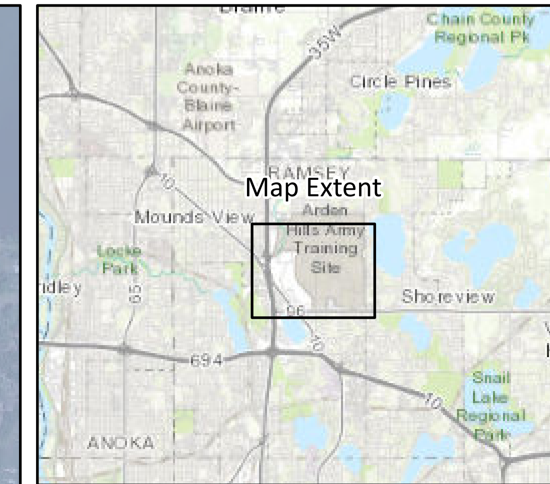
St. Peter Sandstone
Prairie du Chien Group
Jordan Sandstone
St. Lawrence Formation
Tunnel City Group

0 500 1,000
US Feet

Figure 11-7
OU2, Upper Unit 4
Trichloroethene and 1,4-Dioxane
Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: \\voetiongis\GIS\data\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx\Figure 11-7 - OU2, Upper Unit 4, Trichloroethene and 1,4 Dioxane Isoconcentration Map





Legend

- PJ#806 — Monitoring Well ID
- 9.78/0.173 — Trichloroethene/1,1,1-Trichloroethane Concentration (µg/L)
- 19.3 — 1,4-Dioxane Concentration (µg/L)
- Monitoring Well
- Extraction Well
- Cross-Section Line
- Site Boundary
- Extraction Well Piping
- 2021 1,4 Dioxane Concentration Contour (µg/L)
- 2021 1,4 Dioxane Concentration Inferred Contour (µg/L)
- Soil Covers

2021 Trichloroethene Concentrations (µg/L)

- 100-1,000 µg/L
- 5-100 µg/L
- Operable Unit 2

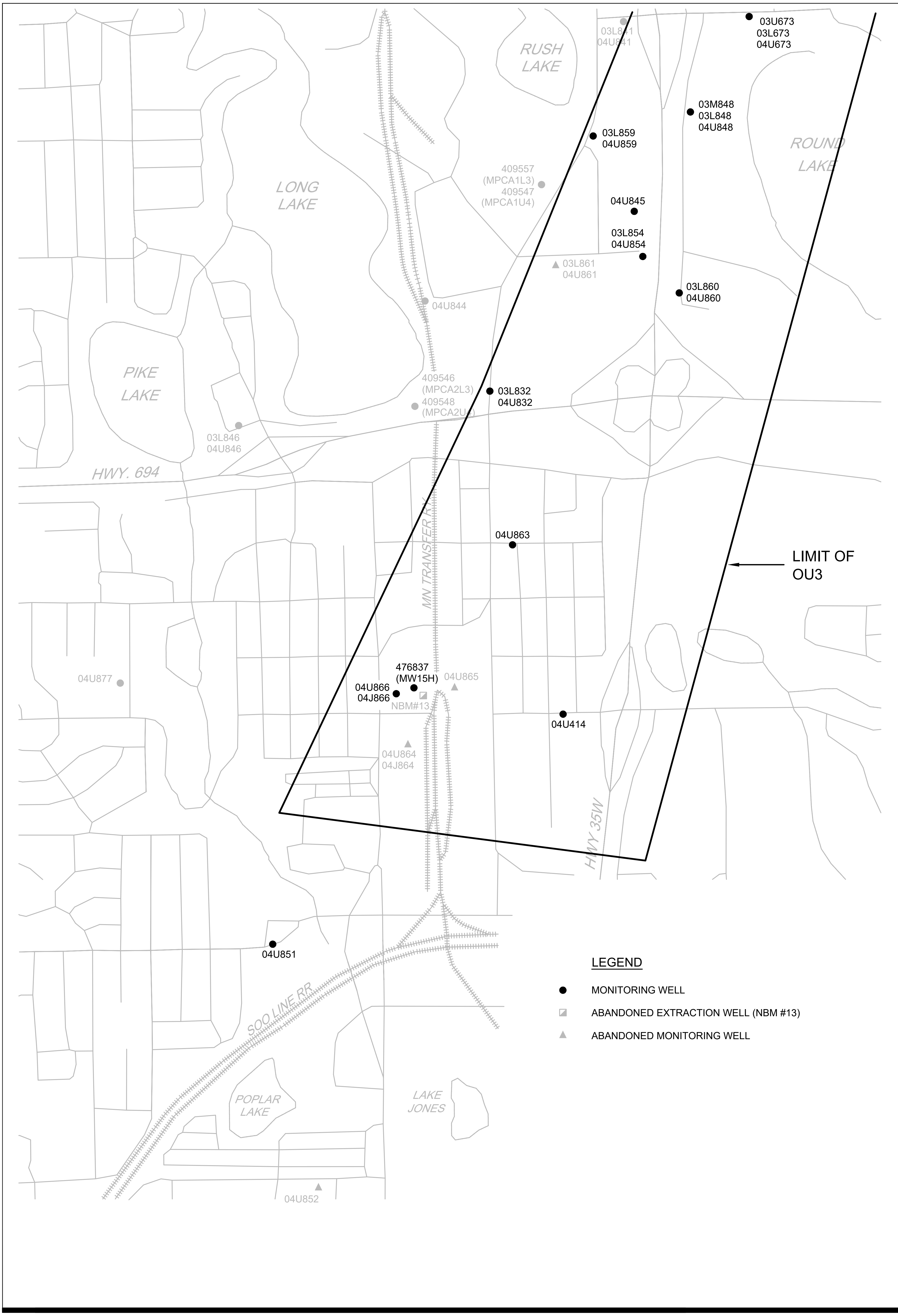
Bedrock Geology

- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Tunnel City Group

0 500 1,000
US Feet

Figure 11-8
OU2, Lower Unit 4
Trichloroethene and 1,4-Dioxane Isoconcentration Map
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx\Figure 11-8 - OU2, Lower Unit 4, Tricholoroethene and 1,4 Dioxane Isoconcentration Map



GHD

OPERABLE UNIT 3
ARDEN HILLS, MINNESOTA

SITE PLAN

Project No. 12563220
Date January 2022

FIGURE 12-1

Tables

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Table ES-1 Status of Remedial Actions: FY 2021 Annual Report

Remedy Component		Is the component being implemented?	Is the component doing what it is supposed to?	Has the component undergone final closeout?	Comments
OU1: Deep Groundwater					
#1	Alternate Water Supply/Well Abandonment	Yes	Yes	No	
#2	Drilling Advisories	Yes	Yes	No	
#3	Extract Groundwater	Yes	Yes	No	NBCGRS pumping has resumed as of November 2018
#4	Removal of VOCs by GAC (Discharge Quality)	Yes	Yes	No	
#5	Discharge of Treated Water	Yes	Yes	No	
#6	Groundwater Monitoring with Verification of Continuing Aquifer	Yes	Yes	No	
#7	Overall Remedy	Yes	Yes	No	
OU2: 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	
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.
#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.
					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 Site G dump) are addressed by Remedy Component #8.
#5	Maintain Existing Site Caps	Yes	Yes	Yes	
#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	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.
#2	Groundwater Containment/Mass Removal	No	Not Applicable	No	
#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	EPA and MPCA have approved a formal change of the remedy to MNA. A Record of Decision amendment was prepared and approved in FY 2017.
#6	Overall Remedy	Yes	Yes	No	

Table ES-1 Status of Remedial Actions: FY 2021 Annual Report

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.
#5	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.
#4	Overall Remedy	Yes			
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.
#9	Overall Remedy	Yes	Yes	No	
Operable Unit 2: Building 102 Shallow					
#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.
#4	Overall Remedy	Yes	Yes	No	
Operable Unit 2: Aquatic Sites					
#1	Pond G Surface Water Treatment	Yes	Yes	Yes	
#2	Pond G Surface Water Monitoring	Yes	Yes	Yes	
#3	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	
#7	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	
#4	Overall Remedy	Yes	Yes	No	

Notes:
GAC = Granular activated carbon
LUCRD = Land Use Control Remedial Design Record of Decision
MNA = Monitored natural attenuation
NBCGRS = New Brighton Contaminated Groundwater Recovery System
OU = Operable unit
SVE = Soil vapor extraction
TGRS = TCAAP Groundwater Recovery System
VOC = Volatile organic compound

Table 2-1 Summary of OU1 Monitoring Requirements

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

Notes:
MDH = Minnesota Department of Health
N/A = Not applicable
OU1 - Operable Unit 1
VOC = Volatile organic compound

Table 2-2 OU1 Groundwater Quality Data

		1,1,1-Trichloroethane	1,1,2-Trichloroethane	1,1-Dichloroethane	1,1-Dichloroethene	1,4-Dioxane	cis-1,2-Dichloroethene	Trichloroethene
OU1 Cleanup Level (µg/L) [a]		200	3	70	6	---	70	5
MDH HRL (µg/L) [b]		---	---	---	---	1	---	---
Sample Location	**Date**							
04J822	09/15/2021	<1.00	<1.00	0.715 JP	0.401 JP	0.938	0.729 JP	1.02
04J849	09/15/2021	0.770 JP	<1.00	0.547 JP	0.977 JP	<0.400	<1.00	1.55
04U839	09/16/2021	0.562 JP	<1.00	1.87	2.42	6.10	0.525 JP	27.2
04U855	09/15/2021	0.388 JP	<1.00	1.23	1.61	9.40	0.269 JP	25.0
04U871	09/16/2021	3.55	<1.00	3.50	6.31	8.65	2.53	86.0
04U872	09/15/2021	<1.00	<1.00	0.976 JP	0.648 JP	1.98	2.97	4.47
04U877	09/15/2021	<1.00	<1.00	0.725 JP	<1.00	1.32	<1.00	0.284 JP
04U879	09/15/2021	<1.00	<1.00	<1.00	<1.00	<0.416	<1.00	0.228 JMS174/162

Notes:

a. All values are given in micrograms per liter (µg/L) unless otherwise noted. The cleanup level for OU1 Groundwater is from page 18 of OU1 Record of Decision.

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 cleanup level or HRL.

--- = No relevant cleanup level or HRL for this compound.
µg/L = Microgram(s) per liter
JP = Reported value is between the MDL and the Reporting Limit
JMS = Result is estimated due to outlying matrix spike recovery.
OU = Operable Unit

Table 2-3 Group 1, 2, 3, 5 and 6 Mann-Kendall Summary for OU1

Group	No. Samples	Fraction of Detections	No. Time Periods	S Value	Exact Two-Tailed P Value	Results Trend	Threshold Triggered?	Comments
OU1 Wells:								
04J822	13	13 / 13	13	-60	0.0001	Decreasing Trend (p<0.05)	No	
04J849	14	8 / 14	13	50	0.0005	Increasing Trend (p<0.05)	Yes	Continued annual monitoring of this well is appropriate to further evaluate how the OU1 plume is shifting.
04U839	11	11 / 11	9	18	0.0752	Probably Increasing Trend (p<0.1)	Yes	This increase may be influenced by the NBCGRS shut down.
04U855	9	9 / 9	9	29	0.0013	Increasing Trend (p<0.05)	Yes	Continued annual monitoring of this well is appropriate to further evaluate how the OU1 plume is shifting.
04U871	15	15 / 15	13	2	0.9522	No Significant Trend	No	
04U872	14	14 / 14	13	14	0.4354	No Significant Trend	No	
04U877	13	13 / 13	13	-7	0.7184	No Significant Trend	No	
04U879	10	7 / 10	9	9	0.4065	No Significant Trend	No	

Notes:
µg/L = Microgram(s) per liter
NBCGRS = New Brighton Contaminated Groundwater Recovery System
ND = Non-detect
OU = Operable Unit
P Value = represents uncertainty in the trend
S Value = indicates increasing (positive S) or decreasing (negative S) trend

Table 5-1 Summary of Site A Shallow Groundwater Monitoring Requirements

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. VOC-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

Notes:
VOC = Volatile organic compound

Table 5-2 Site A Groundwater Quality Data

		1,1-Dichloroethane	1,1-Dichloroethene	Antimony (dissolved)	Benzene	Chloroform (Trichloromethane)	cis-1,2-Dichloroethene	Tetrachloroethene	Trichloroethene
Site A Cleanup Level (µg/L) [a]		70	6	5	10	60	70	7	30
Sample Location	Date								
01U039	09/14/2021	<1.00	<1.00	N/A	<1.00	<5.00	0.413 JP	<1.00	<1.00
01U102	09/14/2021	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	<1.00	<1.00
01U103	09/14/2021	<1.00	<1.00	4.23	<1.00	<5.00	<1.00	<1.00	<1.00
01U115	09/14/2021	<1.00	<1.00	N/A	<1.00	<5.00	17.4	<1.00	2.80
01U116	09/14/2021	<1.00	<1.00	N/A	<1.00	<5.00	0.438 JP	<1.00	0.230 JP
01U117	09/14/2021	<1.00	<1.00	N/A	<1.00	<5.00	13.3	1.72	<1.00
01U126	09/14/2021	<1.00	<1.00	N/A	<1.00	<5.00	4.03	6.40	1.17
01U138	09/14/2021	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	<1.00	<1.00
01U139	09/14/2021	<1.00	1.29	N/A	9.73	<5.00	1,030	<1.00	0.554 JP
01U140	09/14/2021	<1.00	<1.00	N/A	0.287 JP	<5.00	3.62	<1.00	0.218 JP
01U157	09/14/2021	<1.00	<1.00	N/A	0.110 JP	<5.00	30.6	<1.00	<1.00
01U158	09/14/2021	<1.00	<1.00	N/A	0.161 JP	<5.00	11.3	<1.00	0.314 JP
01U350	09/14/2021	<1.00	<1.00	N/A	<1.00	0.227 JP	0.239 JP	0.608 JP	<1.00
01U352	09/14/2021	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	<1.00	<1.00
01U353	09/14/2021	<1.00	<1.00	N/A	<1.00	<5.00	1.62	<1.00	<1.00
01U355	09/14/2021	<1.00	<1.00	N/A	0.194 JP	<5.00	31.8	<1.00	<1.00
01U356	09/14/2021	<1.00	<1.00	N/A	0.125 JP	<5.00	16.9	<1.00	<1.00
01U357	09/14/2021	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	<1.00	<1.00
01U358	09/14/2021	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	<1.00	<1.00
01U901	09/14/2021	<1.00	<1.00	N/A	<1.00	<5.00	0.188 JP	<1.00	<1.00
01U902	09/15/2021	<1.00	0.195 JP	<4.00	2.98	<5.00	173	<1.00	<1.00
01U903	09/15/2021	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	<1.00	<1.00
01U904	09/14/2021	<1.00	<1.00	<4.00	<1.00	<5.00	<1.00	<1.00	<1.00
01U905	09/15/2021	<1.00	<1.00	N/A	<1.00	<5.00	<1.00	<1.00	<1.00
01U906	09/15/2021	<1.00	<1.00	N/A	<1.00	<5.00	0.194 JP	<1.00	<1.00
01U907	09/15/2021	<1.00	<1.00	N/A	<1.00	<5.00	0.382 JP	<1.00	<1.00

Notes:

a. All values are given in micrograms per liter (µg/L) unless otherwise noted. The cleanup level for Site A Groundwater is from Table 2 of OU2 Record of Decision. Gray shading indicates exceedance of cleanup level.

µg/L = Microgram(s) per liter

JP = Reported value is between the Method Detection Limit and the Reporting Limit

N/A = Not applicable

OU = Operable Unit

Table 6-1 Summary of Site C Shallow Groundwater Monitoring Requirements

Remedy Component	Monitoring Requirements	Implementing Party	Documents Containing the Monitoring Plan
#1: Groundwater 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 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 6-2 Water Quality Data for Site C Groundwater

		Lead (dissolved)
Site C Cleanup Level (µg/L) [a]		**15**
Sample Location	**Date**	
01U046	09/15/2021	<2.00
01U561	09/15/2021	<2.00
01U562	09/15/2021	<2.00
01U563	09/15/2021	1.29 JP
01U564	09/15/2021	1.56 JP
01U567	09/15/2021	<2.00
01U571	09/15/2021	1.97 JP
01U573	09/15/2021	**92.9**
01U574	09/15/2021	**35.2**
01U575	09/15/2021	2.98
01U576	09/15/2021	<2.00

Notes:

a. All values are given in micrograms per liter (µg/L) unless otherwise noted. The cleanup level for Site C Groundwater is from Table 1 of OU2 Record of Decision Amendment #1. Gray shading indicates exceedance of cleanup level.

JP = Reported value is between the Method Detection Limit and the Reporting Limit
OU = Operable Unit

Table 6-3 Water Quality Data for Site C Surface Water

		Lead (dissolved)
Surface Water Cleanup Level (µg/L) [a]		6.9
Sample Location	**Date**	
NE Wetland	09/15/2021	<2.00
NE Wetland	09/16/2021	<2.00
NE Wetland	09/17/2021	<2.00
SW-5	09/15/2021	<2.00
SW-5	09/16/2021	<2.00
SW-5	09/17/2021	<2.00
SW-6	09/15/2021	4.06
SW-6	09/16/2021	<2.00
SW-6	09/17/2021	<2.00

Notes:

a. All values are given in micrograms per liter (µg/L) unless otherwise noted. The cleanup level for Site C surface water is from Table 1 of OU2 Record of Decision Amendment #1.

Gray shading indicates exceedance of cleanup level.

FB = Field blank

FD = Field duplicate

JP = Reported value is between the Method Detection Limit and the Reporting Limit

OU = Operable Unit

Table 6-4 Contingency Locations for Site C Monitoring

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

Notes:

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.

MPCA = Minnesota Pollution Control Agency

USEPA = United States Environmental Protection Agency

Table 7-1
Summary of Groundwater Monitoring Requirements
Fiscal Year 2021
Site I, OU2

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 Space 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 Space Systems	Site I Monitoring Plan in Annual Performance Report

Table 7-2

Most Recent Groundwater Quality Data (FY 2013)
Site I, OU2

			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 - Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit

µg/L - micrograms per liter

Table 8-1
Summary of Groundwater Monitoring Requirements
Fiscal Year 2021
Site K, OU2

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 Space 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 Space Systems	Site K Monitoring Plan in Annual Performance Report
	b. Pumping volumes and rates for reporting	Northrop Grumman Space 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 Space Systems	Site K Monitoring Plan in Annual Performance Report
#7 Additional Investigation	a. None (completed)		

Table 8-2

Groundwater Quality Data
Fiscal Year 2021
Site K, OU2

			cis-1,2-Dichloroethene	trans-1,2-Dichloroethene	Trichloroethene
Site K Cleanup Level [1]			**70 (Total DCE)**		**30**
Location	**Date**	**Dup**	ug/L	ug/L	ug/L
01U128	06/07/21		< 1.00	0.285 JP	< 1.00
01U603	06/07/21		5.45	0.426 JP	3.24
01U608R	08/10/21		976	120	53.6
01U609R	08/10/21		4,650	478 JP	23,600
01U611R	08/10/21		1,370	123	2,520
01U611R	08/10/21	D	1,420	114	2,570
01U615	06/07/21		2,400	528	1,770
01U617	06/07/21		2.48	0.222 JP	< 1.00
01U618	06/07/21		0.950 JP	0.237 JP	1.25
01U621	06/07/21		< 1.00	< 1.00	< 1.00
03U621	06/07/21		< 1.00	< 1.00	< 1.00
K04-MW (482083)	06/07/21		< 1.00	< 1.00	< 1.00
K04-MW (482083)	06/07/21	D	< 1.00	< 1.00	< 1.00

Notes:

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

DCE - Dichlororethene

JP - Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit.

Table 8-3
Groundwater Elevation Monitoring
Fiscal Year 2021
Site K, OU2

Well ID	Groundwater Elevation (June 2020)	Groundwater Elevation (Historical Maximum)	Groundwater Elevation (June 2021)
01U047	Abandoned	875.75	Abandoned
01U048	875.85	876.61	873.42
01U052	876.71	876.64	875.60
01U065	Abandoned	874.91	Abandoned
01U128	876.91	878.33	874.87
01U601	Abandoned	886.65	Abandoned
01U602	Abandoned	886.37	Abandoned
01U603	881.40	882.86	877.52
01U604	Abandoned	879.79	Abandoned
01U605	Abandoned	879.61	Abandoned
01U607	Damaged	887.56	887.03
01U608	Abandoned	888.06	Abandoned
01U608R	--	883.45	883.45 *
01U609	Abandoned	886.83	Abandoned
01U609R	--	883.53	883.53 *
01U611	Abandoned	887.16	Abandoned
01U611R	--	883.66	883.66 *
01U612	880.98	884.70	879.87
01U613	Abandoned	886.15	Abandoned
01U615	882.92	883.71	878.66
01U616	Abandoned	882.75	Abandoned
01U617	880.88	883.22	877.07
01U618	884.25	885.58	881.51
01U619	Abandoned	886.60	Abandoned
01U620	Abandoned	881.93	Abandoned
01U621	881.76	883.87	878.59
01U624A	Abandoned	881.66	Abandoned
01U624B	Abandoned	881.63	Abandoned
01U624C	Abandoned	881.64	Abandoned
01U624D	Abandoned	881.64	Abandoned
01U625A	881.83	883.95	877.99
01U625B	881.78	883.90	877.97
01U625C	Obstructed	887.91	Obstructed
01U625D	881.76	883.91	877.96
01U626A	881.71	882.77	877.44
01U626B	881.28	883.50	877.36
01U626C	881.28	883.58	877.42
01U626D	881.33	883.61	877.48
01U627A	882.70	883.14	878.26
01U627B	881.37	883.57	877.57
01U627C	881.29	883.56	877.50
01U627D	881.30	883.57	877.50
01U628A	Abandoned	880.39	Abandoned
01U628B	Abandoned	880.34	Abandoned
01U628C	Abandoned	880.25	Abandoned
01U628D	Abandoned	880.25	Abandoned
482085 (K01MW)	Abandoned	887.09	Abandoned
482084 (K02MW)	Abandoned	887.41	Abandoned
482083 (K04MW)	883.88	885.38	881.96
03U621	861.81	862.73	861.11

Notes:
All elevations are in feet.
* - Elevation measured 8/9/2021

Table 8-4

Treatment System Concentrations (Organics)
Fiscal Year 2021
Site K, OU2

			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	12/09/2020		<1.00	<1.00	<1.00	0.946 JP	<1.00	<1.00	<1.00
Effluent	12/09/2020	D	<1.00	<1.00	<1.00	0.977 JP	<1.00	<1.00	<1.00
Effluent	03/04/2021		<1.00	<1.00	<1.00	0.700 JP	<1.00	<1.00	<1.00
Effluent	06/07/2021		<1.00	<1.00	<1.00	5.96	0.350 JP	1.37	<1.00
Effluent	06/07/2021	D	<1.00	<1.00	<1.00	6.07	0.371 JP	1.40	<1.00
Effluent	09/01/2021		<1.00	<1.00	<1.00	2.35	<1.00	0.253 JP	<1.00
Effluent	09/01/2021	D	<1.00	<1.00	<1.00	2.28	<1.00	<1.00	<1.00
Influent	12/09/2020		<1.00	0.321 JP	<1.00	155	14.5	36.0	1.15
Influent	03/04/2021		<1.00	0.350 JP	<1.00	109	17.7	24.2	0.671 JP
Influent	03/04/2021	D	<1.00	0.371 JP	<1.00	111	18.0	24.6	0.647 JP
Influent	06/07/2021		<1.00	0.473 JP	<1.00	164	20.5	57.7	2.24
Influent	09/01/2021		<1.00	<1.00	<1.00	89.3	14.0	17.1	0.659 JP

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

D - Field Duplicate
JP - Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit
µg/L - micrograms per liter

Table 8-5

Treatment System Concentrations (Inorganics)
Fiscal Year 2021
Site K, OU2

			Copper	Cyanide	Lead	Mercury	Silver	Zinc	Total Phosphorus
	Effluent Limit[(1)]		**21**	**17**	**106**	**0.20**	**3.4**	**134**	**1**
Location	**Date**		**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**µg/L**	**mg/L**
Effluent	12/09/2020		1.73 JP	< 5.00	< 2.00	< 0.200	< 2.00	6.97 JP	0.163
Effluent	03/04/2021		3.26 JP	< 5.00	< 2.00	< 0.200	< 2.00	4.01 JP	0.111
Effluent	06/07/2021		3.88 JP	56.7	< 2.00	< 0.200	< 2.00	3.09 JP	< 0.259 UB 0.0939
Effluent	07/09/2021			< 5.00					
Effluent	09/01/2021		3.21 JP	< 5.00	< 2.00	< 0.200	< 2.00	< 25.0	0.311

Notes:

(1) Substantive Requirement Document Concentration Limit, Maximum Daily Effluent Concentration.
Shading indicates exceedence of Effluent Limit.
JP - Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit
UB# - Result is qualified as non-detect based on an associated blank detection. The following numerical value is the blank concentration.
µg/L - micrograms per liter

Table 8-6

Summary of Monthly VOC Removal
Fiscal Year 2021
Site K, OU2

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, 2020						404.9
October[1]	246,123	206.97	0.96	0.43	0.00	0.42
November	217,406	206.97	0.96	0.38	0.00	0.37
December	209,544	206.97	0.96	0.36	0.00	0.36
January	169,424	153.27	0.70	0.22	0.00	0.22
February	159,823	153.27	0.70	0.20	0.00	0.20
March	231,377	153.27	0.70	0.30	0.00	0.29
April	429,081	244.91	7.76	0.88	0.03	0.85
May	464,455	244.91	7.76	0.95	0.03	0.92
June	366,311	244.91	7.76	0.75	0.02	0.73
July	294,733	121.06	2.44	0.30	0.01	0.29
August	227,829	121.06	2.44	0.23	0.00	0.23
September	298,626	121.06	2.44	0.30	0.01	0.30
Total - FY 2021						5.18
Cumulative To Date						410.1

Notes:

[1] Influent and Effluent VOC concentrations from the quarterly VOC samples collected on 12/9/2020, 3/4/2021, 6/7/2021, and 9/1/2021.
lbs - pounds
µg/L - micrograms per liter

Table 8-7

1,4-Dioxane Groundwater Sampling Results
Fiscal Year 2021
Site K, OU2

			1,4-Dioxane
Screening Criteria (HRL)			**1.0**
Location	**Date**		**µg/L**
03U621	06/07/2021		11.3

Notes:

HRL Health Risk Limit (Minnesota Department of Health).
Shading indicates exceedence of the HRL.
µg/L micrograms per liter

Table 9-1 Summary of Building 102 Shallow Groundwater Monitoring Requirements

Remedy Component	Monitoring Requirements	Implementing Party	Documents Containing the Monitoring Plan
#1: Monitored Natural Attenuation (Abiotic Degradation)	Outlined below		
#2: Groundwater Monitoring	Outlined below		
#3: Land Use Controls to Restrict Well Installation and to Protect the Remedy Infrastructure	None		
OR: Overall Remedy (Attainment of Cleanup Goals)	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 9-2 Building 102 Groundwater Quality Data

		1,1-Dichloroethene	cis-1,2-Dichloroethene	Trichloroethene	Vinyl chloride
Building 102 Cleanup Level (µg/L) [a]		**6**	**70**	**5**	**0.18**
Sample Location	**Date**				
01L581	09/16/2021	<1.00	4.62	**5.90**	<1.00
01L582	09/16/2021	<1.00	12.4	<1.00	<1.00
01L583	09/16/2021	<1.00	<1.00	<1.00	<1.00
01L584	09/16/2021	<1.00	7.29	**10.4**	<1.00
01U048	09/16/2021	<1.00	0.134 JP	<1.00	<1.00
01U579	09/16/2021	<1.00	4.51	1.50	<1.00
01U580	09/16/2021	<1.00	11.3	2.08	**2.61**
01U581	09/16/2021	<1.00	31.5	**15.0**	<1.00
01U582	09/16/2021	<1.00	0.668 JP	0.221 JP	<1.00
01U583	09/16/2021	<1.00	0.281 JP	0.324 JP	<1.00
01U584	09/16/2021	<1.00	4.18	3.97	**0.333 JP**

Notes:

a. All values are given in micrograms per liter (µg/L) unless otherwise noted. The cleanup levels for Building 102 Groundwater are from page 2-13 of OU2 Record of Decision Amendment #4. Gray shading indicates exceedance of cleanup level.

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

FB = Field blank

JP = Reported value is between the MDL and the Reporting Limit

OU = Operable Unit

Table 11-1
Groundwater Cleanup Levels
TGRS, OU2

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

Notes:
ppb - parts per billion

Table 11-2
Extraction Well Water Pumped
Fiscal Year 2021
TGRS, OU2

	Volume of Water Pumped (gallons)												
	B1	**B3**	**B4**	**B5**	**B6**	**B8**	**B9**	**B11**	**B13**	**SC1**	**SC2**	**SC5**	**Total**
October 2020	9,801,600	1,721,200	16,581,500	16,842,600	9,347,200	6,481,300	9,242,800	0	4,727,400	775,600	0	3,560,200	79,081,400
(gpm)	218	38	368	374	208	144	205	0	105	17	0	79	1,756
November 2020	9,430,850	5,110,700	17,139,680	16,675,852	8,835,478	5,001,654	6,951,290	0	4,413,300	754,900	0	3,424,036	77,737,740
(gpm)	220	119	400	390	206	117	163	0	103	18	0	80	1,816
December 2020	9,481,350	6,340,800	17,238,720	16,759,048	8,615,422	4,655,146	6,218,410	0	4,390,700	748,900	0	3,444,464	77,892,960
(gpm)	214	143	389	378	195	105	140	0	99	17	0	78	1,759
January 2021	9,667,600	6,101,800	16,860,600	15,393,700	9,317,500	5,965,400	7,927,700	0	4,080,652	772,324	0	3,596,800	79,684,076
(gpm)	217	138	379	346	209	134	178	0	92	17	0	81	1,791
February 2021	8,876,890	5,273,400	15,329,630	13,768,670	8,670,530	5,634,160	8,022,380	0	3,285,540	761,100	0	3,227,390	72,849,690
(gpm)	220	131	380	341	215	140	199	0	81	19	0	80	1,807
March 2021	5,518,760	5,977,000	16,985,450	15,615,880	9,607,060	7,505,700	10,505,840	0	3,632,200	841,400	0	3,544,840	79,734,130
(gpm)	124	134	380	350	215	168	235	0	81	19	0	79	1,786
April 2021	9,483,550	5,828,200	16,434,370	14,724,900	9,294,880	6,052,240	8,655,890	0	3,434,500	781,340	0	3,402,760	78,092,630
(gpm)	220	135	380	341	215	140	200	0	80	18	0	79	1,808
May 2021	9,732,440	6,001,800	16,964,040	15,185,380	9,594,860	6,250,340	8,935,710	0	3,520,000	769,200	0	3,517,580	80,471,350
(gpm)	218	134	380	340	215	140	200	0	79	17	0	79	1,803
June 2021	7,919,040	5,947,100	16,304,240	14,749,040	9,065,950	6,160,580	8,860,810	0	3,392,400	731,700	0	2,963,040	76,093,900
(gpm)	186	138	377	341	210	143	205	0	79	17	0	69	1,764
July 2021	9,631,810	5,987,800	16,848,570	15,277,810	9,519,190	6,374,530	9,091,460	0	3,450,000	677,500	0	3,431,660	80,290,330
(gpm)	216	134	377	342	213	143	204	0	77	15	0	77	1,799
August 2021	8,940,750	4,937,300	15,546,840	14,032,140	8,778,050	4,984,330	7,299,850	0	2,998,400	673,400	0	3,238,970	71,430,030
(gpm)	200	111	348	314	197	112	164	0	67	15	0	73	1,600
September 2021	9,396,230	5,883,100	16,313,980	14,716,840	9,225,080	4,834,560	8,803,630	0	3,369,000	717,100	0	3,285,430	76,544,950
(gpm)	218	136	378	341	214	112	204	0	78	17	0	76	1,772
Total FY 2021	**107,880,870**	**65,110,200**	**198,547,620**	**183,741,860**	**109,871,200**	**69,899,940**	**100,515,770**	**0**	**44,694,092**	**9,004,464**	**0**	**40,637,170**	**929,903,186**
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**
FY21 Average Flow Rate (gpm)	290	936	1,261	1,769
MOS Operational Minimum (gpm)	415	600	1,010	1,745

Table 11-3

Pumphouse Down Time
Fiscal Year 2021
TGRS, OU2

Well Name	FY21 Down Time (Days)	FY20 Down Time (Days)	FY19 Down Time (Days)	FY18 Down Time (Days)	FY17 Down Time (Days)
B1	23.0	10.4	11.4	10.9	3.3
B2	(1)	(1)	(1)	(1)	(1)
B3	38.6	31.6	3.9	3.6	3.7
B4	4.0	10.2	0.8	13.8	3.3
B5	3.9	9.4	0.8	32.0	4.0
B6	5.4	9.9	4.5	17.9	8.7
B7	(1)	(1)	(1)	(1)	(1)
B8	14.4	26.5	16.8	8.1	7.1
B9	7.8	28.6	10.8	14.8	11.2
B10	(1)	(1)	(1)	(1)	(1)
B11	(1)	(1)	(1)	(1)	(1)
B12	(1)	(1)	(1)	(1)	(1)
B13	7.4	8.6	2.1	18.8	4.3
SC1	5.4	8.5	2.9	6.2	3.9
SC2	(1)	(1)	(1)	25.2	3.7
SC3	(1)	(1)	(1)	(1)	(1)
SC4	(1)	(1)	(1)	(1)	(1)
SC5	9.8	8.8	6.6	4.3	20.2

Note:

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

Table 11-4

Down Time By Category
Fiscal Year 2021
TGRS, OU2

Category	**Down Time (Days)**
Pumphouse Component	5.9
Treatment Center Component	2.0
Electrical Service	3.9
Miscellaneous	0.0
Preventive Maintenance	0.0
System Modification	0.1
Forcemain	0.0
Total System Equivalent	12.0
Anticipated Down Time for Fiscal Year 2022	
Pumphouse Component	4.0
Treatment Center Component	1.5
Electrical Service	2.0
Miscellaneous	1.0
Preventive Maintenance	1.0
System Modification	5.0
Forcemain	3.0

Table 11-5

VOC Mass Loading Summary
Fiscal Year 2021
TGRS, OU2

Well	Percent Contribution to VOC Mass Removal	FY 2021 Total Pounds VOCs Mass Removed
B1	3.7%	65.1
B2[1]	0.0%	0.00
B3	0.1%	1.37
B4	4.7%	82.8
B5	5.2%	91.5
B6	1.1%	19.1
B7[1]	0.0%	0.00
B8	0.2%	4.22
B9	0.9%	16.2
B10[1]	0.0%	0.00
B11[1]	0.0%	0.00
B12[1]	0.0%	0.00
B13	1.8%	31.5
SC1	5.5%	96
SC2[1]	0.0%	0.00
SC3[1]	0.0%	0.00
SC4[1]	0.0%	0.00
SC5	76.6%	1,338
Fiscal Year 2021 Total (lbs)		**1,746**
Daily Average (lbs/day)		**4.8**

Notes:

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

Table 11-5

VOC Mass Loading Summary
Fiscal Year 2021
TGRS, OU2

Historical Total

Fiscal Year		Pounds VOC Mass Removed
2021		1,746
2020		2,013
2019		1,807
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		**224,226**

Table 11-6

VOC Concentrations in TGRS Extraction Wells
Fiscal Year 2021
TGRS, OU2

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	12/09/2020		4.04 JMS13.4JD66.0	0.594 JPJD66.5	0.908 JPJD67.6	< 1.00	4.17 JD61.7	1.71 JD71.9	62.1
03F302	B1	06/08/2021		4.14	0.707 JP	0.925 JP	< 1.00	4.46	2.07 JC23.3	95.0
03F303	B2	06/08/2021		< 1.00	0.175 JP	0.799 JP	0.355 JP	1.29	1.44 JC23.3	32.3
03F304	B3	12/09/2020		< 1.00	0.150 JP	< 1.00	< 1.00	< 1.00	< 1.00	1.54
03F304	B3	12/09/2020	D	< 1.00	0.125 JP	0.199 JP	< 1.00	< 1.00	< 1.00	1.42
03F304	B3	06/08/2021		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.76
03F305	B4	12/09/2020		3.43	1.87	1.96	< 1.00	1.24	0.362 JP	51.8
03F305	B4	06/08/2021		2.71	1.53	1.38	< 1.00	0.938 JP	0.530 JPJC23.3	57.2
03F305	B4	06/08/2021	D	2.87	1.55	1.41	< 1.00	0.967 JP	0.528 JPJC23.3	56.9
03F306	B5	12/09/2020		2.02	1.93	2.18	< 1.00	0.912 JP	3.86	58.7
03F306	B5	06/08/2021		1.85	1.83	1.70	< 1.00	0.792 JP	4.46 JC23.3	70.3
03F307	B6	12/09/2020		0.522 JP	0.246 JP	0.360 JP	< 1.00	0.153 JP	< 1.00	21.1
03F307	B6	06/08/2021		0.290 JP	0.227 JP	0.247 JP	< 1.00	0.160 JP	< 1.00	22.6
03F312	B11	12/09/2020		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.93
03F312	B11	12/09/2020	D	< 1.00	0.122 JP	< 1.00	< 1.00	< 1.00	< 1.00	2.56
03F312	B11	06/08/2021		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	4.21
03F319	B13	12/09/2020		3.86	1.45	1.08	< 1.00	8.20	0.336 JP	78.1
03F319	B13	06/08/2021		3.73	1.77	1.03	< 1.00	7.76	0.405 JPJC23.3	107
03U301	SC1	12/09/2020		24.9 JP	5.15 JP	< 50.0	< 50.0	133	< 50.0	1380
03U301	SC1	06/08/2021		20.9 JP	< 50.0	< 50.0	< 50.0	102	< 50.0	1500
03U317	SC5	12/09/2020		1250	28.0	50.2	< 1.00	11.0	6.86	3940
03U317	SC5	06/08/2021		739	16.8 JP	33.2 JP	< 100	< 100	< 100	3670
PJ#309	B8	12/09/2020		0.264 JP	0.215 JP	0.257 JP	< 1.00	< 1.00	< 1.00	5.26
PJ#309	B8	06/08/2021		0.177 JP	0.173 JP	0.230 JP	< 1.00	< 1.00	< 1.00	5.99
PJ#310	B9	12/09/2020		0.693 JP	1.05	1.12	< 1.00	0.418 JP	< 1.00	17.7
PJ#310	B9	06/08/2021		0.495 JP	0.819 JP	0.863 JP	< 1.00	0.293 JP	< 1.00	22.1

Notes:

µg/L	- micrograms per liter
D	- Field Duplicate
JP	- Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit.
JMS#	- Result is qualified as estimated due to outlying MS recovery. The following numerical value is the associated % MS recovery.
JC#	- Result is qualified as estimated due to outlying continuing calibration result. The following numerical value is the associated % D value.
JD#	- Result is qualified as estimated due to outlying relative percent difference from matrix spike analyses. The following numerical value is the associated relative percent difference.

Table 11-7

Groundwater Quality Data
Fiscal Year 2021
TGRS, OU2

Location	Date	Sample ID	Dup	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	4	70	5	5
				µg/L	µg/L	µg/L	µg/L	µg/L	µg/L	µg/L
03L802	06/03/2021	W-210603-EM-20		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	1.21
03L806	06/02/2021	W-210602-EM-11		0.824 JP	0.159 JP	0.351 JP	<1.00	0.255 JP	<1.00	27.5
03M802	06/03/2021	W-210603-EM-18		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	6.43
03M802	06/03/2021	W-210603-EM-19	FB	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
03M806	06/02/2021	W-210602-EM-12		0.919 JP	39.3	32.8	0.528 JP	10.3	<1.00	263
03M806	06/02/2021	W-210602-EM-13	D	0.914 JP	38.8	31.9	0.546 JP	10.0	<1.00	265
03U093	06/03/2021	W-210603-EM-22		72.6	0.714 JP	5.78	<1.00	5.65	<1.00	117
03U099	06/03/2021	W-210603-EM-21		0.624 JP	<1.00	<1.00	<1.00	<1.00	<1.00	1.51
03U677	06/07/2021	W-210607-EM-26		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	<1.00
03U708	06/03/2021	W-210603-EM-23		1.92	<1.00	0.615 JP	<1.00	0.589 JP	19.4	47.7
03U708	06/03/2021	W-210603-EM-24	D	1.84	<1.00	0.627 JP	<1.00	0.532 JP	20.4	47.5
03U801	06/03/2021	W-210603-EM-16		<1.00	<1.00	<1.00	<1.00	0.200 JP	<1.00	13.3
03U806	06/02/2021	W-210602-EM-14		<1.00	0.579 JP	0.407 JP	<1.00	0.219 JP	0.629 JP	33.0
04J077	06/03/2021	W-210603-EM-25		0.533 JP	1.03	1.32	<1.00	0.429 JP	<1.00	33.4
04U711	06/02/2021	W-210602-EM-15		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.415 JP
04U802	06/03/2021	W-210603-EM-17		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.285 JP
04U806	06/02/2021	W-210602-EM-09		0.563 JP	0.530 JP	0.640 JP	<1.00	0.318 JP	<1.00	26.0
04U833	06/02/2021	W-210602-EM-08		<1.00	<1.00	<1.00	<1.00	<1.00	<1.00	0.479 JP
PJ#806	06/02/2021	W-210602-EM-10		0.173 JP	<1.00	<1.00	<1.00	<1.00	<1.00	9.78

Notes:
(1) - Cleanup levels for TGRS are from the OU2 ROD. Shading indicates exceedence of the cleanup level.
µg/L - micrograms per liter
D - Field Duplicate
JP - Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit.
JL# - Result is qualified as estimated due to outlying LCS recovery or recoveries. The following numerical value is the associated % LCS recovery or recoveries.

Table 11-8
Summary Of OU2 Deep Groundwater Monitoring Requirements
TGRS, OU2

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 Space Systems/Army	Deep groundwater monitoring plan in Annual Report
	b. Pumping volumes and rates for comparison to design rates	Northrop Grumman Space Systems/Army	Deep groundwater monitoring plan in Annual Report
	c. Influent and extraction well water quality for overall mass removal calculations	Northrop Grumman Space Systems/Army	Deep groundwater monitoring plan in Annual Report
#2 Groundwater Treatment	• Outlined below		
#3 Treated Water Discharge	• Effluent monitoring to verify attainment of treatment requirements	Northrop Grumman Space Systems/Army	Deep groundwater monitoring plan in Annual Report
#4 Land Use Controls	• None		
#5 Review of New Technologies	• None		
#6 Groundwater Monitoring	a. Water levels to draw contour maps showing hydraulic zone of capture	Northrop Grumman Space Systems/Army	Deep groundwater monitoring plan in Annual Report
	b. Groundwater quality to verify attainment of clean up goals	Northrop Grumman Space Systems/Army	Deep groundwater monitoring plan in Annual Report
Overall Remedy	a. Groundwater quality to verify attainment of clean up goals	Northrop Grumman Space Systems/Army	Deep groundwater monitoring plan in Annual Report

Table 11-9

1,4-Dioxane Concentrations in TGRS and Extraction Wells
TGRS, OU2

				1,4-Dioxane
		Screening Criteria (HRL)		1.0
Location	**Alias**	**Date**	**Dup**	**µg/L**
03F302	B1	06/08/2021		4.54
03F303	B2	06/08/2021		< 0.400
03F304	B3	06/08/2021		7.98
03F305	B4	06/08/2021		19.2 JFD61
03F305	B4	06/08/2021	D	10.2 JFD61
03F306	B5	06/08/2021		15.5
03F307	B6	06/08/2021		13.5
PJ#309	B8	06/08/2021		12.7
PJ#310	B9	06/08/2021		16.3 JD45.3
03F312	B11	06/08/2021		< 0.400
03F319	B13	06/08/2021		14.5
03U301	SC1	06/08/2021		9.74
03U317	SC5	06/08/2021		15.0

Notes:

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

µg/L - micrograms per liter

D - Field Duplicate

JD# - Result is qualified as estimated due to outlying RPD value.
The following numerical value is the associated outlying RPD value.

JFD# - Result is qualified as estimated due to outlying field duplicate results.
The following numerical value is the associated relative percent differen

Table 11-10

1,4-Dioxane Concentrations in Monitoring Wells
TGRS, OU2

			1,4-Dioxane
	Screening Criteria (HRL)		**1.0**
Location	**Date**	**Dup**	**µg/L**
03L802	06/03/2021		0.519
03L806	06/02/2021		19.4
03M802	06/03/2021		< 0.400
03M806	06/02/2021		22.4
03M806	06/02/2021	D	22.6
03U093	06/03/2021		2.00
03U099	06/03/2021		< 0.400
03U677	06/07/2021		< 0.400
03U708	06/03/2021		< 0.400
03U708	06/03/2021	D	< 0.400
03U801	06/03/2021		0.478
03U806	06/02/2021		9.99
04J077	06/03/2021		15.2
04U711	06/02/2021		8.50
04U802	06/03/2021		0.713
04U806	06/02/2021		18.7
04U833	06/02/2021		19.1
PJ#806	06/02/2021		19.3

Notes:

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

µg/L - micrograms per liter

D - Field Duplicate

Table 12-1

Groundwater Quality Data
Fiscal Year 2021
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**
03M848	06/02/2021		<1.00	<1.00	0.294 JP	0.401 JP	4.70	94.5
04U832	06/02/2021		0.847 JP	<1.00	2.92	3.41	2.37	43.6
04U863	06/02/2021		<1.00	<1.00	<1.00	<1.00	<1.00	0.247 JP

Notes:

(1) - Cleanup levels for OU3 are from the OU3 ROD. Shading indicates exceedence of the cleanup level.
JP - Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit.
µg/L - microgram per liter

Table 12-2

Mann-Kendall Statistical Summary
Fiscal Year 2021
Operable Unit 3

	Well	Kendall S	Number of Data Points	Raw Trend	Confidence	Coefficient of Variance	Raw Trend Decision	MAROS Conclusion	TCE Concentration 2021
	Edge of Plume Wells								
*	03L673	-8	6	Decreasing	89.81%	0.1997	Stable or No Trend	Stable	75.8
*	03L848	-11	6	Decreasing	97.20%	0.3324	Definite	Decreasing	1.59
*	04U673	-11	6	Decreasing	97.20%	0.2795	Definite	Decreasing	21.4
	04U832	-1	6	Decreasing	50.00%	0.1137	Stable or No Trend	Stable	43.6
*	04U845	-7	6	Decreasing	86.40%	0.3080	Stable or No Trend	Stable	8.26
*	04U848	-13	6	Decreasing	99.17%	0.2274	Definite	Decreasing	2.9
*	04U854	-9	6	Decreasing	93.20%	0.1682	Probable	Decreasing	7.07
	Center of Plume Wells								
*	03L859	-6	6	Decreasing	81.46%	0.2040	Stable or No Trend	Stable	5.75
	03M848	-5	6	Decreasing	76.50%	0.0652	Stable or No Trend	Stable	94.5
*	04U859	-14	6	Decreasing	99.51%	0.3496	Definite	Decreasing	21.6

Notes:

* - Denotes latest sample results collected in FY 2020

Table 12-3

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 Space Systems	OU3 Monitoring Plan in Annual Report
		b.	Groundwater sampling to track progress of clean-up and attenuation of plume.	Northrop Grumman Space 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 Space Systems	OU3 Monitoring Plan in Annual Report

Table 12-4

1,4-Dioxane Groundwater Sampling Results
Fiscal Year 2021
Operable Unit 3

			1,4-Dioxane
Screening Criteria (HRL)			1.0
Location	**Date**	**Dup**	**µg/L**
03M848	06/02/2021		0.839
04U832	06/02/2021		4.22
04U863	06/02/2021		<0.400

Notes:

HRL - Health Risk Limit (Minnesota Department of Health)

µg/L - micrograms per liter

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Appendix A

FY 2021 – FY 2025 Monitoring Plans

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FY 2021 TO 2025 MONITORING PLAN FOR GROUNDWATER MONITORING WELLS

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

Footnotes:

(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

(1) 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.

(2) Sample extraction well annually or biennially, as shown, since it is no longer being pumped.

(3) Wells 04U414 and 04U851 monitored every 5 years during event preceding 5-year review

(4) Sample OU1 private water supply well as late as September 30, if necessary due to temporary inaccessibility.

Appendix A.1
FY 2021 - FY 2025 Monitoring Plan for Groundwater Monitoring Wells

Well Information			Notes	June 21	June 22	June 23	June 24	June 25	Purpose For Monitoring(3)		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
Operable Unit 1											
03U	03U811			---	---	---	---	---	---	---	Adandonded 2020
03U	03U821			---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
03U	03U822			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	None	
03U	03U831			---	---	---	---	---	---	---	Abandoned 2006
03U	409550	PCA 6U3		---	Q,L(B)	---	Q,L(B)	---	OR	None	
03U	409596	BS118U3		---	---	---	---	---	---	---	Abandoned 2007, may need replacement
03M	03M843			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	None	
03L	03L811			---	---	---	---	---	---	---	Adandonded 2020
03L	03L822			---	Q,L(B)	---	Q,L(B)	---	OR	None	
03L	03L832			---	Q,L(B)	---	Q,L(B)	---	OR	None	
03L	03L841			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	None	
03L	03L846			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	None	
03L	03L853			---	---	---	---	---	---	---	
03L	409556	PCA4L3		---	Q,L(B)	---	Q,L(B)	---	1.a, OR	None	
03L	409557	PCA1L3		---	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)	---	OR	3.b	
PC	04U834			---	Q,L(B)	---	Q,L(B)	---	OR	None	
PC	04U836	MW-1		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	04U837	MW-3		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	04U838	MW-5		---	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)	---	OR	3.b	
PC	04U843			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	3.b	
PC	04U844			---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	04U846			---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	04U847			---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	04U849			---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	04U850			---	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)	---	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)	---	1.a, OR	3.b	
PC	04U881			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	None	
PC	04U882			---	Q,L(B)	---	Q,L(B)	---	OR	None	
PC	04U883			---	Q,L(B)	---	Q,L(B)	---	1.a, OR	None	
04U	04U884	New Brighton Pilot Boring 1		Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	OR	3.b	
PC	191942	BS118U4		---	---	---	---	---	---	---	Abandoned 2007, may need replacement
PC	200154	UM Golf Course		---	Q(B)	---	Q(B)	---	1.a, OR	---	
PC	200814	American Linen		---	---	---	---	---	---	---	
PC	206688	Cloverpond		---	Q(B)	---	Q(B)	---	1.a, OR	---	

FY 2021 - FY 2025 Monitoring Plan for Groundwater Monitoring Wells

Well Information									Purpose For Monitoring(3)		
Unit	Well I.D.	Common Name	Notes	June 21	June 22	June 23	June 24	June 25	Water Quality	Water Level	Comments
PC	234547	Honeywell Ridgeway		---	---	---	---	---	---	---	
PC	409547	PCA1U4		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	409548	PCA2U4		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	409549	PCA3U4		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
PC	409555	PCA5U4		---	Q,L(B)	---	Q,L(B)	---	1.a, OR	3.b	
PC	512761	Gross Golf Course #2		---	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)	---	OR	None	
J	04J835			---	---	---	---	---	---	---	
J	04J836	MW-2		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
J	04J837	MW-4		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
J	04J838	MW-6		---	Q,L(B)	---	Q,L(B)	---	OR	3.b	
J	04J839	MW-8		---	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	Property owner did not grant access in FY 20
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)	---	OR	None	
J	200524	St. Anthony #5		---	Q(B)	---	Q(B)	---	OR	---	Army gets St. Anthony Data
J	200803	St. Anthony #4		---	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)	---	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)	---	OR	None	
UNK	234546	Honeywell Ridgeway		---	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			---	---	---	---	---	---	---	Abandoned FY20
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	

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Well Information									Purpose For Monitoring(3)		
Unit	Well I.D.	Common Name	Notes	June 21	June 22	June 23	June 24	June 25	Water Quality	Water Level	Comments
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	
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			Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	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
01U	01U905	Well 1		---	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	---	---	
01U	01U906	Well 2		---	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	---	---	
01U	01U907	Well 3		---	Q,L(B)	Q,L(B)	Q,L(B)	Q,L(B)	---	---	
Operable Unit 2 - Site C Shallow Groundwater											
01U	01U045			---	---	---	---	---	---	---	Abandoned FY14

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Well Information			Notes	June 21	June 22	June 23	June 24	June 25	Purpose For Monitoring(3)		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
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 FY 14
01U	01U636			---	---	---	---	---	---	---	Abandoned FY 14
01U	01U639			---	---	---	---	---	---	---	Abandoned FY 14
01U	01U640			---	---	---	---	---	---	---	Abandoned FY 14
01U	01U666			---	---	---	---	---	---	---	Abandoned FY 14
01U	01U667			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	OR	Abandoned FY14, replacement pending
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

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Well Information									Purpose For Monitoring[3]		
Unit	Well I.D.	Common Name	Notes	June 21	June 22	June 23	June 24	June 25	Water Quality	Water Level	Comments
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, replaced FY21
01U	01U609			L(A)	L(A)	L(A)	L(A)	L(A)	---	---	Abandoned FY14, replaced FY21
01U	01U611			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	---	---	Abandoned FY14, replaced FY21
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	
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)	---	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

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Well Information									Purpose For Monitoring[3]		
Unit	Well I.D.	Common Name	Notes	June 21	June 22	June 23	June 24	June 25	Water Quality	Water Level	Comments
03U	03U001			---	L(A)	---	L(A)	---	---	1.a	
03U	03U002			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U003			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U004			---	---	---	---	---	---	---	Abandoned FY13
03U	03U005			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U007			---	Q,L(A)	---	Q,L(A)	---	Background	1.a	
03U	03U008			---	L(A)	---	L(A)	---	---	1.a	
03U	03U009			---	Q,L(A)	---	Q,L(A)	---	Background	1.a	
03U	03U010			---	L(A)	---	L(A)	---	---	1.a	
03U	03U011			---	L(A)	---	L(A)	---	---	1.a	
03U	03U012			---	---	---	---	---	---	---	Abandonded 2009
03U	03U013			---	L(A)	---	L(A)	---	---	1.a	
03U	03U014			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U015			---	L(A)	---	L(A)	---	---	1.a	
03U	03U016			---	L(A)	---	L(A)	---	---	1.a	
03U	03U017			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U018			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U019			---	L(A)	---	L(A)	---	---	1.a	
03U	03U020			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U021			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U022			---	L(A)	---	L(A)	---	---	1.a	
03U	03U023			---	L(A)	---	L(A)	---	---	1.a	
03U	03U024			---	L(A)	---	L(A)	---	---	1.a	
03U	03U025			---	L(A)	---	L(A)	---	---	1.a	
03U	03U026			---	L(A)	---	L(A)	---	---	1.a	
03U	03U027			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U028			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U029			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U030			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U031			---	---	---	---	---	---	---	Abandoned FY14
03U	03U032			---	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)	---	OR	1.a	
03U	03U078			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U079			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U082			---	L(A)	---	L(A)	---	---	1.a	
03U	03U083			---	L(A)	---	L(A)	---	---	1.a	
03U	03U084			---	---	---	---	---	---	---	Abandoned FY14
03U	03U087			---	L(A)	---	L(A)	---	---	1.a	
03U	03U088			---	L(A)	---	L(A)	---	---	1.a	
03U	03U089			---	L(A)	---	L(A)	---	---	1.a	
03U	03U090			---	L(A)	---	L(A)	---	---	1.a	
03U	03U092			---	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)	---	OR	1.a	
03U	03U096			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	

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Well Information			Notes	June 21	June 22	June 23	June 24	June 25	Purpose For Monitoring(3)		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
03U	03U097			---	---	---	---	---	---	---	
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)	---	---	1.a	
03U	03U112			---	L(A)	---	L(A)	---	---	1.a	
03U	03U113			---	L(A)	---	L(A)	---	---	1.a	
03U	03U114			---	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)	---	OR	1.a	
03U	03U316	SC4	(5)	---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U317	SC5									See Appendix A.2
03U	03U320	SC6									See Appendix A.2
03U	03U321	SC7									See Appendix A.2
03U	03U322	SC8									See Appendix A.2
03U	03U323	SC9									See Appendix A.2
03U	03U324	SC10									See Appendix A.2
03U	03U325	SC11									See Appendix A.2
03U	03U326	SC12									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)	---	OR	1.a	
03U	03U671			---	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)	---	OR	1.a	
03U	03U702			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U703			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U704			---	L(A)	---	L(A)	---	---	1.a	
03U	03U705			---	L(A)	---	L(A)	---	---	1.a	
03U	03U706			---	L(A)	---	L(A)	---	---	1.a	
03U	03U707			---	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)	---	OR	1.a	
03U	03U710			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U711			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U715			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03U	03U716			---	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)	---	OR	1.a	
03U	03U804			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	

FY 2021 - FY 2025 Monitoring Plan for Groundwater Monitoring Wells

Well Information			Notes	June 21	June 22	June 23	June 24	June 25	Purpose For Monitoring[3]		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
03U	03U805			---	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)	---	---	1.a	
03M	03M002			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03M	03M003			---	L(A)	---	L(A)	---	---	1.a	
03M	03M004			---	---	---	---	---	---	---	Abandoned FY13
03M	03M005			---	L(A)	---	L(A)	---	---	1.a	
03M	03M007			---	L(A)	---	L(A)	---	---	1.a	
03M	03M010			---	L(A)	---	L(A)	---	---	1.a	
03M	03M012			---	---	---	---	---	---	---	Abandonded 2009
03M	03M013			---	L(A)	---	L(A)	---	---	1.a	
03M	03M017			---	L(A)	---	L(A)	---	---	1.a	
03M	03M020			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03M	03M713			---	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)	---	---	1.a	
03L	03L002			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L003			---	L(A)	---	L(A)	---	---	1.a	
03L	03L004			---	---	---	---	---	---	---	Abandoned FY13
03L	03L005			---	L(A)	---	L(A)	---	---	1.a	
03L	03L007			---	Q,L(A)	---	Q,L(A)	---	Background	1.a	
03L	03L010			---	L(A)	---	L(A)	---	---	1.a	
03L	03L012			---	---	---	---	---	---	---	Abandonded 2009
03L	03L013			---	L(A)	---	L(A)	---	---	1.a	
03L	03L014			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L017			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L018			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L020			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L021			---	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)	---	OR	1.a	
03L	03L078			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L079			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
03L	03L080			---	L(A)	---	L(A)	---	---	1.a	
03L	03L081			---	L(A)	---	L(A)	---	---	1.a	
03L	03L084			---	---	---	---	---	---	---	Abandoned FY14
03L	03L113			---	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)	---	OR	1.a	
03L	03L833			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	

FY 2021 - FY 2025 Monitoring Plan for Groundwater Monitoring Wells

Well Information			Notes	June 21	June 22	June 23	June 24	June 25	Purpose For Monitoring(3)		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
PC	04U001			---	L(A)	---	L(A)	---	---	1.a	
PC	04U002			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC	04U003			---	L(A)	---	L(A)	---	---	1.a	
PC	04U007			---	Q,L(A)	---	Q,L(A)	---	Background	1.a	
PC	04U012			---	L(A)	---	L(A)	---	---	1.a	
PC	04U020			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC	04U027			---	---	---	---	---	---	---	Abandoned FY14
PC	04U077			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC	04U510			---	Q,L(A)	---	Q,L(A)	---	Background	1.a	
PC	04U701			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC	04U702			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC	04U708			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC	04U709			---	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)	---	OR	1.a	
PC	04U714			---	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)	---	OR	1.a	
J	04J708			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
J	04J713			---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
J	04J714			---	L(A)	---	L(A)	---	---	1.a	
PC/J	PJ#003			---	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)	---	OR	1.a	
PC/J	PJ#313	B12	(5)	---	Q,L(A)	---	Q,L(A)	---	OR	1.a	
PC/J	PJ#802			---	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)	---	---	---	
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)	---	OR	2.a	
03M	03M848			Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	Q,L(A)	OR	2.a	

FY 2021 - FY 2025 Monitoring Plan for Groundwater Monitoring Wells

Well Information			Notes	June 21	June 22	June 23	June 24	June 25	Purpose For Monitoring[3]		Comments
Unit	Well I.D.	Common Name							Water Quality	Water Level	
03L	03L673			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
03L	03L832			---	L(A)	---	L(A)	---	---	2.a	
03L	03L848			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
03L	03L854			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
03L	03L859			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
03L	03L860			---	L(A)	---	L(A)	---	---	2.a	
03L	03L861			---	---	---	---	---	---	---	Abandoned FY06
03L	476837	MW15H		---	---	---	---	---	---	---	
PC	04U414	414U4	(6)	---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
PC	04U673			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
PC	04U832			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	Contingency Action for FY08
PC	04U845			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	Contingency Action for FY08
PC	04U848			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
PC	04U851		(6)	---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
PC	04U852			---	---	---	---	---	---	---	Abandoned FY09
PC	04U854			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
PC	04U859			---	Q,L(A)	---	Q,L(A)	---	OR	2.a	
PC	04U860			---	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)	---	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)	---	OR	2.a	
Well Inventory											
(Entries under "Notes" refer to the well inventory category)											
---	200180	Town & Country Golf Course	1b	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	2279 Marshal Ave
---	200522	Windsor Green	1b	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	Silver Lake Rd & Cty Rd E
---	200523	Windsor Green	1b	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	Silver Lake Rd & Cty Rd E
---	234421	BioClean (BioChem)	1b	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	2151 Mustang Dr
---	234544	R&D Systems	1b	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	2201 Kennedy St NE
---	249632	Montzka, Harold	1b	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	2301 N Upland Crest NE
---	433298	Town & Country Golf Course	1b	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	2279 Marshall Ave
---	509052	Shriners Hospital	1b	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	2025 E River Rd
---	537801	Midway Industrial	1b	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	4759 Old Hwy 8
---	756236	Alcan	1c	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	150 26th Ave SE
---	UNK057310	Murlowski	2a	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	1589 26th Avenue NW
---	200176	Waldorf Paper Products	2b	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	2236 Myrtle Ave
---	249007	Walton, Toni	2b	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	4453 Old Hwy 10
---	S00002	Midland Hills Country Club	2b	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	2001 N Fulham St
---	200076	Old Dutch Foods, Inc	2c	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	2375 Terminal Rd
---	236439	Waldorf Paper Products	2c	Q(B)	---	---	Q(B)	Q(B)	Well Inventory	---	2250 Wabash Ave

FY 2021 - FY 2025 Monitoring Plan for Groundwater Monitoring Wells

Well Information									Purpose For Monitoring(3)		
Unit	Well I.D.	Common Name	Notes	June 21	June 22	June 23	June 24	June 25	Water Quality	Water Level	Comments
General Notes:											
The next major sampling event for Well Inventory will be in June 2024 (conducted every 4 years)											
All of the Site I shallow groundwater wells were sealed in FY14.											

Appendix A.2
FY 2021 - FY 2025 Monitoring Plan for Remedial Treatment Systems

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 (Active Wells) [3]
Treatment System Influent	- Monthly	- Pumping Volumes
	- Monthly	- Water Quality (Active Wells) [3]
Treatment System Effluent	- Monthly	- Water Quality (Active Wells) [3]

Notes:

1. Performed by the City of New Brighton using their Sampling and Analysis Plan.
2. The required analyte list for each specific site is presented in Appendix A.4.
3. VOC List in Appendix A.4. 1,4-Dioxane samples to be collected and analyzed annually (June) at active extraction wells and Treatment System Effluent

Appendix A.3
FY 2020 - FY 2024 Monitoring Plan for Surface Water

Analysis	Analytical Method	Units	Site K Effluent (Outfall 010)	Site C Surface Water Locations (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			

Notes:
A = Annually in June
gal = Gallons
M = Measurement required once per month
mg/L = Milligram(s) per liter
Q = Analysis required once per quarter

Appendix A.4
Site-Specific Lists of Required Analytes

OU1 (DEEP GROUNDWATER) [1]	Cleanup Levels
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
1,4 Dioxane[7]	1

SITE A (SHALLOW GROUNDWATER) [2]	Cleanup Levels
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]	Cleanup Levels
Lead	15

SITE I (SHALLOW GROUNDWATER) [2]	Cleanup Levels
1,2-Dichloroethene (cis and trans)	70
Trichloroethene	30
Vinyl Chloride	0.2

BLDG 102 SHALLOW GROUNDWATER [4]	Cleanup Levels
Vinyl Chloride[5]	0.18
cis-1,2-Dichloroethene	70
Trichloroethene	5
1,1-Dichloroethene	6

SITE K (SHALLOW GROUNDWATER) [2]	Cleanup Levels
1,2-Dichloroethene (cis and trans)	70
Trichloroethene	30

OU2 (DEEP GROUNDWATER) [2]	Cleanup Levels
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
1,4 Dioxane[7]	1

OU3 (DEEP GROUNDWATER) [6]	Cleanup Levels
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)

Analytical Methods:
VOCs: SW-846 Method 8260C
Antimony & Lead: SW-846 Method 6020

Note: Cleanup Levels (in micrograms per liter [µg/L]) from each Record of Decision are shown above 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. 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.

(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.
(7) Value is the Minnesota Department of Health Health Risk Level. Not an official cleanup level.

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.

Michael R. Fix 15 FEB 2008
Twin Cities Army Ammunition Plant

Grant M. Wyffels 2/15/08
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

Monitoring Well Index

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WELL INDEX FOR NEW BRIGHTON/ARDEN HILLS SUPERFUND SITE

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 8.3×10^{-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 Northrop Grumman (Formerly Alliant Techsystems/Orbital ATK) 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 landowners. 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 2021 Appendix B Table B-1 shows the most current well index, and is sorted by Minnesota unique well number. 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.

To search for detailed records regarding a well, open the appropriate file within the Appendix B Attachment 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.

FY 2021 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.

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

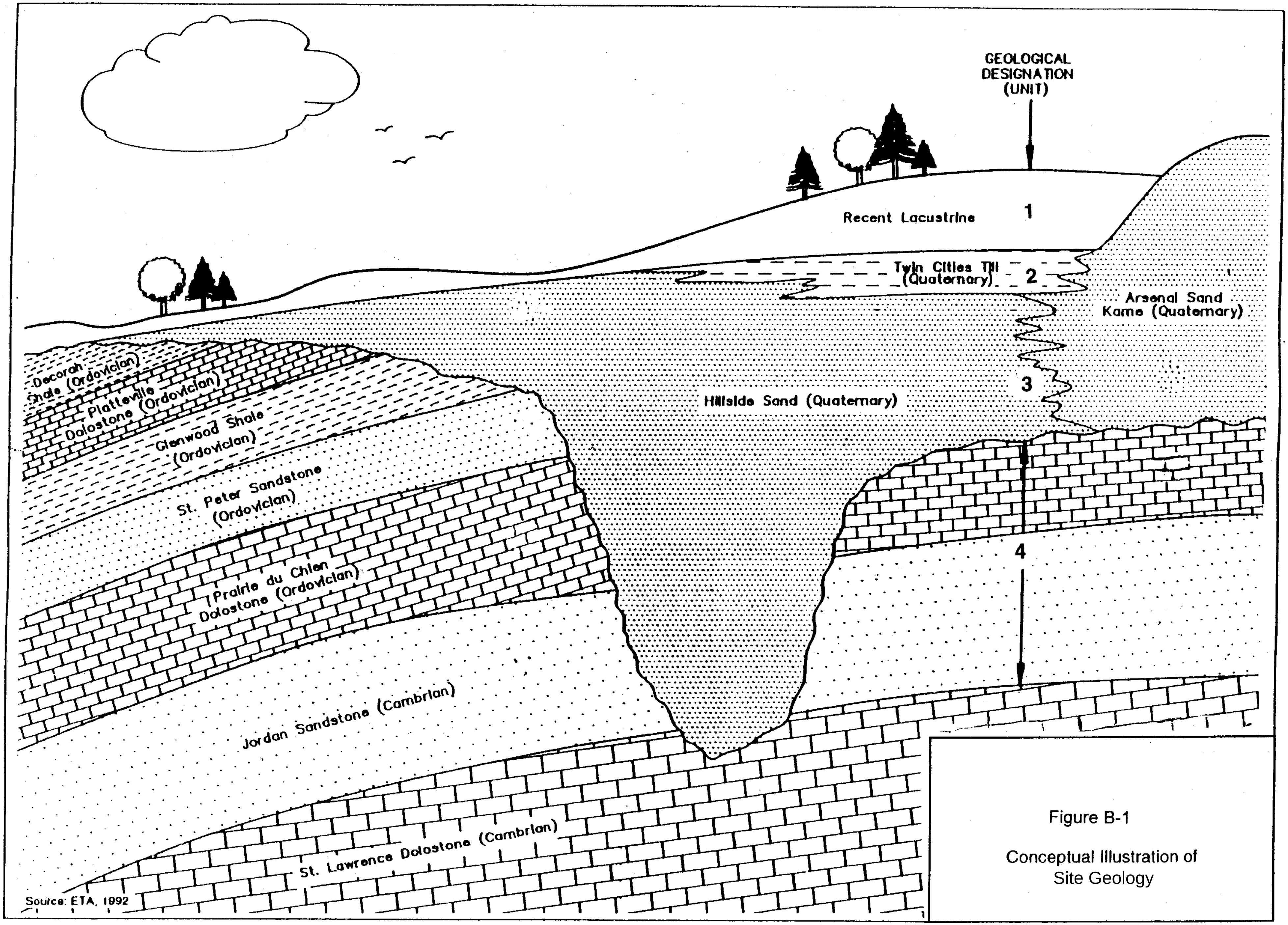
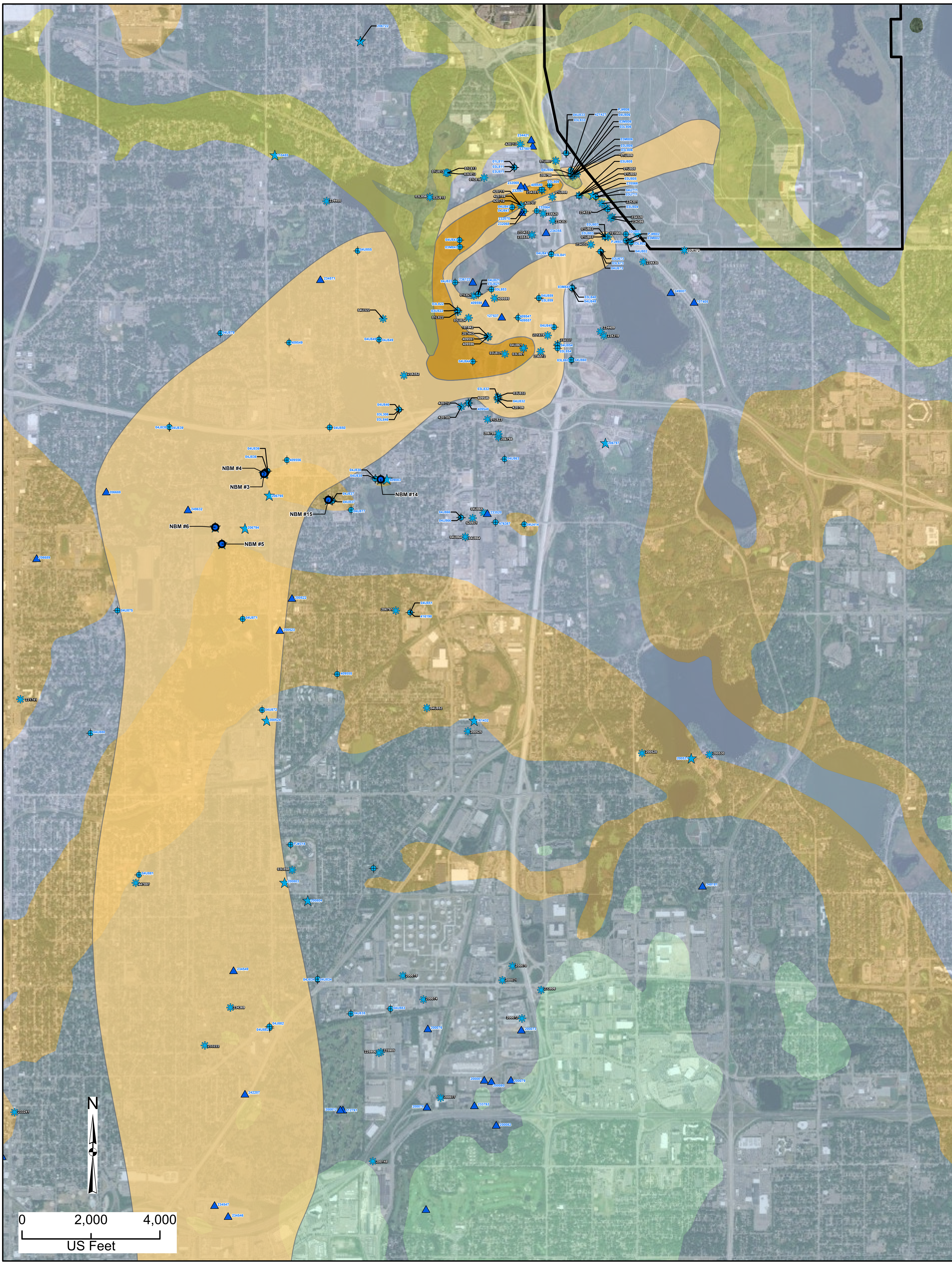
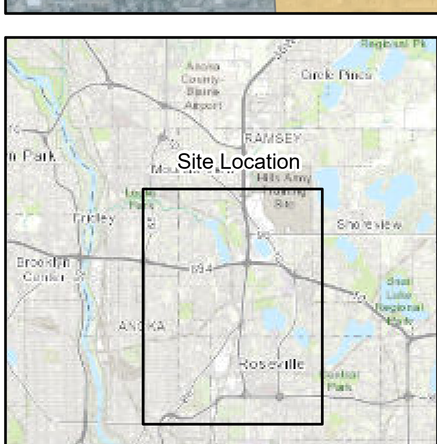


Figure B-1

Conceptual Illustration of Site Geology





Legend

- Monitoring Well
- Private Well
- Public Supply Well
- Sealed Well/Abandoned Well
- New Brighton Municipal Wells
- Operable Unit 2

2020 Trichloroethene Concentrations (μg/L)

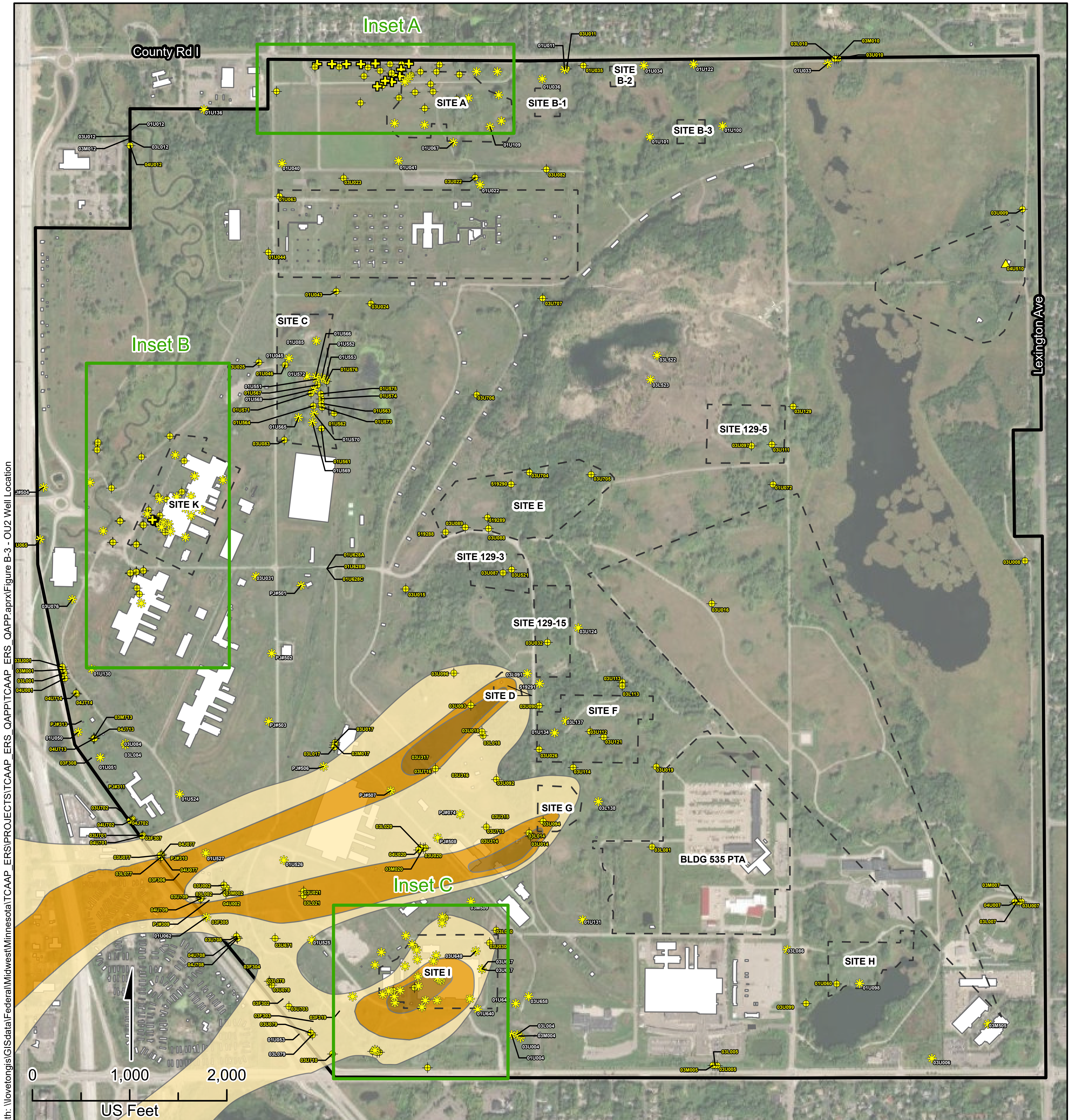
- 5-100 μg/L
- 100-1,000 μg/L

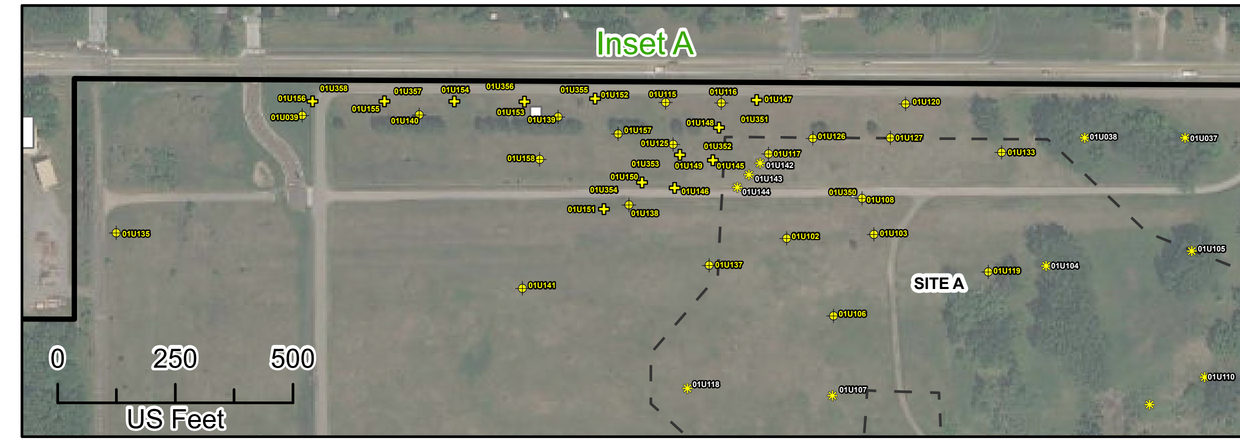
Bedrock Geology

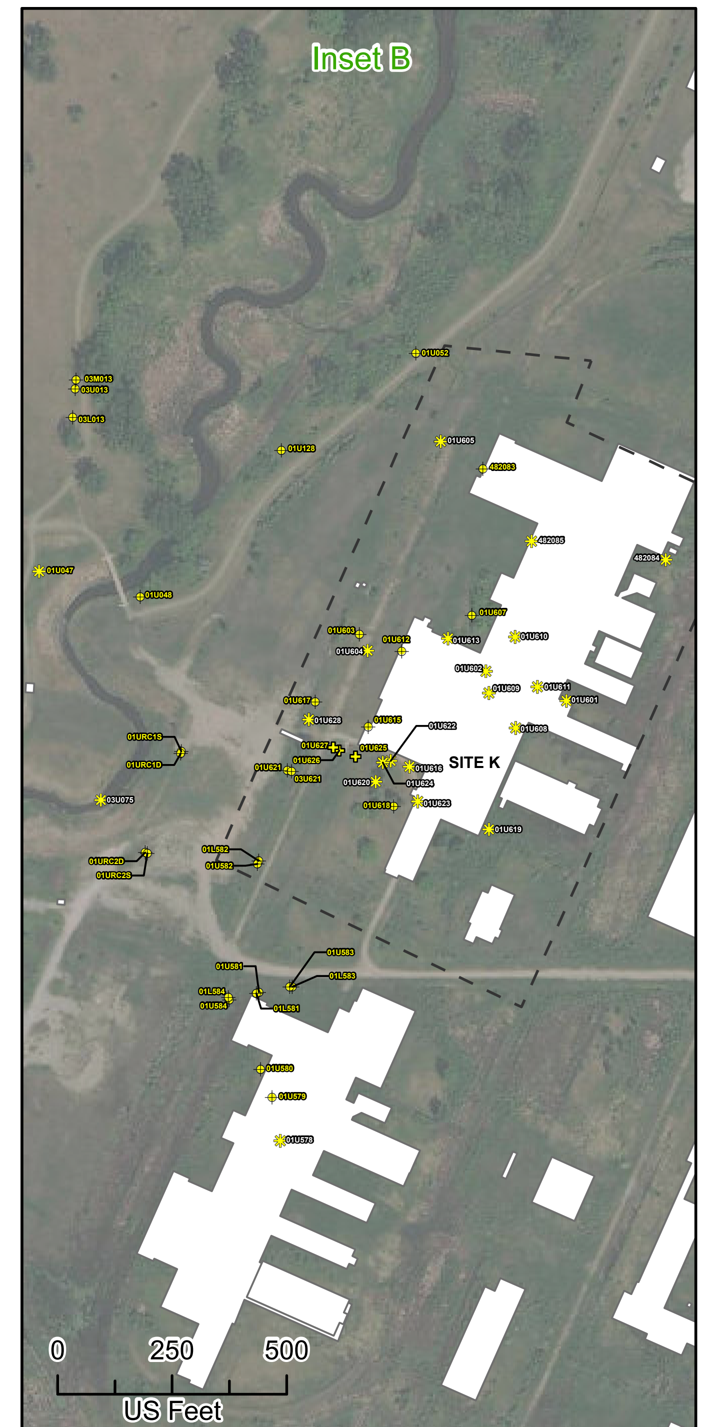
- Decorah Shale, Galena Group
- Platteville and Glenwood Fms
- St. Peter Sandstone
- Prairie du Chien Group
- Jordan Sandstone
- St. Lawrence Formation
- Tunnel City Group

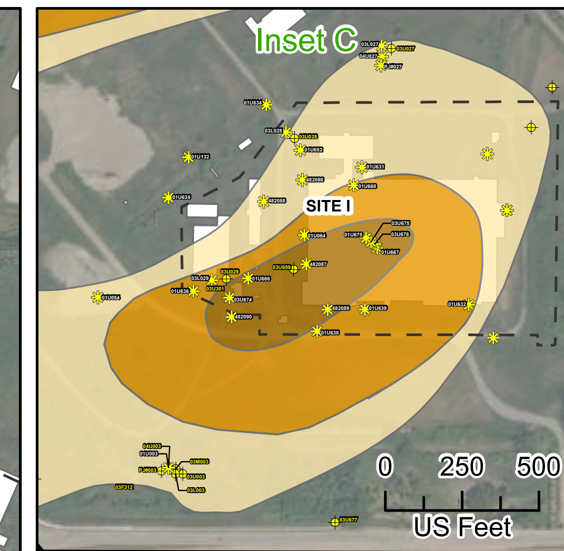
Figure B-2
Annual Performance Report
OU1 and OU3 Well Location
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 2/10/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx









Legend

- Monitoring Well
- Private Well
- Public Supply Well
- Piezometer
- Sealed Well/Abandoned Well

2021 Trichloroethene Concentrations (µg/L)

- 5-100 µg/L
- 100-1,000 µg/L
- 1,000+ µg/L

- Operable Unit 2
- Buildings
- Site Boundaries

Figure B-3
OU2 Well Location
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: \\voetonga\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx\Figure B-3 - OU2 Well Location

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Appendix C

Data Collection, Management, and Presentation

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DATA COLLECTION, MANAGEMENT, AND PRESENTATION

INTRODUCTION

A groundwater monitoring program was initiated in January 1984 to obtain water level and water quality data at Operable Unit (OU) 1, OU2 and OU3. Each year has been divided into quarters with each quarter assigned a number. Accordingly, FY 2021 was comprised of Quarter 149 (October through December), Quarter 150 (January through March), Quarter 151 (April through June), and Quarter 152 (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" (PIKA-Arcadis JV, Revision 18, 22 June 2020), which covers all sites.

Prior to 1 November 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 1 November 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.

GROUNDWATER LEVELS AND GROUNDWATER QUALITY

Data Collection and Management

Groundwater level and groundwater quality data were collected in accordance with the FY 2021 Annual Monitoring Plan (Appendix A), which established the monitoring responsibilities for both the Army and Northrop Grumman (formerly Orbital ATK). 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 2021 was therefore a minor sampling event. As of FY 2021, sampling only includes 1,4-dioxane analyses at OU1 and OU2 deep groundwater locations after determining it was not a chemical of concern (COC) at the Building 102 Site.

Water level monitoring and water sampling were conducted by JV for the Army and by GHD (formerly Conestoga-Rovers & Associates, Inc.) for Northrop Grumman (formerly Orbital ATK). Laboratory analysis for all sites was performed by Pace Analytical National Center for Testing & Innovation Laboratory, Mt Juliet, Tennessee. 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 COCs. 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 COC. Appendix C.2 presents deviations from the FY 2021 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 and validation was performed by GHD for both EA- and GHD-collected data. Data verification and validation information was compiled into quarterly Data Usability Reports (DURs) that were submitted to the Minnesota Pollution Control Agency (MCPA) and United States Environmental Protection Agency (EPA) for review. If any MPCA/EPA-requested revisions were necessary, a final DUR was resubmitted. The final MPCA/EPA approval letter has not yet been received for the FY 2021 Quarter 3 and 4 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).

Groundwater Elevation Contour Maps

The most extensive water level monitoring events performed during FY 2021 were in June (Quarter 151) and in September (Quarter 152). 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, and 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.

Groundwater Quality Contour Maps and Cross-Sections

The most extensive sampling events performed during FY 2021 were in June (Quarter 151) and in September (Quarter 152). These 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 Sites A, C, and 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 corresponding 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 COCs 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. A second 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; however, they 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 COC 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 COC 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 COC 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 COC 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. 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.

DEVIATIONS FROM MONITORING PROGRAM

DEEP GROUNDWATER VOC SITES

As of FY 2021, 1,4-dioxane is considered a COC for OU1 and OU2 deep groundwater; monitoring for 1,4-dioxane has been discontinued at all other sites.

OU1: DEEP GROUNDWATER

September 2021:
03U811: Well was noted as abandoned and sealed, not sampled.
04J847: Property owner did not grant access for monitoring.

OU2: SITE A SHALLOW GROUNDWATER

September 2021:
01U350: Sampled as an alternative to well 01U108, which was sealed in 2020.

OU2: SITE C SHALLOW GROUNDWATER

No deviations.

OU2: SITE C SURFACE WATER

No deviations.

OU2: BUILDING 102 SHALLOW GROUNDWATER

All Wells: Sample VOCs; as per the 2020 QAPP (rev18) update, the project laboratory could not provide reporting limits as low as the Building 102 cleanup level.

OU2: SITE K SHALLOW GROUNDWATER

September 2021:
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.

OU2: SITE I SHALLOW GROUNDWATER

June 2020:
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 Database

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COMPREHENSIVE GROUNDWATER QUALITY AND GROUNDWATER LEVEL DATABASES

The historical groundwater databases are located on this CD in a folder named Appendix D.1.

This folder contains four Microsoft Excel files:

Compelev_FY21 Groundwater elevations

Comporwq_FY21 Groundwater quality: organic data

Compinwq_FY21 Groundwater quality: inorganic data (excluding Site C)

Site C wq_FY21 Groundwater quality: inorganic data (Site C only)

STATISTICAL EVALUATIONS – WELL GROUPS

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

GROUP 3 ** – DOWNGRADIENT SENTINEL

04U871	04U875	04U851	

GROUP 4 – LATERAL SENTINEL

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

GROUP 5 – GLOBAL PLUME

04J077	04U702	04U848	04U877
04J702	04U709	04U851	04U879
04J708	04U711	04U852 abandoned	04U880
04J713	04U713	04U855	04U881
04J834	04U802	04U859	04U882
04J864 abandoned	04U806	04U860	200154

04J866	04U832	04U861 abandoned	234546
04J882	04U833	04U863	234549 out of service
04U002	04U834	04U864 abandoned	409547
04U020	04U841	04U865 abandoned	409548
04U027abandoned	04U843	04U866	409549
04U077	04U844	04U871	409555
04U673	04U845	04U872	512761
04U701	04U846	04U875	PJ#318

GROUP 5 UNIT 3 WELLS (EVALUATED AS INDIVIDUAL TRENDS)

03L822	03U821	03U822	03L822
409550	409596 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.

Table D-2-1 Mann-Kendall Decision Matrix

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

Table D-2-2 Response Thresholds By Group

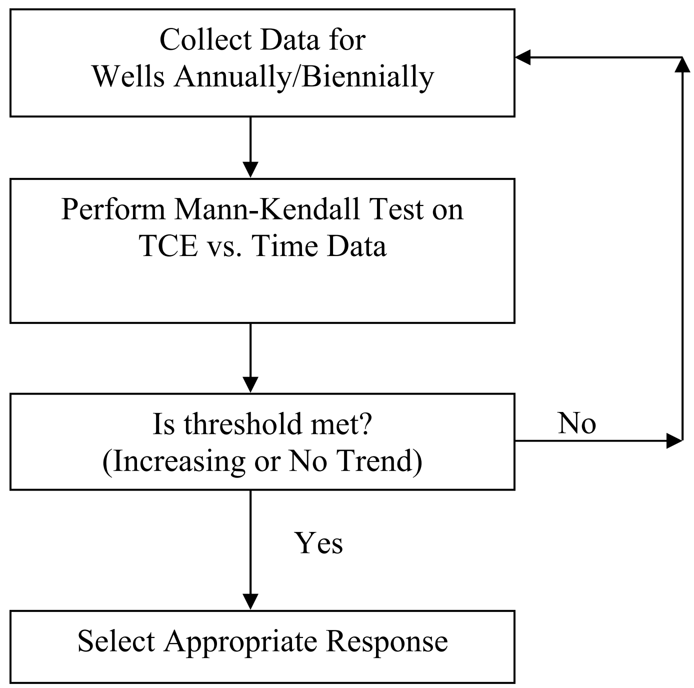
Well Group	Purpose	Measure	Time Window/ Monitoring Frequency	Test	Response Threshold
Group 1	AWC Immediately Downgradient of TGRS	AWC Trend	6 years/annual	Mann-Kendall	Stable, Increasing, or No Trend
Group 2	Defining Plume Size (Low Concentration Edges)	Individual Well Trend for TCE	12 years/biennial	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

Notes:

A Response Threshold is the test result(s) that triggers further response. See text for additional explanation of response process.

AWC = Area-Weighted Concentration

EVALUATION PROCESS



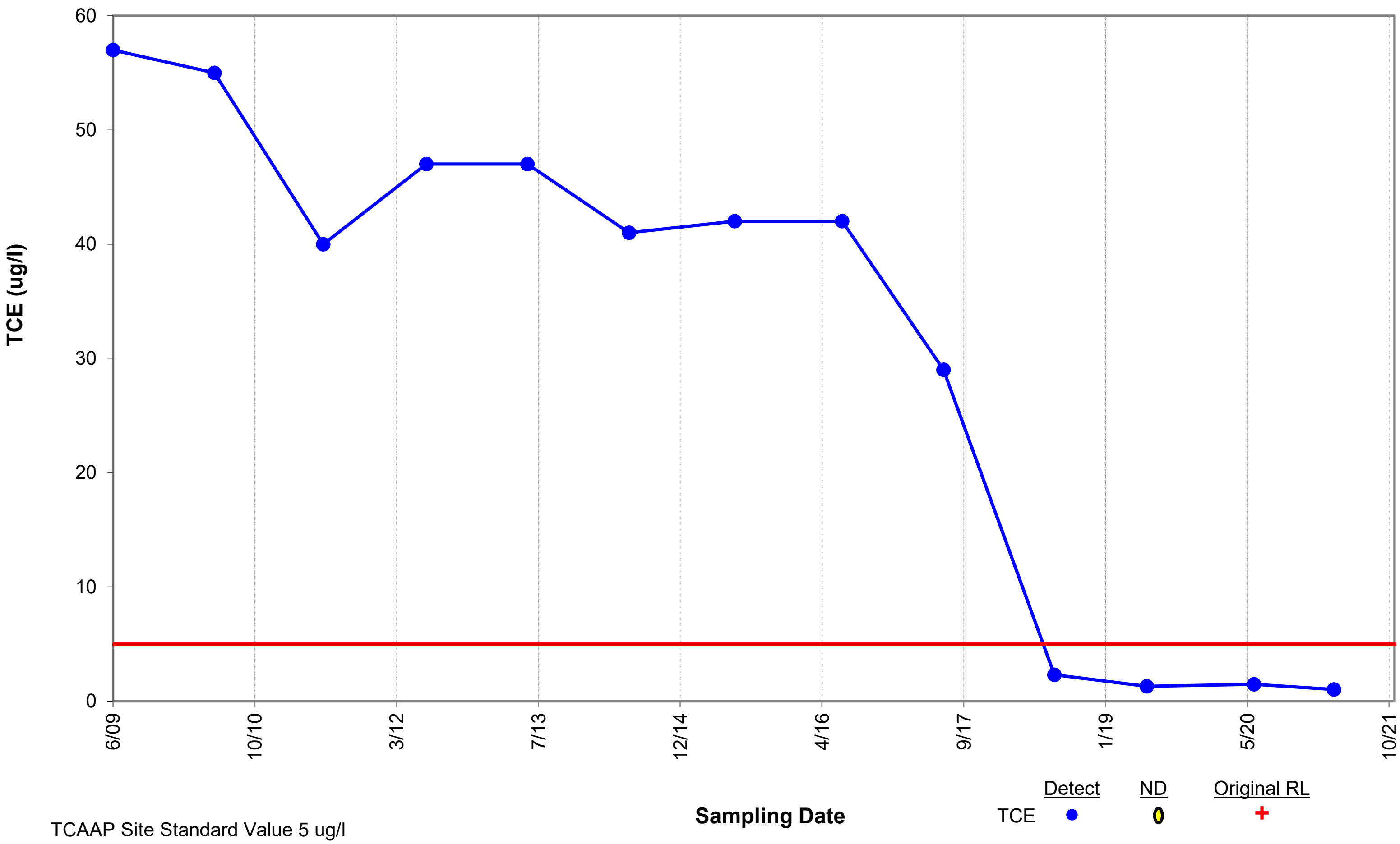
RESPONSES TO THRESHOLD INDICATORS

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.



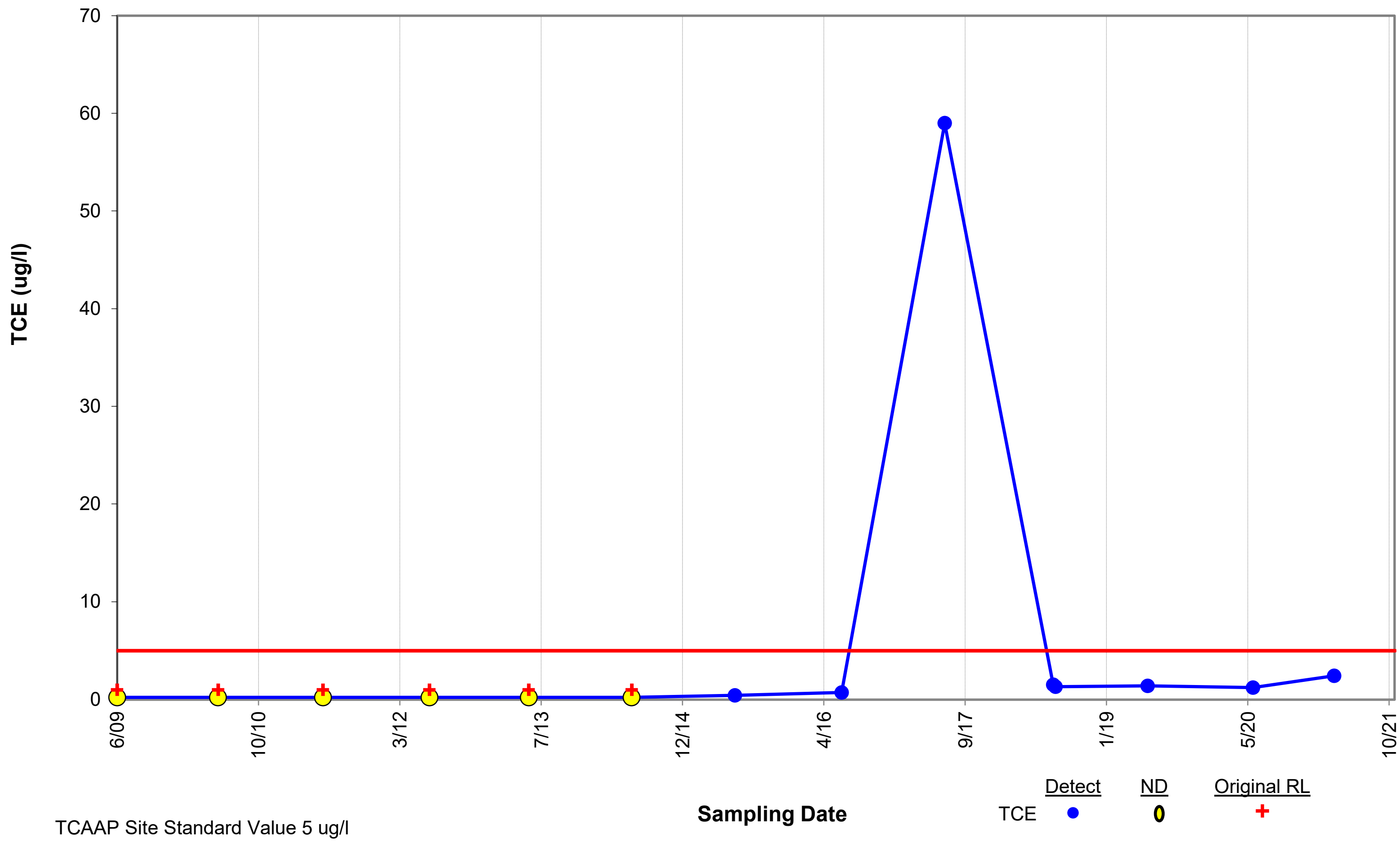
Mann-Kendall Test Result: DECREASING TREND

S =	-60
two-tailed p-value =	<0.05
Trend =	Decreasing

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend).

Concentration vs. Time Plot – TCE in Well 04J822
Twin Cities Army Ammunition Plant

Figure D-2-1



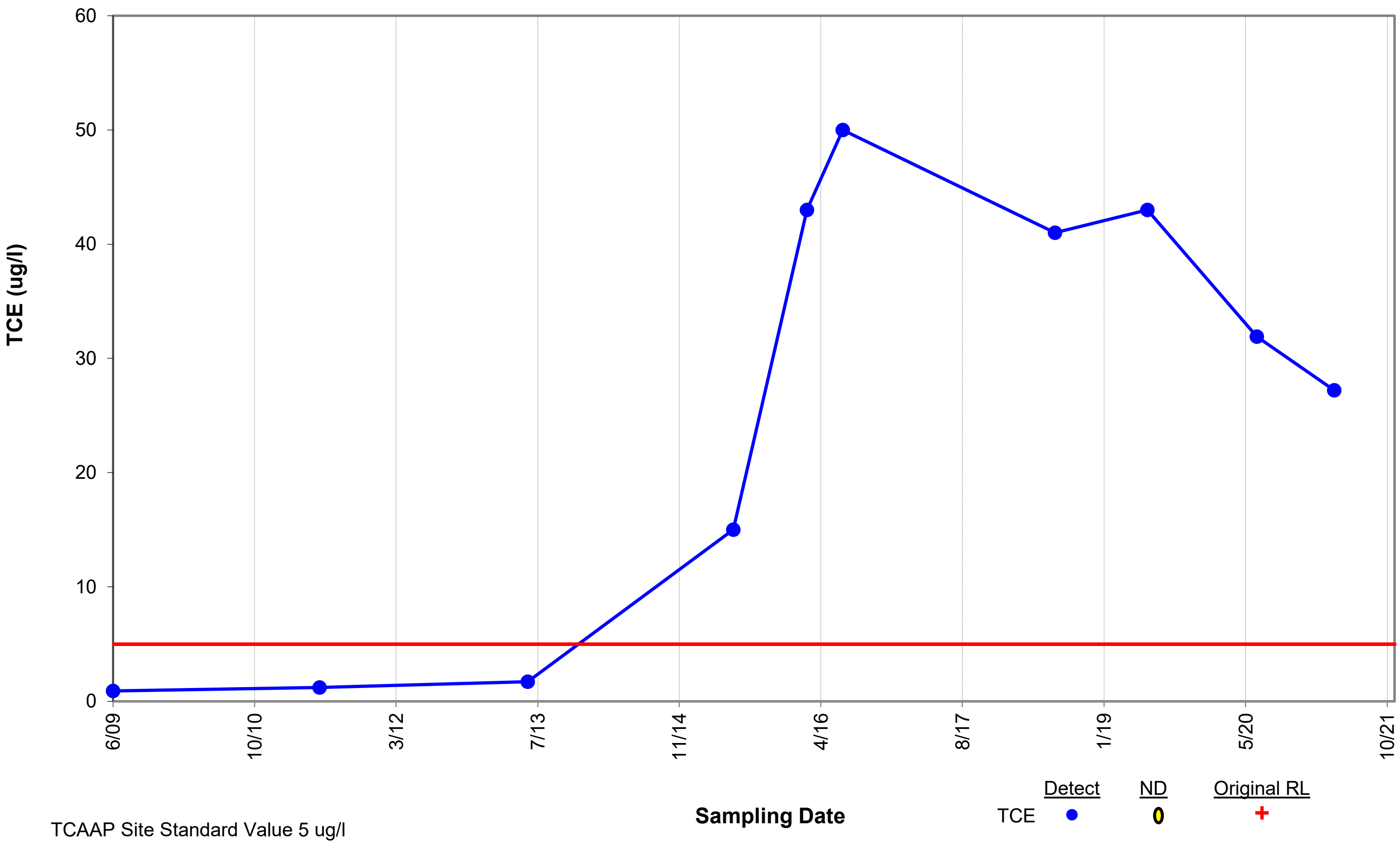
Mann-Kendall Test Result: **INCREASING TREND**

S =	50
two-tailed p-value =	<0.05
Trend =	Increasing

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend).

Concentration vs. Time Plot – TCE in Well 04J849
Twin Cities Army Ammunition Plant

Figure D-2-2



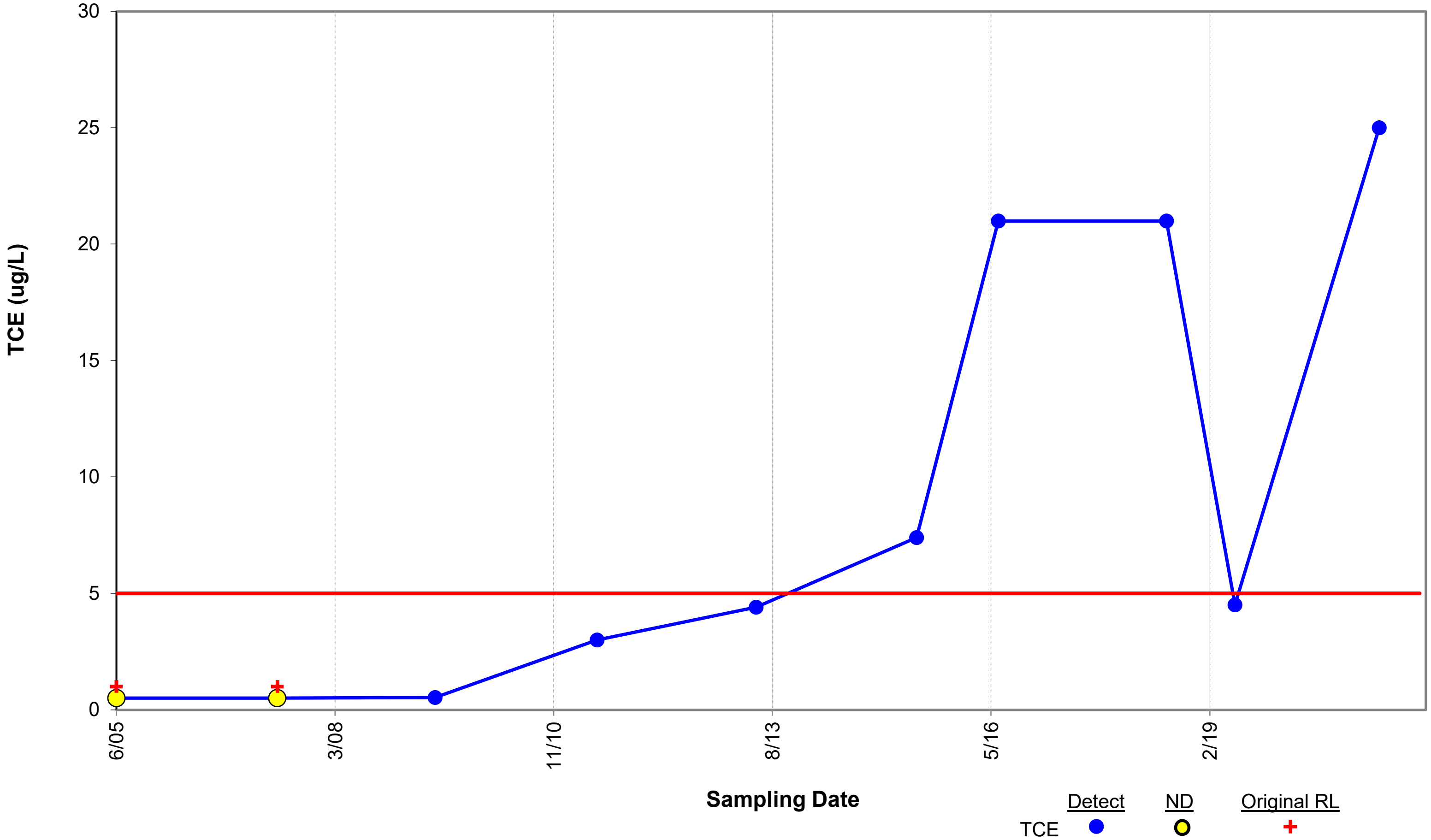
Mann-Kendall Test Result: **INCREASING TREND**

S =	18
two-tailed p-value =	<0.1
Trend =	Increasing

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend).

Concentration vs. Time Plot – TCE in Well 04U839
Twin Cities Army Ammunition Plant

Figure D-2-3



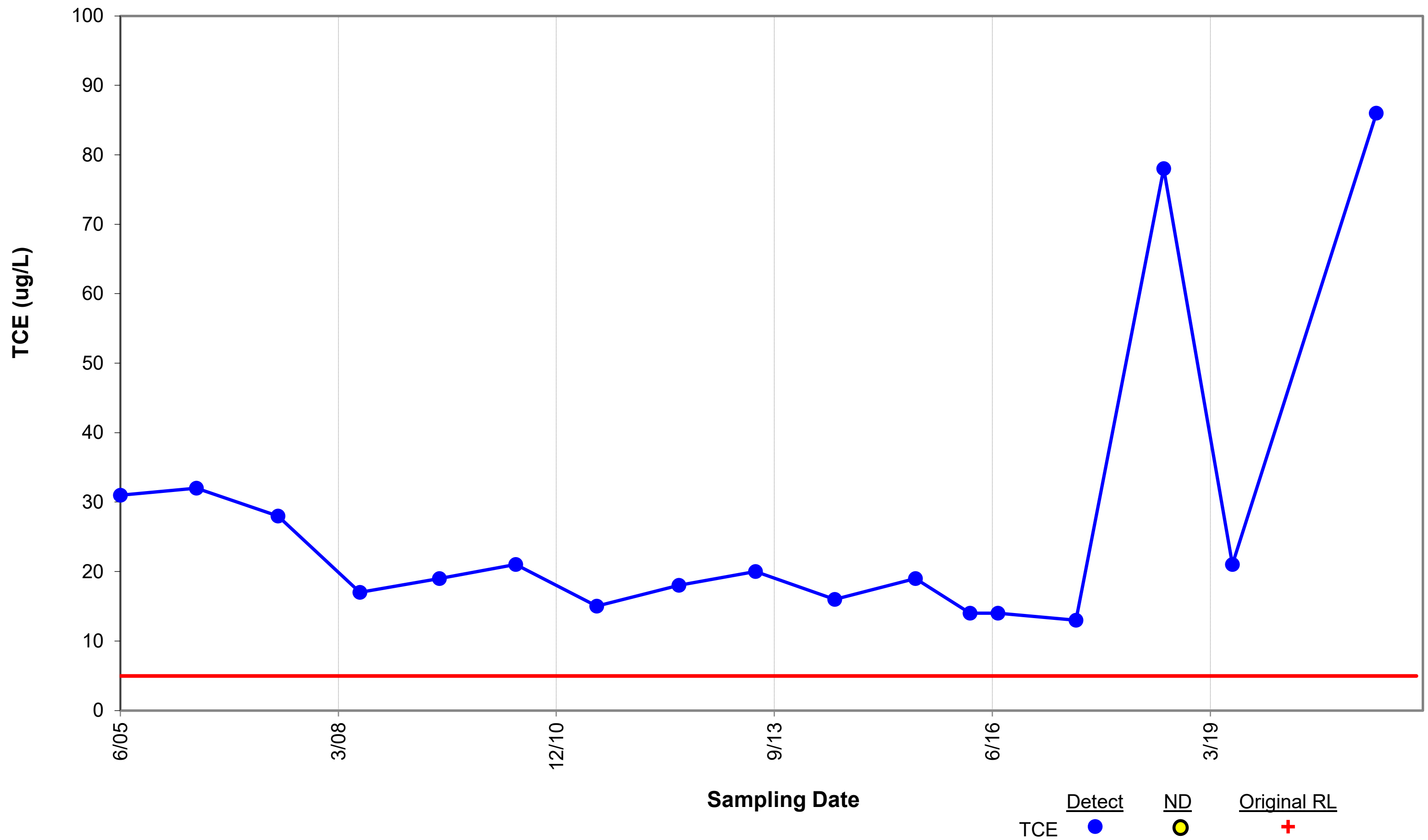
Mann-Kendall Test Result: **INCREASING TREND**

S =	29
two-tailed p-value =	<0.05
Trend =	Increasing

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend).

Concentration vs. Time Plot – TCE in Well 04U855
Twin Cities Army Ammunitions Plant

Figure D-2-4



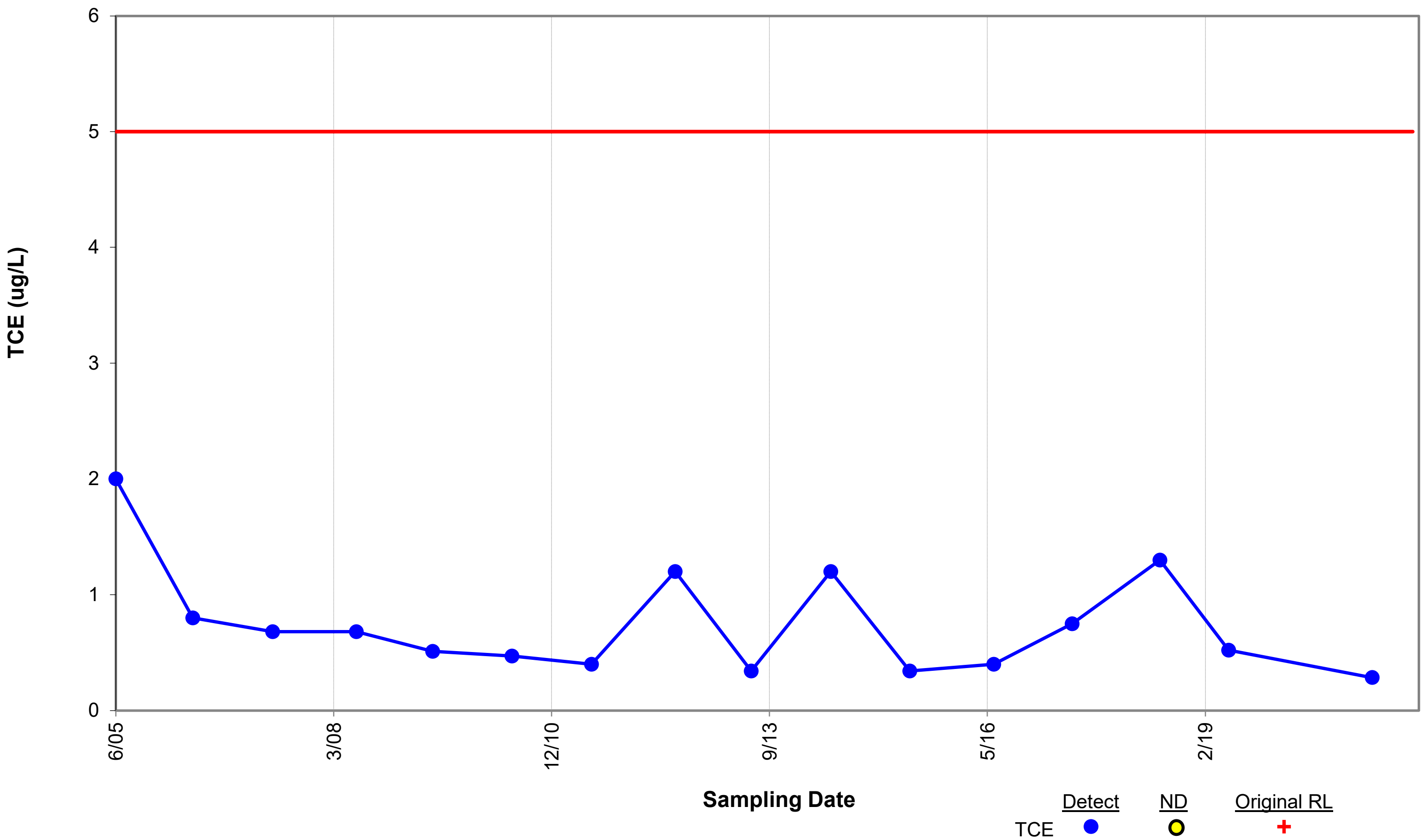
Mann-Kendall Test Result: No Significant Trend

S =	2
two-tailed p-value =	0.95
Trend =	None

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend).

Concentration vs. Time Plot – TCE in Well 04U871
Twin Cities Army Ammunitions Plant

Figure D-2-5



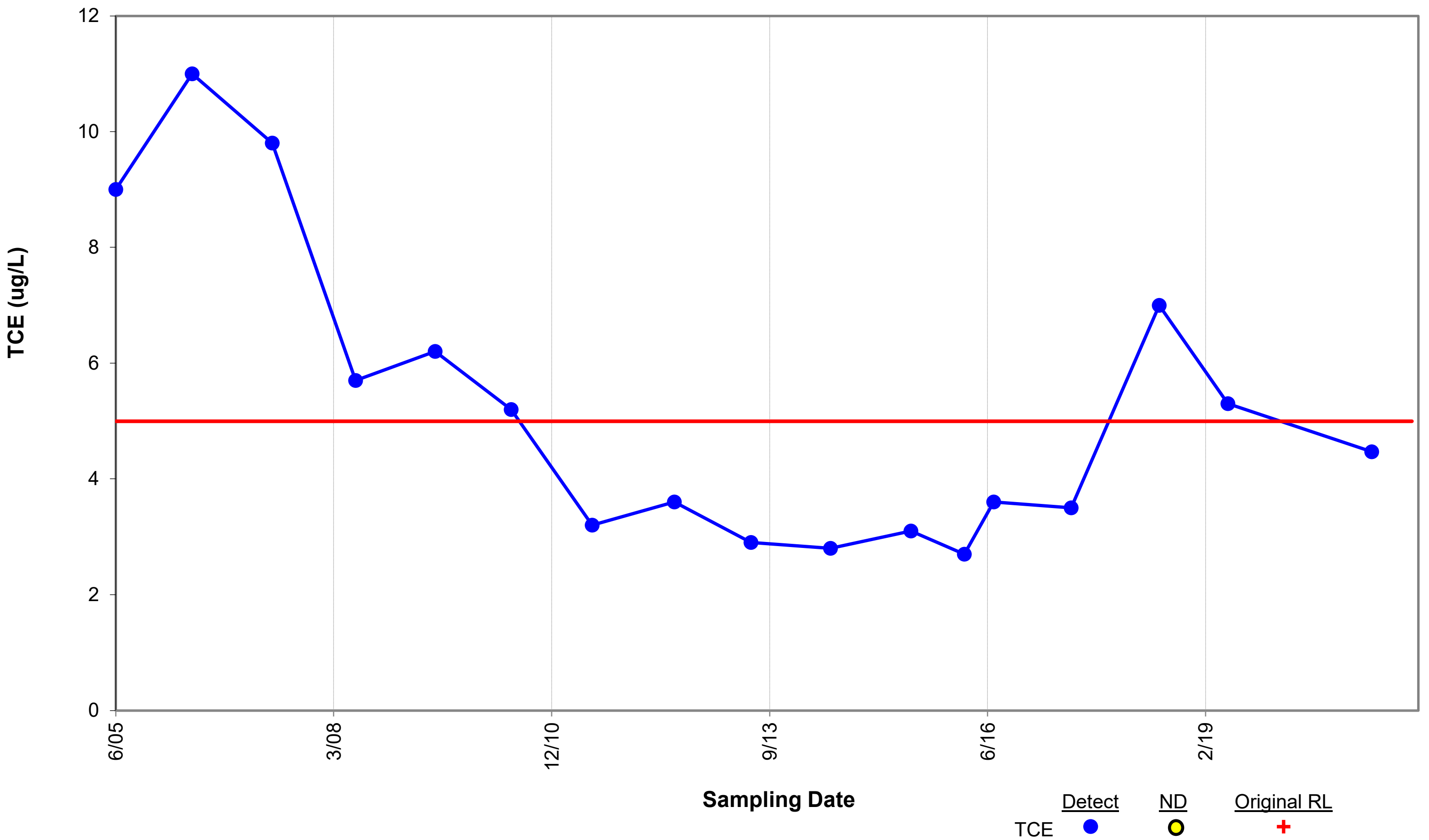
Mann-Kendall Test Result: **No Significant Trend**

S =	-7
two-tailed p-value =	0.72
Trend =	None

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend).

Concentration vs. Time Plot – TCE in Well 04U877
Twin Cities Army Ammunitions Plant

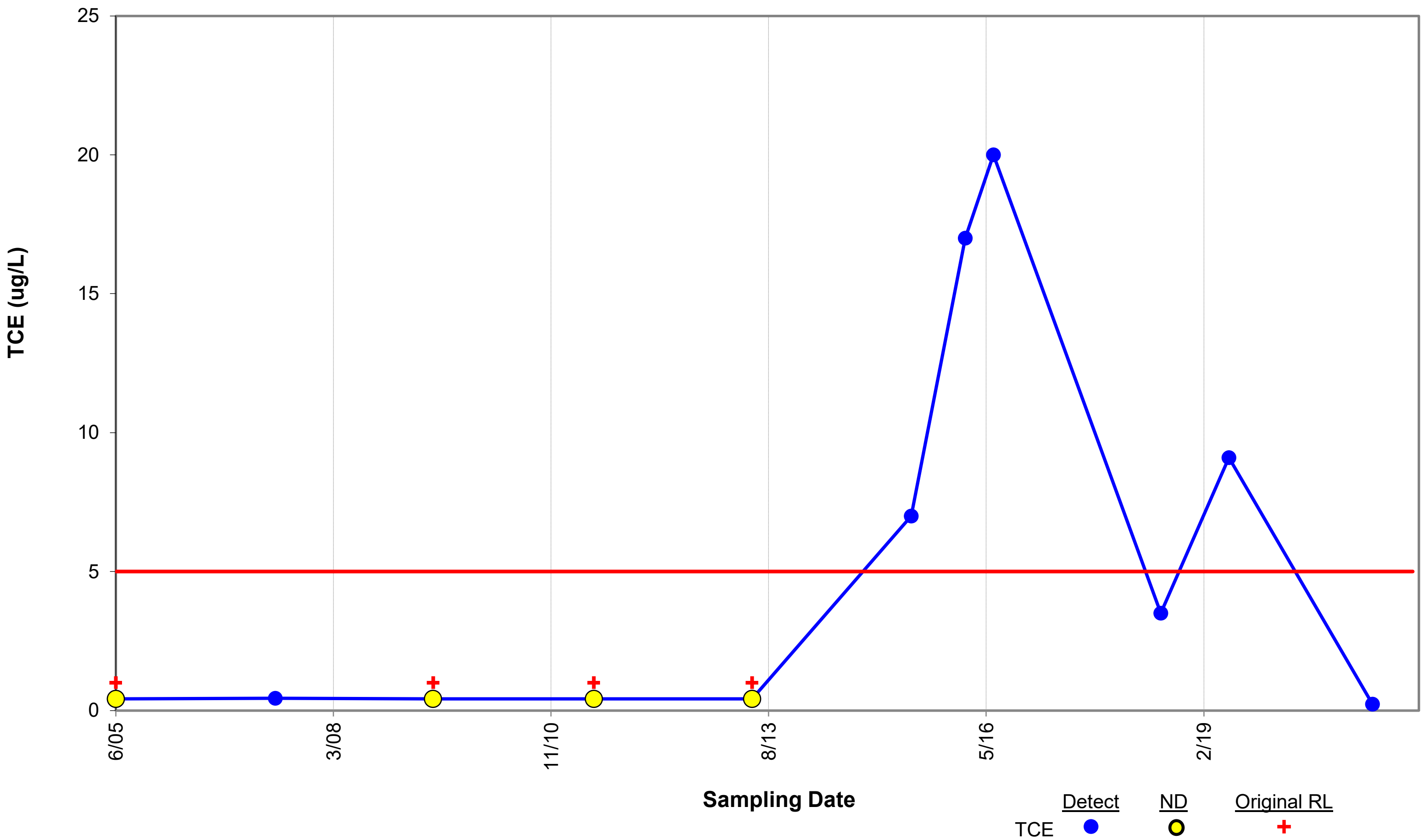
Figure D-2-6



Mann-Kendall Test Result:	**No Significant Trend**	
S =	14	
two-tailed p-value =	0.44	H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend).
Trend =	None	

Concentration vs. Time Plot – TCE in Well 04U872
Twin Cities Army Ammunitions Plant

Figure D-2-7



Mann-Kendall Test Result: No Significant Trend

S =	9
two-tailed p-value =	0.41
Trend =	None

H0: No Trend vs. H1: Up Or Down Trend. (Note: A p-value < 0.05 indicates a statistically significant trend).

Concentration vs. Time Plot – TCE in Well 04U879
Twin Cities Army Ammunitions Plant

Figure D-2-8

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Appendix E

Well Survey

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FY 2021 ANNUAL PERFORMANCE REPORT

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)
- 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 2021 UPDATE

The updated MDH database was provided to EA on 7 January 2022. 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 1 October 2020 and 30 September 2021. Due to the later sampling date for FY 2021, further investigative efforts have not yet commenced for these wells. When initiated, investigation will primarily focus 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. All seven wells identified within the study area classified as environmental wells and placed 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 are potentially located within the area of concern and that the MDH identified as having a change in status from active or inactive to sealed will be further investigated for confirmation of their sealed status. There were 22 wells disclosed during FY21 that are located within the study area. Of the 22 wells disclosed, 15 were categorized as 7b (undocumented as sealed or improperly abandoned). Five wells were categorized as 4b (unknown location potentially within the Study Area), pending further investigation. Three wells -522737, H000332469, and H000339465 - were already present on the Well Inventory Database and previously categorized as 6 (522737) or 7a (H000332469 and H000339465). Ownership information of these wells were updated, and they were recategorized as 4b until current status is determined.

Sealed wells were found by reviewing the MDH sealed well list. The 72 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 2021 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 2024.

Information contained in Tables E-2 through E-4 has been updated in the well inventory database, provided as an Excel file "Well Inventory Main Database FY 2021."

Table E-1 Well Inventory Category Descriptions

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 or 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
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 MDH Constructed Wells FY21

Unique Number	Category	Last Name or Business Name	Street	City	Use	Depth	Date Drilled
773090	6	US Army	N/A	N/A	Environmental Well	7	5/25/2021
773092	6	US Army	N/A	N/A	Environmental Well	7	5/25/2021
841082	6	Hawkins, Inc.	3100 E Hennepin Avenue	Minneapolis	Environmental Well	25	6/17/2021
847568	6	Determan, LLP	1241 72nd Avenue NE	Fridley	Environmental Well	18	10/22/2020
850987	6	Wall Development Co.	495 Malcolm Avenue SE	Minneapolis	Environmental Well	480	4/1/2021
850988	6	Wall Development Co.	699 29th Avenue SE	Minneapolis	Environmental Well	460	3/31/2021
850989	6	Wall Development Co.	700 29th Avenue SE	Minneapolis	Environmental Well	460	3/29/2021

Notes:
MDH = Minnesota Department of Health

Table E-3 MDH Disclosed Wells FY21

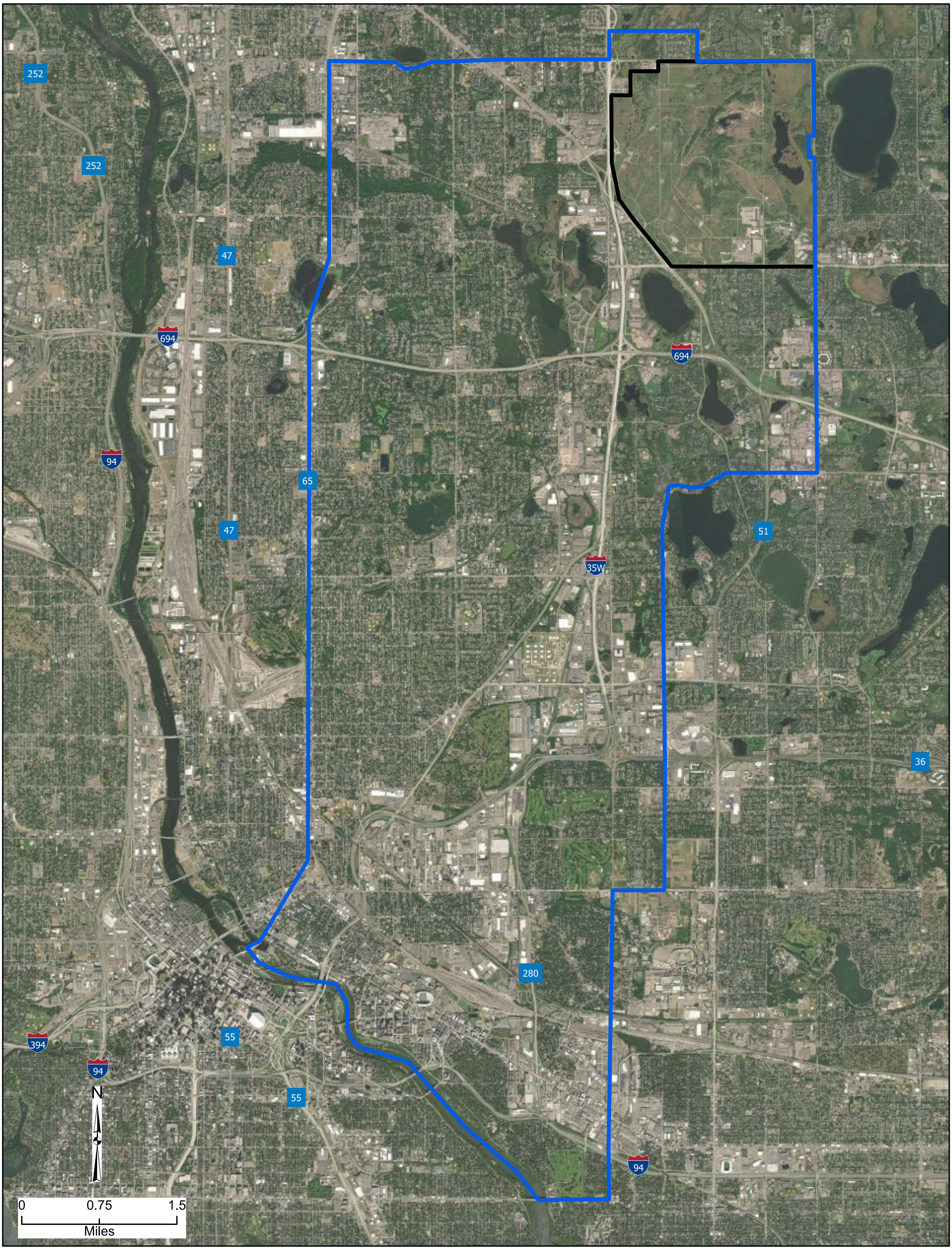
Unique Number	Category	Last Name or Business Name	Street	City	Status	Date Completed	Depth	Date Drilled
522737	4b	205 5th Avenue, LLC	205 Fifth Avenue NW	New Brighton	In Use	11/30/2020	N/A	N/A
H000163097	7b	CTW Group, Inc.	1768 Tatum Street	Falcon Heights	Sealed	4/28/2021	N/A	N/A
H000332469	7a	Braur	1705 Rose Place N	Roseville	Sealed	3/31/2021	N/A	N/A
H000339465	7b	Beach	1957 Rice Creek Road	New Brighton	Sealed	3/17/2021	N/A	N/A
UNK0585158	7b	Korkiattikan	1875 Glenpaul Avenue	Arden Hills	Sealed	10/16/2020	N/A	N/A
UNK0585213	7b	Bond	1144 Long Lake Road	New Brighton	Sealed	10/19/2020	N/A	N/A
UNK0586320	7b	Strobush	2500 Woodcrest Drive	Mounds View	Sealed	11/23/2020	N/A	N/A
UNK0586341	7b	Perucco	2807 Valley View Lane	New Brighton	Sealed	11/23/2020	N/A	N/A
UNK0586573	7b	Zimmerman	1843 Polk Street NE	Minneapolis	Sealed	12/1/2020	N/A	N/A
UNK0587781	7b	Robert Mark Management Group, LLC	1151 Tenth Street NW	New Brighton	Sealed	1/8/2021	N/A	N/A
UNK0588770	7b	Strand	2470 Clearview Avenue	Mounds View	Sealed	2/12/2021	N/A	N/A
UNK0589970	4b	Yang	298 67th Avenue NE	Fridley	Not In Use	3/25/2021	N/A	N/A
UNK0591091	7b	Clearscape Holding, LLC	175 Old Highway 8	New Brighton	Sealed	5/7/2021	N/A	N/A
UNK0591092	7b	Clearscape Holding, LLC	175 Old Highway 8	New Brighton	Sealed	5/7/2021	N/A	N/A
UNK0591093	7b	Clearscape Holding, LLC	175 Old Highway 8	New Brighton	Sealed	5/7/2021	N/A	N/A
UNK0591151	4b	Cash for Houses, Inc.	3007 Fairview Avenue N	Roseville	Not In Use	5/10/2021	N/A	N/A
UNK0591176	7b	APD Building, LLC	2341 St. Croix Street	Roseville	Sealed	5/11/2021	N/A	N/A
UNK0591267	4b	Ibiza, LLC	2221 Seventh Street NW	New Brighton	Not In Use	5/13/2021	N/A	N/A
UNK0591936	7b	Leavy	4625 2½ Street NE	Fridley	Sealed	6/8/2021	N/A	N/A
UNK0592024	4b	Krinke	2909 Troseth Road	Roseville	In Use	6/10/2021	N/A	N/A
UNK0593172	7b	Sanborn	1890 Tatum Street	Falcon Heights	Sealed	7/12/2021	N/A	N/A
UNK0594305	4b	Frederickson	1357 Floral Drive W	Arden Hills	Not In Use	8/12/2021	N/A	N/A

Table E-4 MDH Sealed Wells FY21

Unique Number	Category	Last Name or Business Name	Street	City	Use	Date Sealed
256787	7a	Wall Development Co.	525 Malcolm Avenue SE	Minneapolis	Water Supply	11/20/2020
0000424055	7a	US Army Command	2200 Old Highway 8 NW	New Brighton	WMEW	11/23/2020
0000426808	7a	US Army Command	2200 Old Highway 8 NW	New Brighton	WMEW	11/23/2020
0000426809	7a	US Army Command	2200 Old Highway 8 NW	New Brighton	WMEW	11/23/2020
0000473404	7a	Beach	2251 Long Lake Road	New Brighton	WMEW	10/20/2020
0000473405	7a	Beach	2251 Long Lake Road	New Brighton	WMEW	10/20/2020
0000473406	7a	Beach	2251 Long Lake Road	New Brighton	WMEW	10/20/2020
0000498006	7a	Beach	2251 Long Lake Road	New Brighton	WMEW	10/20/2020
0000799338	7a	U of Minnesota Environmental Health and Safety	1701 Sixth Street SE	Minneapolis	WMEW	7/1/2021
0000821414	7a	Tomas	2501 Lowry Avenue NE	St. Anthony	WMEW	12/29/2020
0000821415	7a	Tomas	2501 Lowry Avenue NE	St. Anthony	WMEW	12/29/2020
0000821416	7a	Tomas	2501 Lowry Avenue NE	St. Anthony	WMEW	12/29/2020
H000333868	7a	Walton	825 41 Avenue	Columbia Heights	Env. Boring	3/12/2021
H000364123	7a	MN DOT	N/A	N/A	WMEW	3/3/2021
H000366918	7a	Development 65	2501 Ne Lowry Avenue	St. Anthony	WMTB	1/7/2021
H000367198	7a	Carpio	1108 45th Avenue	Columbia Heights	Water Supply	10/2/2020
H000367428	7a	Welsh Construction	2501 Fairview Avenue N	Roseville	WMTB	6/24/2021
H000373967	7a	Terracon Consultants	N/A	Columbia Heights	WMEW	10/28/2020
H000374449	7a	Zawadski Homes	460 W Shore Court	Shoreview	Water Supply	12/9/2020
H000374864	7a	Town and Country Club	300 Mississippi Boulevard	St. Paul	Env. Boring	12/21/2020
H000376246	7a	MTM	2063 Marshall Avenue	St. Paul	Env. Boring	3/30/2021
H000376247	7a	MTM	2069 Marshall Avenue	St. Paul	Env. Boring	3/30/2021
H000376906	7a	Reilley	7660 Spring Lake Road	Mounds View	Water Supply	4/9/2021
H000376908	7a	Tschida	1888 County Road C2 W	Roseville	Water Supply	4/20/2021
H000376909	7a	Israelson	4625 2½ Street NE	Fridley	Water Supply	4/20/2021
H000377064	7a	City of Fridley	N/A	Fridley	WMEW	10/20/2020
H000377417	7a	Columbia Heights Economic Development Authority	950 40Th Avenue NE	Columbia Heights	Other	10/2/2020
H000377784	7a	Workshop Vandalia Owner, LLC	550 Vandalia Street	St. Paul	WMEW	10/5/2020
H000379194	7a	Keck	1766 St. Marys Street St.	St. Paul	Water Supply	11/11/2020
H000379195	7a	Richards	1776 St. Marys Street	St. Paul	Water Supply	10/28/2020
H000379511	7a	Witt	1900 Tatum Street	Falcon Heights	Water Supply	10/23/2020
H000379529	7a	Sanford	3731 New Brighton Road	Arden Hills	Water Supply	2/21/2021
H000380381	7a	Hegvik	6125 Woody Lane	Fridley	Water Supply	10/26/2020
H000380415	7a	Kisch	1620 Onondaga Street NE	Fridley	Water Supply	5/26/2021
H000380512	7a	VKO Enterprises	953 Westgate Drive	St. Paul	WMEW	11/20/2020
H000380789	7a	Taylor	2221 Seventh Street NW	New Brighton	Water Supply	5/7/2021
H000380952	7a	Smith	6600 Central Avenue NE	Fridley	Water Supply	11/6/2020

Table E-4 MDH Sealed Wells FY21

Unique Number	Category	Last Name or Business Name	Street	City	Use	Date Sealed
H000381356	7a	Yackel	1473 Onondaga Street NE	Fridley	Water Supply	6/21/2021
H000381386	7a	Sandberg	1698 Oakwood Drive	Shoreview	Water Supply	10/14/2020
H000381401	7a	Sandberg	1698 Oakwood Drive	Shoreview	Water Supply	10/14/2020
H000381431	7a	Buckley	2807 Valley View Lane	New Brighton	Water Supply	11/13/2020
H000381450	7a	Hayden	1906 Jerrold Avenue	Arden Hills	Water Supply	11/25/2020
H000381516	7a	Huber	1934 Jerrold Avenue	Hills	Water Supply	1/20/2021
H000381587	7a	Mortinsen	6774 Channel Road	Fridley	Water Supply	3/29/2021
H000381630	7a	Valentine	1411 First Avenue NW	New Brighton	Env. Boring	3/12/2021
H000381749	7a	Caribou Cabin, LLC	6290 Highway 65 NE	Fridley	WMEW	11/12/2020
H000381951	7a	Beach	2251 Long Lake Road	New Brighton	WMEW	10/21/2020
H000381952	7a	Beach	2251 Long Lake Road	New Brighton	WMEW	10/21/2020
H000382828	7a	Clearscapes Holdings, LLC	175 Old Highway 8	New Brighton	Env. Boring	3/8/2021
H000382989	7a	Hosler	1724 Lake Valentine Road	Arden Hills	Water Supply	4/21/2021
H000383018	7a	Wellington Management, Inc.	792 Curfew Street	St. Paul	Env. Boring	3/9/2021
H000383068	7a	City of St. Paul Sewer	2230 Energy Park Drive	St. Paul	Env. Boring	4/15/2021
H000383432	7a	607 Holdings, LLC	607 22 Avenue	Minneapolis	Other	3/16/2021
H000383433	7a	University of Minnesota	51 E River Road	Road Minneapolis	Other	3/11/2021
H000383626	7a	Trident Development, LLC	1700 Highway 96	Arden Hills	WMTB	2/18/2021
H000383726	7a	City of New Brighton	700 Fifth Street NW	New Brighton	WMEW	2/3/2021
H000383749	7a	Bona	2931 Partridge Road	Roseville	WMEW	2/4/2021
H000383816	7a	Village Bank	2636 University Avenue NE	Minneapolis	WMTB	3/29/2021
H000383833	7a	Dobratz	2350 Territorial Road	St. Paul	WMTB	4/7/2021
H000383835	7a	GIJV MN2 LLC	2100 Old Highway 8 N	New Brighton	WMTB	4/8/2021
H000383837	7a	Vieau Assoc.	2805 Long Lake Road	St. Paul	Env. Boring	4/8/2021
H000383849	7a	Scannell Properties, LLC	4200 Round Lake Road W	Arden Hills	WMTB	4/27/2021
H000384460	7a	USACE	1755 Pinewood Drive	Shoreview	WMTB	3/22/2021
H000384461	7a	USACE	1746 Pinewood Drive	Shoreview	WMTB	3/22/2021
H000384462	7a	USACE	1732 Pinewood Drive	Shoreview	WMTB	3/23/2021
H000384463	7a	USACE	1775 Pinewood Drive	Shoreview	WMTB	3/23/2021
H000384464	7a	USACE	1775 Terrace Drive	Shoreview	WMTB	3/23/2021
H000384465	7a	USACE	1783 Terrace Drive	Shoreview	WMTB	3/23/2021
H000384612	7a	Hansen	5486 Erickson Road	Mounds View	N/A	4/7/2021
H000384627	7a	Halvorson	1785 Lois Drive	Shoreview	Water Supply	5/20/2021
H000384631	7a	Gaudreau	1890 Tatum Street	Falcon Heights	Water Supply	6/9/2021
H000385486	7a	Clovning	5059 Brighton Lane	Mounds View	Water Supply	5/3/2021



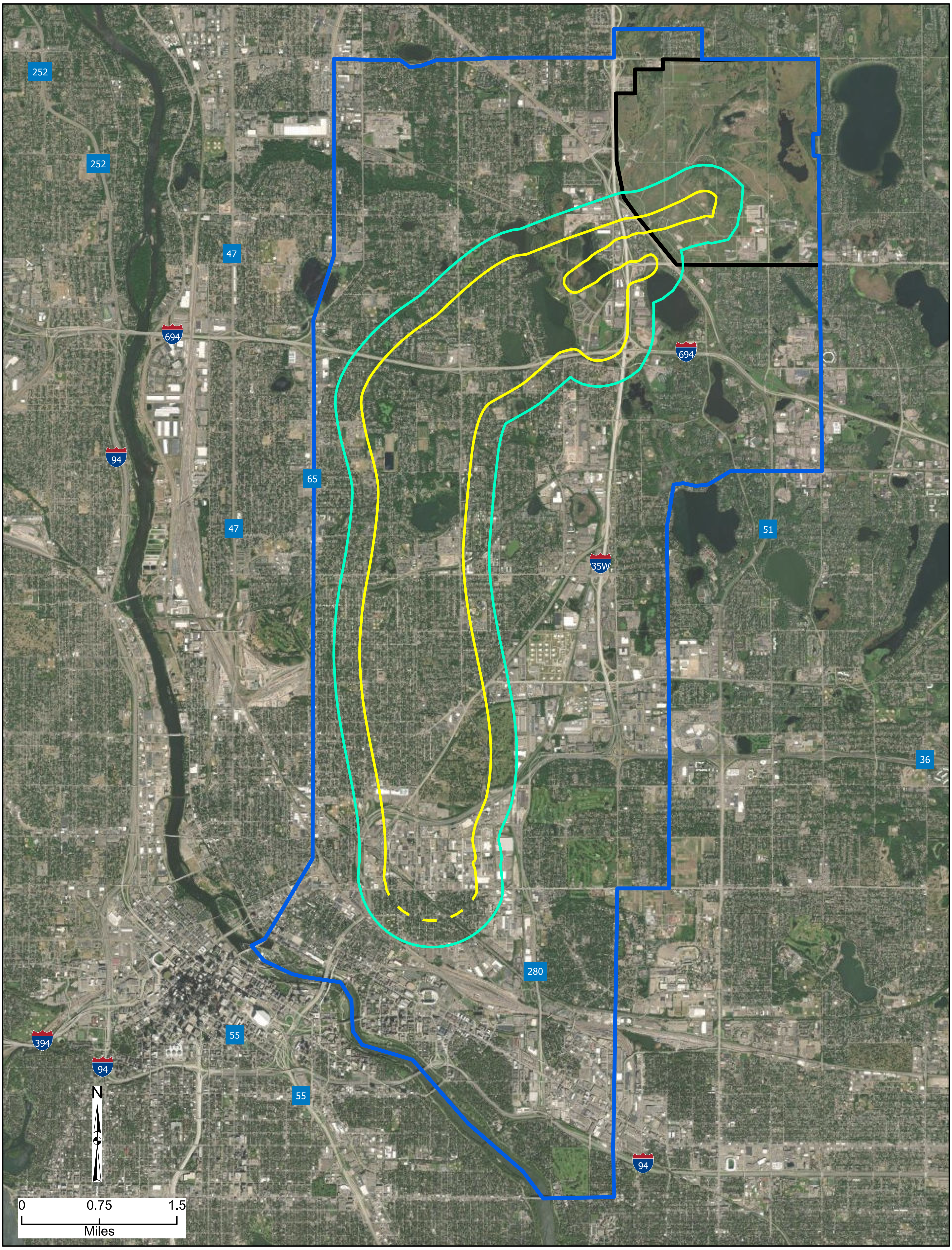
Legend

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.)

Well Inventory Study Area and MDH Special Well Construction Area

Date: 2/10/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx

Figure E-1
Annual Performance Report
Well Inventory Study Area
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota



Legend

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.)

Well Inventory Study Area and MDH Special Well Construction Area

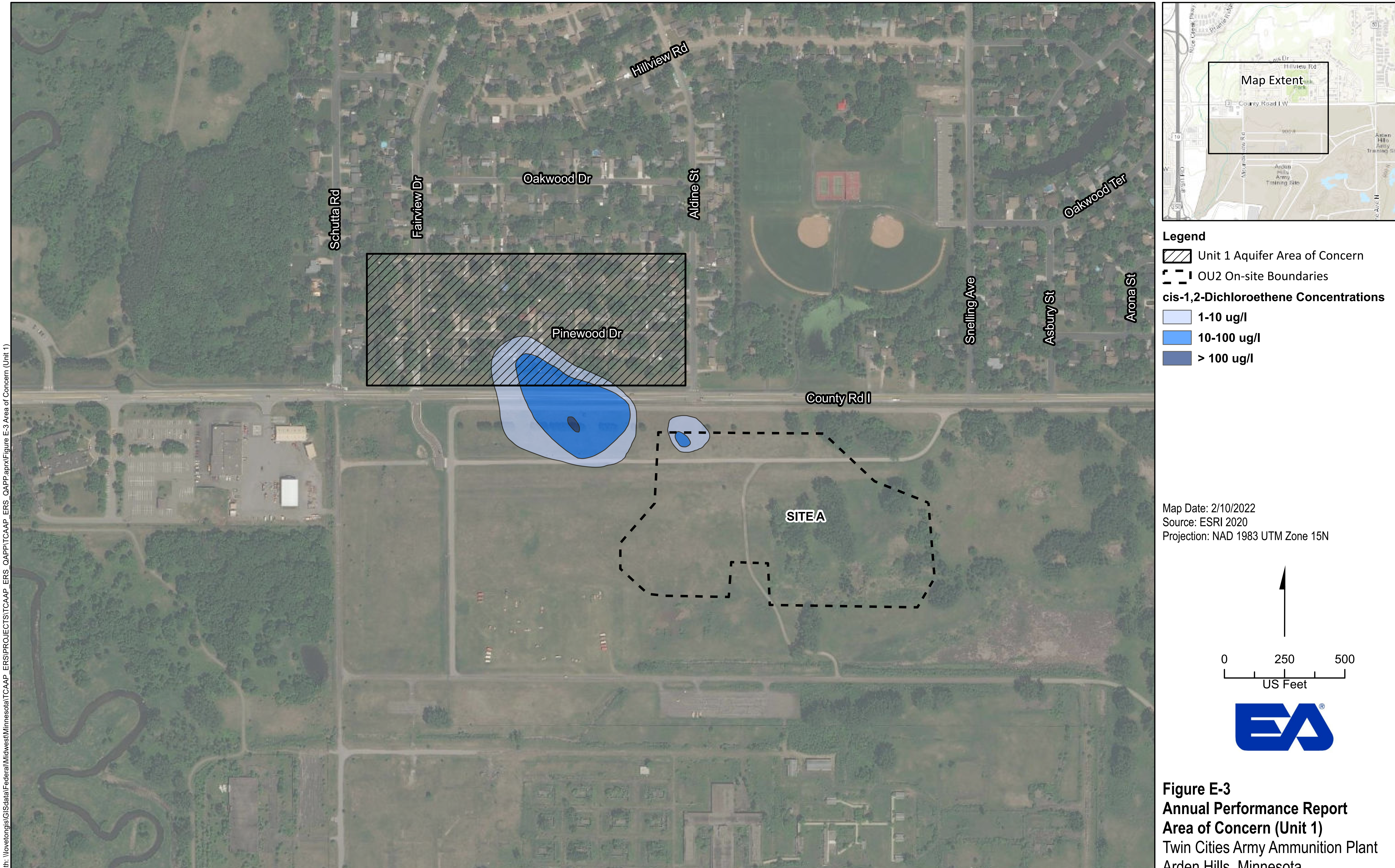
2021 (1 µg/L)

2021 Inferred (1 µg/L)

Area of Concern (1/4 mile Buffer)

Figure E-2
Annual Performance Report
Areas of Concern (Upper Unit 4)
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Date: 2/10/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx



Legend

- Unit 1 Aquifer Area of Concern
- OU2 On-site Boundaries

cis-1,2-Dichloroethene Concentrations

- **1-10 ug/l**
- **10-100 ug/l**
- **> 100 ug/l**

Map Date: 2/10/2022
Source: ESRI 2020
Projection: NAD 1983 UTM Zone 15N

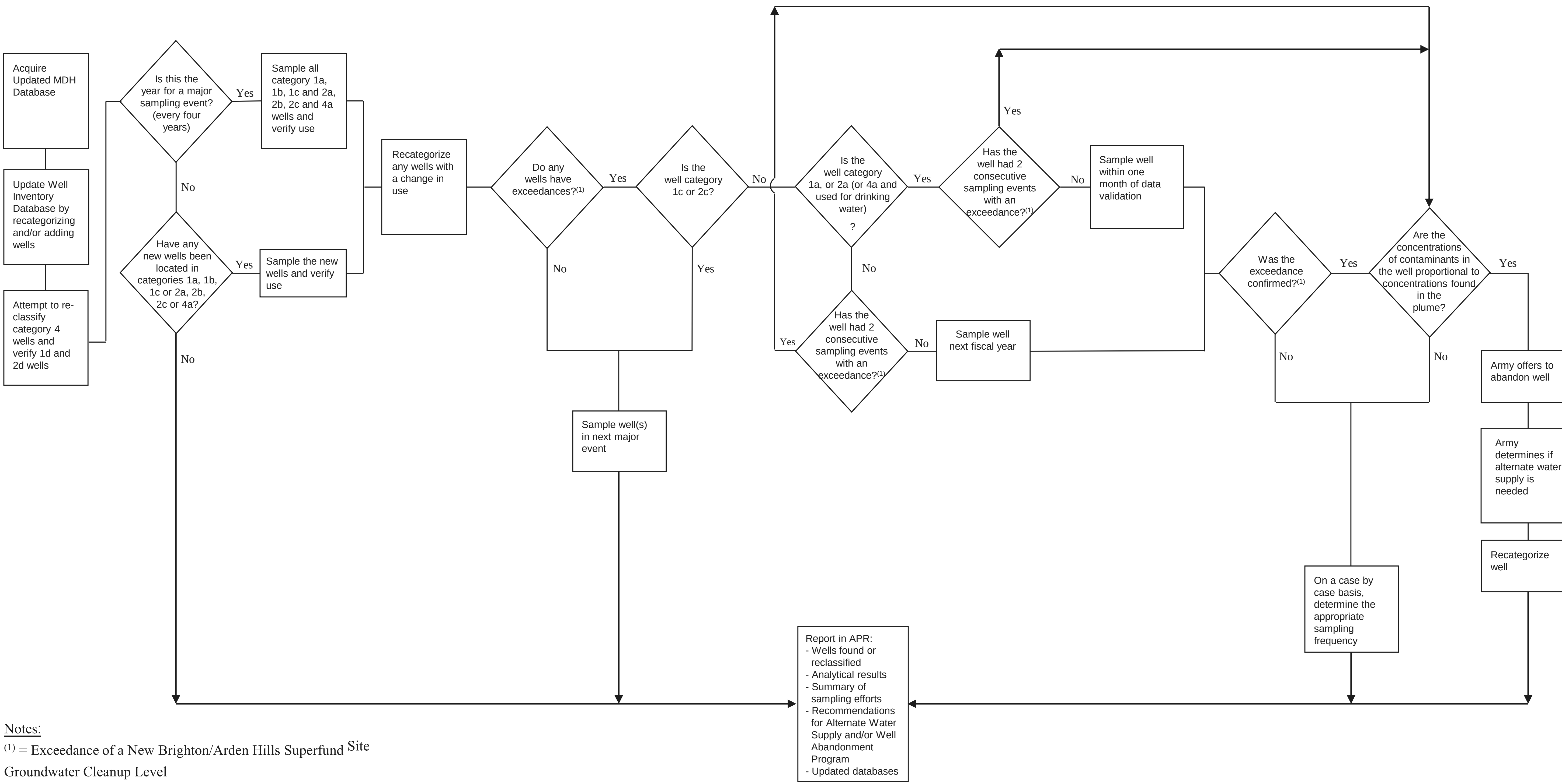
0 250 500
US Feet

Figure E-3
Annual Performance Report
Area of Concern (Unit 1)
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

Path: \\ovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx\Figure E-3 Area of Concern (Unit 1)

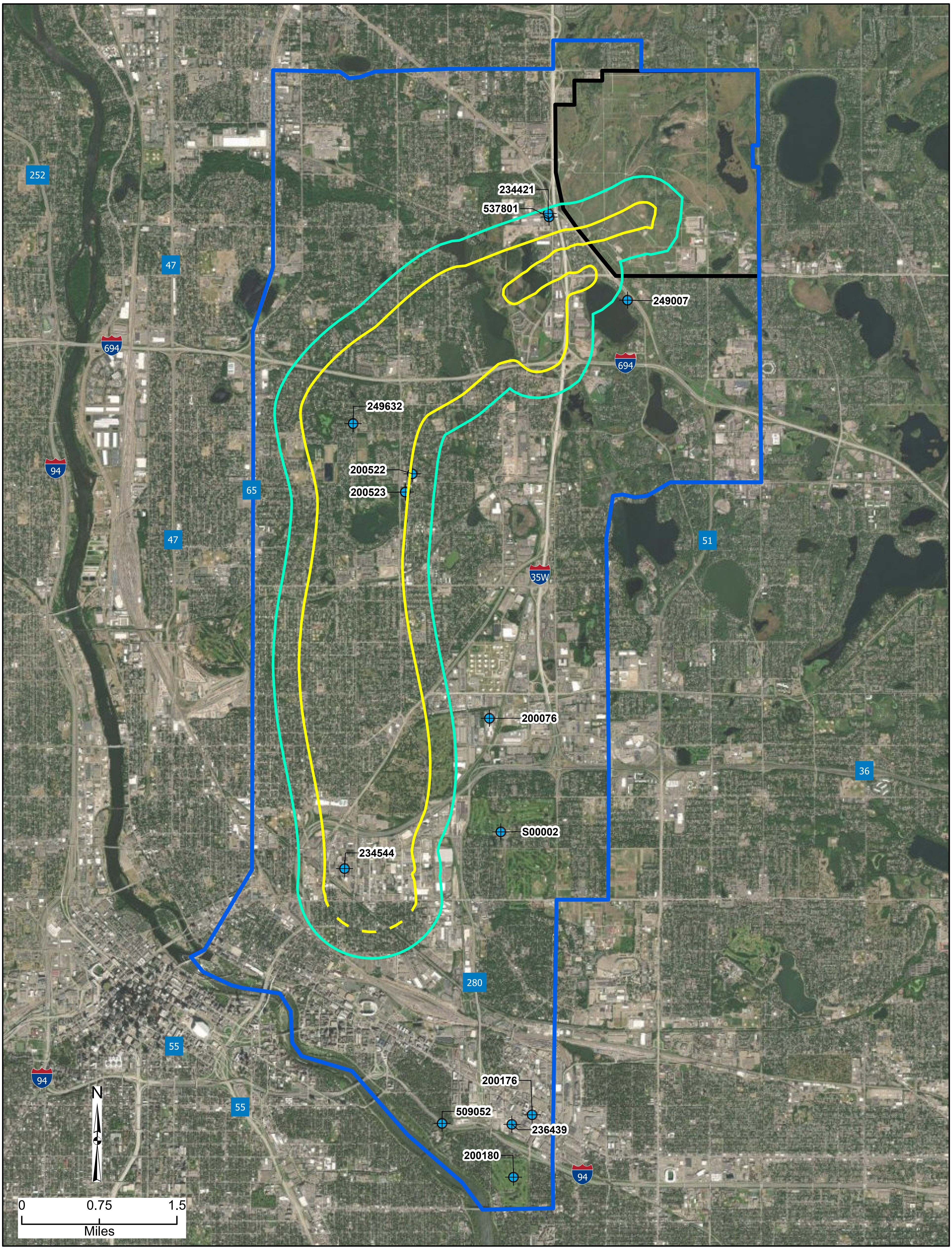
Figure E-4
Annual Requirements for Maintaining Well Inventory Database

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.



Legend

- Well Location
- 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.)
- Well Inventory Study Area and MDH Special Well Construction Area
- Upper Unit 4 1 µg/L TCE Plume (FY 2021)
- Inferred Upper Unit 4 1 µg/L TCE Plume (FY 2021)
- Area of Concern (1/4 mile Buffer)

Date: 2/10/2022
Source: ESRI, 2020
Spatial Reference: NAD 1983 UTM Zone 15N
Path: \\lovetongis\GISdata\Federal\Midwest\Minnesota\TCAAP_ERS\PROJECTS\TCAAP_ERS_QAPP\TCAAP_ERS_QAPP.aprx

Figure E-5
Annual Performance Report
FY 2021 Well Inventory Sampling Locations
Twin Cities Army Ammunition Plant
Arden Hills, Minnesota

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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: 07/22/2021

Inspected by: Linda Albrecht, Mary Lee, Lindsay Olivares, Tim Molitor

Period Covered: From prior annual inspection (8/11/2020) 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	**Yes**	N/A	N/A	N/A	No	No	No	No	**Yes**	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	**Yes**	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	No	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

Site(s) D, E, G, and H have small woody trees in and around the soil cap that will be removed (ex: russian olive, siberian elm, etc.)
New wells in OU2 as follows: Site G (2 new wells), Site I (1 new well), Site K (3 replacement wells and new drive points).
A new vapor intrusion study was completed just north of Site A.
A new treament building (SGRS) is scheduled to break ground in August 2021 on OU2, located between Site D and Site G (outside soil caps).
The soil cover disturbance noted at Site H was the top 2-inches of soil as base and asphalt were laid for the new Sunfish Lake Trail.
The rip-rap runoff located on the eastern portion of site 129-15 has woody tree growth in the rip-rap that may impact the runoff integrity and will be removed.
Construction at the N.G. on the Outdoor Firing Range soil cover has been completed.

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).

Hoa Voscott, Arcadis US Inc.

Description of Deficiency(ies) attached? ☒ **Yes, above** ☐ No (none were identified)

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Appendix G

Site K and TGRS Operational Data

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Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2021
Site K, OU2
Arden Hills, Minnesota

October 2020

10/21/2020	Upon arrival, the system was off and the "Flow meter low water flow rate" light was lit. Turned the system off and exercised and adjusted the influent and effluent flow control valves. Restarted the system and observed normal operation. Down time: 2.6 hours.
10/22/2020	Upon arrival the "Air stripper high/high water level" light was on. Turned the system off and adjusted the influent and effluent flow control valves. Restarted the system and observed normal operation. Down time: None.
10/28/2020	The water level of 01U615 was 11.70 feet below top of casing. The water level of the collection manhole was 13.50 feet below the top of the rim. The system was off due to normal system cycling when the water levels were collected. Down time: None.
10/30/2020	Turned the system off to inspect the packing. The packing is in good condition. Caulked leaks in the building roof. Tightened the building guy wires. Cleaned the vent fans. Inspected the float wires and float tree. Restarted the system and observed normal operation. Down time: 1.2 hours.

November

11/6/2020	Disassembled and flushed the influent and effluent piping. Down time: None.
11/11/2020	Cleaned the sump sight glass. Down time: None.
11/18/2020	The system was off upon arrival and the flow meter low water flow rate light was lit. Restarted the system and exercised the influent and effluent flow control valves. Reset the flow rates and observed normal operation. Down time: 23.7 hours.
11/25/2020	The water level at 01U615 is 11.75 feet below top of casing. Down time: None.
11/26/2020	Thanksgiving Day. The daily inspection was not performed. Meter readings were estimated. Down time: None.

December

12/18/2020	Obtained water level measurement at the recently installed 01U611R. The water level was 6.08 feet below top of casing. The water level at 01U615 was 11.82 feet below top of casing. Down time: None.
12/25/2020	Christmas Day holiday. The inspection was not performed. The meter reading was estimated. Down time: None.

Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2021
Site K, OU2
Arden Hills, Minnesota

12/28/2020 The system was off upon arrival and the flow meter low water flow rate light was lit. Restarted the system and exercised the influent and effluent flow control valves. Reset the flow rates and observed normal operation.

Down time: 15.8 hours.

12/29/2020 The system was off and the low building temperature alarm light was on. Reset the PLC and restarted the system. Inspected the building heater and the heater restarted normally. There was no effluent flow. The effluent drain line was frozen at the low spot. Thawed the line and restarted the system. Exercised and reset the influent and effluent flow control valves. Normal operation observed.

Down time: 13.5 hours.

12/30/2020 The system was off upon arrival and the flow meter low water flow rate light was lit. Restarted the system and exercised the influent and effluent flow control valves. Reset the flow rates and observed normal operation. Also, the building heater was not working. Installed a temporary heater.

Down time: None.

12/31/2020 The flow rate was 6.2 gpm upon arrival. Flushed the tower, exercised the flow control valves, checked maximum influent flow rate and reset the flow control valves to normal operating parameters. Normal operation observed.

Down time: None.

January 2021

1/1/2021 New Year's Day holiday. The inspection was not performed. The meter reading was estimated.

Down time: None.

1/2/2021 The system was off and the low water flow rate alarm was lit. Reset the PLC and restarted the system. Exercised the influent flow control valve and reset the influent flow rate. Normal operation observed.

Down time: 2.5 hours on 1/1/2021 and 2.5 hours on 1/2/2021.

1/3/2021 The system was off and the low water flow rate alarm was lit. Reset the PLC and restarted the system. Backflushed the influent line several times to determine if debris was lodging in spray nozzle at the top of the tower. No debris was found and the influent flow rate maxed out at 19.0 gpm which is normal. Reset the influent flow rate and observed normal operation.

Down time: None, the system achieved the average flow rate expected given the low water table condition.

1/5/2021 Site wide power outage. A northwest bound vehicle struck a power pole that provides power to the Site. Xcel Energy responded and restored power. Restarted the system and observed normal operation.

Down time: 8 hours.

Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2021
Site K, OU2
Arden Hills, Minnesota

January 2021

1/6/2021	The system was off and the low water flow rate alarm was lit. Reset the PLC and restarted the system. Inspected the pump start and stop floats on the float tree in the manhole. Lifted the float tree and the pump turned off normally. Placed the floats back in the manhole and the start float started the pump. Reset the influent flow rate and observed normal operation. Down time:11 hours.
1/7/2021	The system was off and the low water flow rate alarm was lit. Reset the PLC and restarted the system. Backflushed the influent line. Reset the influent flow rate and observed normal operation. Down time: 16.5 hours.
1/8/2021	The system was off and the low water flow rate alarm was lit. Increased the flow rate alarm delay from 10 seconds to 30 seconds. Backflushed the influent line several times. Restarted the system, reset the flow rates and observed normal operation. Down time: None.
1/14/2021	Contracted Preferred Electric to install a new outlet on a separate circuit in the building. When the electrician completed the work and left he unknowingly locked the door handle which has a different key. The dead bolt is typically locked to secure the door. Unable to locate the door handle key on 1/14/2021 therefore the inspection was not performed. Down time: None.
1/15/2021	The system was off and the low water flow rate alarm was lit. Backflushed the influent line several times, inspected the pump start and stop floats and reset the PLC and restarted the system. Normal operation observed. Down time: 46 hours (23 hours of which were from 1/14/2021).
1/21/2021	The system was off and the low water flow rate alarm was lit. Reset the PLC, backflushed the influent line and restarted the system. Normal operation observed. Down time: 8.5 hours.
1/24/2021	The system was off and the low water flow rate alarm was lit. Reset the PLC and restarted the system. Maxed out the flow rate and it was at 12 gpm and slowly decreased to less than 5 gpm and the system turned off. Restarted the system again and the flow rate maintained 11.5 gpm. Normal operation observed. Down time: 12 hours.
1/25/2021	The system was off and the low water flow rate alarm was lit. Reset the PLC and restarted the system. Exercised the influent flow control valve. Reset the influent flow rate and observed normal operation. Down time: 10.5 hours.
1/28/2021	The system was off and the low water flow rate alarm was lit. Reset the PLC and restarted the system. Exercised the influent and effluent flow control valves and reset the influent and effluent flow rates. Normal operation observed. Down time: 14.5 hours.

Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2021
Site K, OU2
Arden Hills, Minnesota

1/30-31/2021	The low water flow rate alarm was lit which turned the system off. The meter reading was estimated. Down time: 35.0 hours.

February 2021

2/1/2021	The flow meter low water flow rate alarm light was on. Reset the PLC and restarted the system. Normal operation observed. Down time: 11.5 hours.
2/6-8/2021	The flow meter low water flow rate alarm light was on. Reset the PLC and restarted the system. Normal operation observed. Down time: 50.0 hours.
2/11-12/2021	The flow meter low water flow rate alarm light was on. Reset the PLC and restarted the system. Exercised influent and effluent flow control valves with system running. Maxed out the flow rate then reset the flow control valves. Normal operation observed. Down time: 35.5 hours.
2/16/2021	Preferred Electric installed new 480 volt electric heater. Down time: None.
2/16/2021	Changed low flow rate alarm set point from 5 gpm to 2 gpm. Changed the flow rate alarm delay from 30 seconds to 60 seconds. Down time: None.
2/19/2021	The flow meter low water flow rate alarm light was on. Reset the PLC and restarted the system. Upon start up the system was pumping at 1.6 gpm. Exercised influent flow control valve and the maximum flow rate was 19.6 gpm, sustained for 1 minute. Set influent flow rate to 15.9 gpm. Possible piece of build up or debris in influent control valve. Returned at 2100 hours, flow rate was at 5.4 gpm. Attempted to increase the flow rate by opening influent valve, flow rate remained the same. Reset the PLC and restarted the system. Normal operation observed. Down time: 6.5 hours.
2/20/2021	Upon arrival system operating at 8.2 gpm. Opened influent valve to maximum and flow rate went to 10.5 gpm max. Closed influent valve for 10 seconds, opened valve and maximum flow went to 18.6 gpm then gradually dropped to 8.5 gpm. Turned system off for 5 minutes, then reset system in auto. System operated at 8.5 gpm max. Down time: None.

February 2021

2/21-22/2021	The flow meter low water flow rate alarm light was on. Reset the PLC and restarted the system. Turned the system off. Removed and inspected the pump and the floats from the manhole. No issues with pump or floats. Replaced influent flow control valve. Inspected flow meter wiring and harnesses. One of the plug-ins into the control board was loose, reinstalled plug-in and restarted the system. Reset the influent and effluent flow rates. Normal operation observed. Down time: 2.0 hours.

Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2021
Site K, OU2
Arden Hills, Minnesota

2/24/2021	The flow meter low water flow rate alarm light was on. Reset the PLC and restarted the system. Normal operation observed. Down time: 18.5 hours.
2/26/2021	The flow meter low water flow rate alarm light was on. Reset the PLC and restarted the system. Flow rate decreased gradually. Returned to site, inspected plug-ins into the control board on flow meter and connections in the control panel. Checked control cabinet and flow meter connections for continuity. Reset system and normal operation was observed. Down time: None.
2/27/2021	The flow meter low water flow rate alarm light was on. Reset the PLC and restarted system. Observed 11.2 gpm flow rate. Removed manhole cover and top float was all the way up. Manually cycled the system by lifting and lowering the float tree. Normal float system operation was observed. Observed that bottom float was clear of obstruction. Flow rate remained at 11.2 gpm during float check. Checked wire connections to blower Hand/Off/Auto switch. Checked wire connections in control panel. System remained operating. Normal operation observed. Down time: 18.5 hours.
March 2021	
3/1/2021	The flow meter low water flow rate alarm light was on. Reset the PLC and restarted the system. Flow rate immediately began dropping. Notified team. Down time: None.
3/3/2021	The flow meter low water flow rate alarm light was on. Reset the PLC and restarted the system. Flow rate displayed 0.0 gpm. Inspected flow meter control board and found loose plug-in. Reconnected plug-in and restarted system. Observed normal operation. Down time: 23.0 hours.
3/4/2021	The flow meter low water flow rate alarm light was on. Reset the PLC and restarted the system. Observed normal operation. Completed quarterly sampling of the treatment system at 13:00. Shut down system at 15:55 and replaced analog card in the PLC. Restarted system in hand, observed normal operation. Set system in auto. Down time: 19.5 hours.
3/5/2021	The flow meter low water flow rate alarm light was on. Reset the PLC and restarted the system. Observed normal operation. Reset system in hand. Down time: 7.0 hours.
3/9/2021	Preferred Electric on site to diagnose treatment system low flow alarm issue. Switched system from hand to auto at 7:45. Down time: 5.5 hours.
3/10/2021	Air stripper high alarm light was on. Reset the PLC and restarted the system. Observed normal operation. Down time: 20.0 hours.

Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2021
Site K, OU2
Arden Hills, Minnesota

3/22/2021 Upon arrival the flow rate was at 4.2 gpm. The influent valve was exercised between 0.0 gpm to completely open. A flow rate of 8.5 gpm was reached when the influent valve was completely open. System was shut down for 15 minutes. The system was reset in hand and the flow rate was set to 10.7 gpm. The system was restarted in auto with a flow rate of 10.5 gpm. Observed normal operation.

Down time: None.

April 2021

4/2/2021 Upon arrival flow rate at 5.9 gpm. The influent valve was exercised from 0.0 gpm to completely open. The flow rate increased to 12.1 gpm at completely open, then immediately started to drop. The system was shut down for 15 minutes then restarted in hand. The flow rate was set to 10.5 gpm and restarted in auto. Observed normal operations at a flow rate of 10.5 gpm.

Down time: 5.5 hours.

4/6-7/2021 High flow rate light on upon arrival. Reset and restarted system. Observed normal operation.
Down time: 47.5 hours.

May 2021

5/17/2021 Upon arrival on-site, the flow rate was at 9.8 gpm. The influent flow valve was exercised until a max flow of 11.9 gpm was reached at completely open. The flow was then set to 10.6 gpm. Normal operation was observed.

Down time: 1.5 hours.

5/24/2021 Upon arrival on-site, the flow rate was at 9.9 gpm. The influent flow valve was exercised until a max flow of 15.0 gpm was reached at completely open. The flow was then set to 10.8 gpm. Normal operation was observed.

Down time: None.

5/26/2021 During monthly preventative maintenance, blower vibration was higher than normal. Turned off system and cleaned level sight glass on sump. Restarted system in Auto. System did not start due to the sump level being below the pump start float. Returned to the site after a wait period and the high sump level alarm light was on. Reset the system and set the flow rate to 11.0 gpm. Observed normal operation.

Down time: None.

June 2021

6/7/2021 System down and high water level alarm light on upon arrival on-site, reset system. The system was restarted in Hand and the flow rate was set to 10.8 gpm. Lowered the sump level to 3". Let the system run in hand for 2 hours. Observed normal operation.

Down time: 2.5 hours.

6/11/2021 Upon arrival on-site the flow rate was at 9.1 gpm. Influent valve exercised until flow rate increased to 16.2 gpm at completely open. Set flow rate to 10.5 gpm. Observed normal operation.

Down time: None.

Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2021
Site K, OU2
Arden Hills, Minnesota

6/14/2021 Upon arrival on-site the flow rate was at 9.2 gpm. Attempted to exercise influent valve. Valve difficult to move and caused the flow rate to jump around. System was reset in Hand and saw increase in flow rate when valve is completely open, however valve was still difficult to move. Reset system in Hand again and was able to clear the blockage. Set flow rate to 10.8 gpm and reset system in Auto. Observed normal operation.

Down time: None.

6/18/2021 Upon arrival on-site the flow rate was at 5.9 gpm. Exercised influent valve, flow rate wasn't able to get above 7.5 gpm when influent valve was completely open. System was reset in Hand and the flow rate dropped slowly. Shut down system for 15 minutes. Reset system in Hand again and set flow rate to 10.5 gpm. Reset system in Auto. Observed normal operation.

Down time: 0.5 hours.

6/21/2021 Upon arrival on-site the flow rate was at 6.1 gpm. Flow rate was only at 7.4 gpm when influent valve completely open. Exercising the influent valve did not increase the flow rate. System was shut down for 15 minutes and reset in Hand. Set flow rate to 10.8 gpm and reset system in Auto. Observed normal operation.

Down time: 0.5 hours.

6/23/2021 Upon arrival on-site the flow rate was at 6.3 gpm. Exercised influent valve. Exercising the influent valve did not increase the flow rate. System was shut down for 45 minutes and reset in Hand. Set flow rate to 10.2 gpm and reset system in Auto. Observed normal operation.

Down time: 1 hour.

6/28/2021 Shutdown system at 1310 for annually electrical inspection, system was cycled a couple times during inspection. Flow rate was at 8.3 gpm upon arrival on site. Slight glass for sump was cleaned with muriatic acid. Once inspection complete system was set in Auto, system remained off due to normal system cycling. System began operating in Auto at 1353, flow rate was set to 11.2 gpm. Observed normal operation.

Down time: 0.5 hours.

6/30/2021 System down upon arrival due to a high water level alarm. Restarted system and set flow rate to 10.1 gpm. Observed normal operation.

Down time: 40 hours.

July 2021

7/9/2021 USGS on site measuring water levels and deploying pressure transducers in the newly installed wells (01U611R, 01U608R, and 01U609R).

Down time: None.

7/12/2021 Upon arrival on-site the flow rate was at 5.8 gpm. Influent valve exercised until flow rate increased to 7.5 gpm at completely open. Adjusted flow rate to the normal range for further troubleshooting later in the day. GHD back on site at 1630, checked distribution nozzle for blockage, could only get influent flow rate to 8.4 gpm with influent valve completely open. Cycled pump many times using float tree. Possible issue with pump, further troubleshooting needed.

Down time: 0.5 hour.

Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2021
Site K, OU2
Arden Hills, Minnesota

7/13/2021 USGS on site for surveying.
Down time: None.

7/14/2021 Upon arrival on-site the flow rate was at 5.6 gpm. Influent valve exercised until flow rate increased to 7.5 gpm at completely open. Adjusted flow rate to the normal range.
Down time: None.

7/20/2021 Upon arrival on-site the flow rate was at 3.6 gpm. Attempted to exercise influent valve, valve moved easily and did not increase the flow rate. Checked manhole water level, at 11.22 ft. Shut down treatment system for ~15 minutes. Exercised influent and effluent valves while treatment system shut down. Manhole water level at 11.10 ft after ~15 minutes. Reset system in Hand, flow rate instantly dropped to 3.7 gpm. Reset system in Auto.
Down time: 0.5 hour.

7/21/2021 USGS on site measuring water levels in newly installed wells (01U611R, 01U608R, and 01U609R).
Down time: None.

7/21/2021 Upon arrival on site, flow rate less than 4 gpm with influent valve completely open. System shut down and flex hose was disconnected from influent valve. Bucket test for flow rate was done and normal pump operation was observed. The top of the stripping tower and spray nozzle were removed. Small rocks were clogging the spray nozzle. The blockage was removed and top and nozzle were reinstalled. System was restarted and set to a flow rate of 10 gpm. Normal operation was observed.
Down time: 2 hours.

7/29/2021 Monthly preventative maintenance was completed.
Down time: 2 hours.

August 2021

8/2/2021 System down, cycling normally.
Down time: None.

8/6/2021 System down, cycling normally.
Down time: None.

August 2021

8/9/2021 System down, cycling normally.
Down time: None.

8/16-18/2021 System down, high-high level alarm. Restarted system. Observed normal operation.
Down time: 41.0 hours.

8/20/2021 System down, cycling normally.
Down time: None.

Appendix G.1

Inspection and Maintenance Activities
Fiscal Year 2021
Site K, OU2
Arden Hills, Minnesota

8/23/2021	Normal monthly preventative maintenance was conducted. Down time: None.
8/30-9/1/2021	System down, high-high level alarm. Restarted system in hand on 9/1, and observed normal operation. Left system running for ~1 hour for quarterly sampling. After sampling, shut down system and restarted in auto. Set flow rate to 10.3 gpm. Observed normal operation. Down time: 29.0 hours.

September

9/1/2021	System down, high-high level alarm. Reset and restarted system in hand, observed normal operation. Left system running for quarterly sampling for ~45 minutes. Completed quarterly sampling and shut down system. Emptied sump water and restarted system in auto. Lowered flow rate to 10.3 gpm. Observed normal operation. Down time: 12.0 hours.
9/3/2021	System down, cycling normally. Down time: None.
9/17/2021	System down, cycling normally. Down time: None.
9/20/2021	System down, cycling normally. Down time: None.
9/24/2021	Normal monthly preventative maintenance was conducted. Down time: None.

Appendix G.2

Maintenance Activities
Fiscal Year 2021
TGRS, OU2
Arden Hills, Minnesota

October 2020

10/1/2020	Treatment System. Pump 3 starts but does not continue to operate normally. Contacted Preferred Electric. Turned the TGRS off. They diagnosed the problem was located in the motor control center (MCC) where the Pump 3 starter bucket contacts the MCC bus bar. The two were shorted and welded together. The parts were removed and taken to a vendor to be rebuilt. Following the work, the TGRS was restarted and normal operation was observed. Down time: 2 hours at B1 and B13. 1.5 hours at B6, B9, SC1 and SC5.
10/7/2020	Treatment System. Turned the TGRS off to install the motor control center parts for Pump 3. Following the work, turned the TGRS on and observed normal operation. While the TGRS was down, Preferred Electric installed wire runs from the blower pressure switches on the air ducts to Towers 3 and 4 to the main control panel. Arcadis programmed the new pressure switches to turn the TGRS off should either blower turn off. Down time: 7.5 hours at B1 and SC5. 7 hours at B3, B6 and SC1. 6 hours at B13. 5.5 hours at B9 and 4.5 hours at B8.
10/9-31/2020	Pumphouse B3. There was a loud spraying sound coming from inside the well casing. Turned the pump off and contacted Thein Well. Increased the flow rates at B4 and B5 while B3 was off. Down time: 535 hours.
10/13/2020	Treatment System. Pumphouses B1, SC1 and SC5. Turned the pumps off to perform monthly maintenance. Following the work, turned the pumps back on and observed normal operation. Down time:1.5 hours at B1 and SC5. 4.5 hours at SC1.
10/29/2020	Pumphouse SC1. Arcadis pumped water from the work they were completing into the SC1 forcemain piping which reduced flow from the SC1 pump. Down time. 5.5 hours.

November 2020

11/1/2020	Treatment System and Well Field. Daylight Savings occurred. Modified the meter readings by one hour. Down time: None.
11/1-6/2020	Pumphouse B3. Turned the pump off to repair a leak in the riser pipe. Thein Well was contracted and they replaced the riser pipe, pump, motor and electrical wire. Following the work, turned the pump on and observed normal operation. Down time: 140 hours.

December 2020

12/17/2020	Building 116. The buildings main power transformer failed which shut down power to the TGRS main control panel. Contacted Preferred Electric and they removed and replaced the transformer. Following the work, restarted the TGRS and observed normal operation. Down time: 24 hours at B1, B13, B3, B6, B8, SC1 and SC5; 20 hours at B4 and B5; 3 hours at
12/25/2020	Christmas Day holiday. The daily inspection was not performed. Meter readings were estimated. Down time: None.

January 2021

1/1/2021	New Years Day Holiday. The daily inspection was not performed. Meter readings were estimated. Down time: None.
1/5/2021	Treatment System and Well Field. Call from Time Communication - TGRS fail. At the site there was no power to the treatment system or the pumphouses. Xcel Energy was on site and working on a power pole across County Highway 10 from Scherer Brothers Lumber. A vehicle slid into a power pole and snapped it in half which stopped power from reaching the Site. Xcel Energy installed a new power pole and restored power to the site at 5 PM. The TGRS was restarted at 6 PM. Down time: 7 hours at B13; 9 hours at B9; 10 hours at B3; 11 hours at B6, B8, SC1 and SC5; 11.5 hours at B1.
1/13/2021	Treatment System and Well Field. At the PLC, observed the uninterruptable power supply (UPS) was off and would not reset. Turned the TGRS off and removed and inspected the UPS and determined it was not repairable. Restarted the TGRS and ordered a replacement UPS. Down time: 2 hours at B1 and 2 hours at SC5.
1/14-18/2021	Pumphouse SC1. The meter stopped totaling. Removed the meter, cleaned it and reinstalled the meter. Normal operation observed. Meter readings were estimated. Down time: None.
1/15-28/2021	Pumphouse B3. There was a leak from the main body of the ECV. Turned the pump off. Removed and replaced the ECV with one from inventory. Restarted the pump, set the flow rate and observed normal operation. Down time: 46 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2021
TGRS, OU2
Arden Hills, Minnesota

January 2021	
1/19-22/2021	Pumphouse SC1. The meter stopped totaling again. Replaced the meter with a meter from inventory. Restarted the pump and observed normal operation. Meter readings were estimated. Down time: None.
1/26-28/2021	Pumphouses B8 and B9. Increased their flow rates while B3 was off. Lowered their flow rates when B3 was turned back on. Down time: None.
1/27/2021	Pumphouse B13. The limit switch on the ECV would not turn the pump off when activated. Performed troubleshooting work but to no avail. Possible programming issue. Down time: 2 hours.
1/28/2021	Treatment System. Turned the TGRS off and installed a new UPS in the Main Control Panel. Following the work, turned the TGRS on and observed normal operation. Down time: 1 hour.
1/30-31/2021	The weekend daily inspections were performed remotely by logging into software to view the real time status of the PLC and by reviewing hourly data collected by the on-site data logger, which is compiled within an automated daily email. With the ability to remotely monitor the TGRS, it has been determined that, going forward, on-site inspections will be performed on Mondays, Wednesdays and Fridays of each week. GHD will be doing at least a virtual inspection of the TGRS components every day and respond on Site if anything the requires immediate action. Down time: None.
February 2021	
2/3-5/2021	Pumphouse B3. Changed the flow rate by changing the pilot setting on the ECV control piping. Increased the pressure too much which decreased the flow rate. Removed and replaced the strainer screen and reset the pilot. Normal operation observed. Down time: 17 hours.
2/15/2021	Pumphouses B8 and B9. Turned the pumps off to change oil in Pump 4 in the treatment system so that the well field would not cycle with only Pump 3 operating. Following the work, turned the pumps back on. Normal operation observed. Down time: None.
2/18/2021	Treatment System. Turned the TGRS off as part of the monthly maintenance work. Following the work, turned the system back on and observed normal operation. Down time: None.
March 2021	
3/9-23/2021	Pumphouse B1. At the pumphouse, the pump was off. Troubleshooting indicated a failed VFD. Arcadis obtained a replacement and installed it. Restarted the pump and observed normal operation. B1 remained off during troubleshooting. The flow rates at B5, B8, and B9 were increased during this time to account for B1 being shut down. Down time: 327 hours.
3/22/2021	Pumphouses SC1 and SC5. During the daily inspection, the iPad glitched and kicked out the previous data. Following the inspection, revisited the pumphouses and obtained the readings. Down time: None.
3/31/2021	Treatment System. Turned the TGRS off as part of the monthly maintenance work. Following the work, turned the system back on and observed normal operation. Down time: None.
April 2021	
4/16/2021	Treatment System. 1,400-gallons of drilling water was poured into Wet Well 1 by Arcadis. Drilling water is awaiting treatment. Down time: None.
4/20/2021	Treatment System. 500-gallons of drilling water was poured into Wet Well 1 by Arcadis. Drilling water is awaiting treatment. Down time: None.
4/23-26/2021	Pumphouse SC1. Flow rate meter was not operational, pump was still operating normally. Pump was shut off. Flow meter was repaired and reinstalled. Pump was turned back on. Observed normal operation for the flow meter and pump. Down time: 1.5 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2021
TGRS, OU2
Arden Hills, Minnesota

April 2021

4/30/2021 Treatment System. Turned the TGRS off as part of the monthly maintenance work. Following the work, turned the system back on and observed normal operation.
Down time: None.

May 2021

5/14/2021 Pumphouse B9. B9 building entry alarm. Building inspected and it appears to be a result of a bad door lock. Alarm acknowledged.
Down time: None.

5/17/2021 Pumphouse SC1. Pumping hose hooked up in SC1 pumphouse for well drilling supervised by Arcadis.
Down time: None.

5/24/2021 Pumphouse SC1. Leak from one of the flow meter gaskets was discovered upon arrival. Pump was shut off. The bolts were tighten on the gasket. The tighten bolts did not resolve the leak. Both gaskets were removed and inspected. Gaskets were reinstalled and pump turned back on. Normal operation observed.
Down time: 2.0 hours.

5/24/2021 Pumphouse B9. During preventative maintenance a leak from the riser pipe was discovered at B9. Contacted project team and vendor to set up repairs. Repairs will be completed during early June.
Down time: None.

5/31/2021 Pumphouse SC5. Low low level alarm at SC5, alarm was acknowledged and flow rate was decreased. Normal operation observed.
Down time: None.

June 2021

6/2/2021 Pumphouse B9. Pump was shut down at 0932 for riser pipe repairs. Upon removal of the riser pipes, leaks were observed at the bottom of the fourth pipe at the check valve and at the bottom of the fifth stick at the pump. The other three pipes showed considerable wear/corrosion on the threads and were replaced as well. The pump and motor were also replaced due to being in use for four years. Restarted pump at 1415. Observed normal operation.
Down time: 5.0 hours.

6/5/2021 Pumphouse B1. During remote monitoring it was discovered that B1 was down due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged. B1 was reset at 1015. Observed normal operation.
Down time: 25.5 hours.

6/5-11/2021 Pumphouse SC5. Low low level alarm at SC5, alarm was acknowledged. Normal operation observed.
Down time: None.

6/6-7/2021 Pumphouse B1. During remote monitoring it was discovered that B1 was down due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and B5, B8, and B9 flow rates increased. B1 was reset at 0650 on 6/7/2021 and B5, B8, and B9 flow rates back to normal. Observed normal operation.
Down time: 31.0 hours.

6/7-8/2021 Pumphouse B1. B1 was discovered down at 1713 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged. Reset VFD at the pumphouse and control panel. Left B1 shut down and B5, B8, and B9 flow rates were increased. Restarted B1 on 6/8/2021. Observed normal operation.
Down time: 18 hours.

6/7-8/2021 Pumphouse B6. Alarm email indicating that B6 was down due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged. B6 was reset and normal operation was observed.
Down time: 10.5 hours.

6/9/2021 Pumphouse B1. B1 was discovered down at 1708 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and B1 reset. Observed normal operation.
Down time: 9.5 hours.

6/10-11/2021 Pumphouse B1. B1 was discovered down at 0932 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and B1 restarted. Observed normal operation.
Down time: 18.5 hours.

6/14/2021 Pumphouse SC5. Low low level alarm at SC5, alarm was acknowledged. Lower SC5 low level standpoint to 4 ft. Normal operation observed.
Down time: None.

6/15/2021 Treatment System and Well Field. GHD on site with Preferred Electric conducting annual electrical inspection. Treatment system and wells off.
Down time: 6 hours at SC5, SC1, B1, B13, B3, B4, B5, B6, B8, and B9.

Appendix G.2

Maintenance Activities
Fiscal Year 2021
TGRS, OU2
Arden Hills, Minnesota

June 2021	
6/17-18/2021	Pumphouse SC5. SC5 was discovered down at 1936 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and B8 flow rate increased. SC5 was reset on 6/18/2021 and observed normal operation. SC5 was discovered down again at 1035 due to VFD Faulted, UPS Power, and Pump Failed to Start alarms. Alarms acknowledged and pump restarted. Observed normal operation in the pumphouse and system ok light on. Down time: 20.0 hours.
6/19/2021	Pumphouse SC5. SC5 was discovered down at 0800 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and pump restarted. Observed normal operation. Down time: 23.5 hours.
6/20/2021	Pumphouse SC5. SC5 was discovered down at 0900 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and pump restarted. Observed normal operation. Down time: 8.0 hours.
6/26/2021	Pumphouse SC5. Low low level alarm at SC5, alarm was acknowledged. Normal operation observed. Down time: None.
6/28/2021	Pumphouse SC5. Low low level alarm at SC5, alarm was acknowledged. Normal operation observed. Down time: None.
6/30/2021	Pumphouse SC5. SC5 was discovered down due to VFD Faulted, UPS Power, and Pump Failed to Start alarms. Alarms acknowledged and pump reset at 0745. Observed normal operation in the pumphouse and system ok light on. Down time: 20.5 hours.
6/30/2021	Repairs were made to 03U002 and 03U029 by Thein Well to bring the wells up to Minnesota Department of Health's code. Repairs were supervised by GHD. Down time: None.
July 2021	
7/1/2021	Pumphouse SC1. Flow meter was discovered to not be rotating at 1702. Shut down pump, removed and cleaned flow meter. Reinstalled flow meter and restarted pump. Down time: 0.5 hour.
7/2/2021	Pumphouse SC5. Upon arrival SC5 was off due to High-High Level, VFD Fault, and Pump Failed Start alarms. Alarms were acknowledged at 11:20, pump automatically restarted and operating normally. Alarms (VFD Fault and Pump Failed to Start) were triggered again at 11:57, the alarms were acknowledged and pump automatically restarted. Alarms (VFD Fault, Pump Failed to Start, and High-High Level) were triggered again, the alarms were acknowledged and the pump automatically restarted. The VFD Fault alarm triggered again at 12:30, went to SC5 pumphouse, the pump was off. Reset SC5 at pumphouse. Acknowledged alarms via remote connection, reset SC5 on control panel. Observed normal operation. Down time: 13.5 hours.
7/5/2021	Pumphouse B8. Received multiple alarm emails for the B8 pumphouse: Building High Temp, Building Low Temp, UPS Power, AC Power, and Building Entry Alarm. Upon arrival to the B8 pumphouse, B8 was running but flow meter showed 0.0 gpm. VFD was running at full speed. It was discovered that Fuse FU-314 was blown, fuse was replaced but did not resolve the flow rate issue. Troubleshooted flow rate issue. No solution determined. Left B8 running with no recorded flow rate (0.0 gpm). Continued to troubleshoot in following days. Down time: 0.5 hour.
7/6/2021	Pumphouse B8. Upon arrival for inspection, B8 was still running on the well field panel, but had 0.0 gpm. The VFD was still running at full speed. Meter at pumphouse had B8 flow rate at 205 gpm. Appeared to be an issue in communication between the pumphouse and PLC. Reviewed wire connections for flow rate meter on analog card. Shut down well at well field panel, rechecked wire connections for flow rate meter in analog card. Shut down and restarted power to pump house, and restarted well at well field panel. Flow rate on well field panel was still 0.0 gpm. Shut down well at well field panel, checked if signal from flow rate meter wire to positive connection. Positive signal worked. Determined issue was with analog card signal. Turned well back on with flow rate of 205 gpm at pumphouse, and flow rate of 0.0 gpm on well field panel. Will replace analog card. Down time: 1 hour.
7/7/2021	Pumphouse B8. At B8 pumphouse to replace analog card. Shut down B8 at well field panel, removed faulty analog card and installed new analog card. Restarted B8 and saw normal flow rate in pumphouse meter and on well field panel. Normal operation observed. Down time: 0.5 hour.
7/19/2021	Treatment System and Well Field. Site-wide power outage. Various alarms at each well. Reset treatment system and wells. Normal operation observed. Down time: 2.0 hours at B1, 2.0 hours at B4, 1.5 hours at B5, 2.0 hours at B6, 2.0 hours at B8, 2.0 hours at B9, 1.5 hours at SC1, and 1.5 hours at SC5.

Appendix G.2

Maintenance Activities
Fiscal Year 2021
TGRS, OU2
Arden Hills, Minnesota

July 2021	
7/21/2021	Treatment System. Installed WWP-2 power tub in the MCC. Tested pump and electric check valve operation, operation was normal. Treated the drilling water in wet well 2 (dumped by Arcadis in June) through AST #3. Tripped wet well 1,2 low level alarm. Disabled alarm for now. Down time: 2.0 hours at B1, 2.0 hours at B4, 2.0 hours at B5, 2.0 hours at B6, 2.0 hours at B8, 2.0 hours at B9, and 2.0 hours at SC5.
7/29/2021	Pumphouse B4. B4 Low-Low Level Alarm, reset well and observed normal operation. Down time: None.
7/29/2021	Treatment System and Well Field. Normal monthly preventative maintenance was conducted. Down time: None.
August 2021	
8/13/2021	Pumphouse B4. Low-low level alarm, pump still operating. Alarm acknowledged. Normal operation observed. Down time: None.
8/14/2021	Treatment System and Well Field. CP AC Power Fail and UPS Fail alarms along with other various failed to start alarms resulting in the entire treatment system and well field to shut down. Acknowledged alarms and reset PLC firewall. Attempted to reset system, Pump 3 and Pump 4 failed to start. Reset system and cycled power to pumps, pumps failed to started. Determined there was an issue with a UPS power supply or fuses. Called Preferred Electric to assist with repairs. Left treatment system and well field shut down. Down time: B1, B13, B3, B4, B5, B6, B8, B9, SC1, and SC5 for 12.5 hours.
8/15/2021	Treatment System and Well Field. Preferred Electric on site with GHD. Through some testing, it was determined that there was no issue with the fuses, but that the PLC control panel was receiving high power voltages (144v instead of 120v). The high incoming power resulted in the UPS in the PLC control panel to fail. A replacement UPS is needed for the treatment system to operate normally. Left treatment system and well field shut down until replacement UPS can be installed. Down time: B1, B13, B3, B4, B5, B6, B8, B9, SC1, and SC5 for 24.0 hours.
8/16/2021	Treatment System and Well Field. A replacement UPS with higher voltage capacity was purchased and installed in the PLC control panel. Replacement UPS kept switching from battery to line voltage. Connected PLC to generator for alternate power source. Restarted PLC and reset firewall. Restarted Pump 4, pump would not start. Restarted Pump 3, pump would not start. Shut down PLC. Called Preferred Electric and Xcel to assist. Preferred Electric on site at 1445. Verified that the incoming power is very unbalanced and the phase to phase volts are very high. MCC WWP-4 cabinet A and C phase fuses are blown. Xcel determined that there was an open fuselink straight west of Building 116. The fuselink was closed and incoming power dropped to normal range. Restarted PLC and treatment system. Pump 4 not operational due to motor issues. Pump 4 motor has a dead short or short to ground and must be rebuilt. Restarted PLC and Pump 3. Started wells B1, B4, B5, B6, SC1 and SC5. System operating normally at low flow (~1,400 gpm). Down time: B1, B4, B5, and SC5 for 20.5 hours, B13 and B3 for 19.5 hours, B6 for 21.5 hours, B8 and B9 for 24 hours, and SC1 for 15 hours.
8/17-8/19/21	Treatment System and Pumphouses B13, B3, B8, and B9. Pump 4 motor repair pending, operating pump 3 only. Wells B8, B9, B3, and B13 turned off. Down time: B13, B3, B8, and B9 down for 72 hours.
8/20/2021	Treatment System. System down due to Pump 4 motor repairs. Pump 4 motor repaired and treatment system and entire well field back running at 1700. Observed normal operation. Down time: B1, B4, B5, B6, SC1, and SC5 for 4.5 hours, B13 for 2.0 hours, B3 for 13.0 hours, and B8 and B9 for 18.0 hours.
8/26/2021	Treatment System and Well Field. Normal monthly preventative maintenance was conducted. Down time: None.
September 2021	
9/7/2021	Treatment System. Alarms MCP P203 Failed to Start, MCP WW3 LSHH 301, and MCP P203 PS Failed to Close. Alarms acknowledged and cleared. Restarted treatment system. Autodialer called out due to WWP4 off for more than 30 minutes. WWP3 and 4 operating normally. Alarm MCP P203 PS Failed to Close, adjusted opening/closing speed values. Observed normal operation. Down time: None
9/9/2021	Treatment System and Well Field. Received autodialer call at 04:38 and no alarm emails. Alarms P203 Failed to Start and WW3 LSHH 301 on main control panel. Treatment system and well field down. Acknowledged alarms. Started treatment system. Received alarm emails MCP P203 Valve Failed to Open and WW3 LSHH 301 at 17:07. Adjusted opening/closing speed values and restarted system. Observed normal operation. Down time: B1, B4, B5, B6, and B9 for 3.5 hours, B8 and SC5 for 3.0 hours, B13 and B3 for 1.5 hours, and SC1 for 9 hours.

Appendix G.2

Maintenance Activities
Fiscal Year 2021
TGRS, OU2
Arden Hills, Minnesota

September 2021

9/9-13/2021	SC1 Pumphouse. SC1 flow meter not turning, pump still operating. Flow meter cleaned and reinstalled. Observed normal operation. Down time: 0.5 hour.
9/12/2021	Treatment System. Received autodialer call at 05:25 and no alarm emails. Alarms P203 Failed to Start and WW3 LSHH 301 on main control panel. Treatment system and well field down. Checked WWP3 overloads and determined they were tripped. Reset WWP3 overloads. Acknowledged alarms. Started treatment system. Observed normal operation. Down time: None
9/14/2021	Treatment System. Shut down treatment system and WWP3 at 08:54. Disabled autodialer. Replaced overloads for WWP3. Restarted system and observed normal operation. Down time: None
9/24/2021	Treatment system and Well Field. Conducted routine monthly preventative maintenance. Down time: None
9/24-30/2021	Pumphouse B8. While conducting monthly preventative maintenance on 9/24/2021 a leak in a riser pipe at B8 was discovered. Shut down B8 at 16:30 on 9/24/2021. Repair to third piece of riser pipe with leak completed on 9/30/2021. B8 restarted at 12:30 on 9/30/2021. Observed normal operation. Down time: 140.0 hours.
9/29-30/2021	Pumphouse SC5. SC5 shut down at 0810 on 9/29/2021 to complete electrical work needed for SGRS construction. Alarms disabled. SC5 restarted at 12:30 on 9/30/2021. Observed normal operation. Down time: 28.5 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2021
TGRS, OU2
Arden Hills, Minnesota

Pumphouse B1

10/13/2020	Treatment System. Pumphouses B1, SC1 and SC5. Turned the pumps off to perform monthly maintenance. Following the work, turned the pumps back on and observed normal operation. Down time:1.5 hours at B1 and SC5. 4.5 hours at SC1.
3/9-23/2021	Pumphouse B1. At the pumphouse, the pump was off. Troubleshooting indicated a failed VFD. Arcadis obtained a replacement and installed it. Restarted the pump and observed normal operation. B1 remained off during troubleshooting. The flow rates at B5, B8, and B9 were increased during this time to account for B1 being shut down. Down time: 327 hours.
6/5/2021	Pumphouse B1. During remote monitoring it was discovered that B1 was down due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged. B1 was reset at 1015. Observed normal operation. Down time: 25.5 hours.
6/6-7/2021	Pumphouse B1. During remote monitoring it was discovered that B1 was down due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and B5, B8, and B9 flow rates increased. B1 was reset at 0650 on 6/7/2021 and B5, B8, and B9 flow rates back to normal. Observed normal operation. Down time: 31.0 hours.
6/7-8/2021	Pumphouse B1. B1 was discovered down at 1713 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged. Reset VFD at the pumphouse and control panel. Left B1 shut down and B5, B8, and B9 flow rates were increased. Restarted B1 on 6/8/2021. Observed normal operation. Down time: 18 hours.
6/9/2021	Pumphouse B1. B1 was discovered down at 1708 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and B1 reset. Observed normal operation. Down time: 9.5 hours.
6/10-11/2021	Pumphouse B1. B1 was discovered down at 0932 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and B1 restarted. Observed normal operation. Down time: 18.5 hours.

Pumphouse B3

10/9-31/2020	Pumphouse B3. There was a loud spraying sound coming from inside the well casing. Turned the pump off and contacted Thein Well. Increased the flow rates at B4 and B5 while B3 was off. Down time: 535 hours.
11/1-6/2020	Pumphouse B3. Turned the pump off to repair a leak in the riser pipe. Thein Well was contracted and they replaced the riser pipe, pump, motor and electrical wire. Following the work, turned the pump on and observed normal operation. Down time: 140 hours.
1/15-28/2021	Pumphouse B3. There was a leak from the main body of the ECV. Turned the pump off. Removed and replaced the ECV with one from inventory. Restarted the pump, set the flow rate and observed normal operation. Down time: 46 hours.
2/3-5/2021	Pumphouse B3. Changed the flow rate by changing the pilot setting on the ECV control piping. Increased the pressure too much which decreased the flow rate. Removed and replaced the strainer screen and reset the pilot. Normal operation observed. Down time: 17 hours.
8/17-8/19/21	Treatment System and Pumphouses B13, B3, B8, and B9. Pump 4 motor repair pending, operating pump 3 only. Wells B8, B9, B3, and B13 turned off. Down time: B13, B3, B8, and B9 down for 72 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2021
TGRS, OU2
Arden Hills, Minnesota

Pumphouse B4

10/9-31/2020	Pumphouse B3. There was a loud spraying sound coming from inside the well casing. Turned the pump off and contacted Thein Well. Increased the flow rates at B4 and B5 while B3 was off. Down time: 535 hours.
7/29/2021	Pumphouse B4. B4 Low-Low Level Alarm, reset well and observed normal operation. Down time: None.
8/13/2021	Pumphouse B4. Low-low level alarm, pump still operating. Alarm acknowledged. Normal operation observed. Down time: None.

Pumphouse B5

10/9-31/2020	Pumphouse B3. There was a loud spraying sound coming from inside the well casing. Turned the pump off and contacted Thein Well. Increased the flow rates at B4 and B5 while B3 was off. Down time: 535 hours.
3/9-23/2021	Pumphouse B1. At the pumphouse, the pump was off. Troubleshooting indicated a failed VFD. Arcadis obtained a replacement and installed it. Restarted the pump and observed normal operation. B1 remained off during troubleshooting. The flow rates at B5, B8, and B9 were increased during this time to account for B1 being shut down. Down time: 327 hours.
6/6-7/2021	Pumphouse B1. During remote monitoring it was discovered that B1 was down due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and B5, B8, and B9 flow rates increased. B1 was reset at 0650 on 6/7/2021 and B5, B8, and B9 flow rates back to normal. Observed normal operation. Down time: 31.0 hours.
6/7-8/2021	Pumphouse B1. B1 was discovered down at 1713 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged. Reset VFD at the pumphouse and control panel. Left B1 shut down and B5, B8, and B9 flow rates were increased. Restarted B1 on 6/8/2021. Observed normal operation. Down time: 18 hours.

Pumphouse B6

6/7-8/2021	Pumphouse B6. Alarm email indicating that B6 was down due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged. B6 was reset and normal operation was observed. Down time: 10.5 hours.

Pumphouse B8

1/26-28/2021	Pumphouses B8 and B9. Increased their flow rates while B3 was off. Lowered their flow rates when B3 was turned back on. Down time: None.
2/15/2021	Pumphouses B8 and B9. Turned the pumps off to change oil in Pump 4 in the treatment system so that the well field would not cycle with only Pump 3 operating. Following the work, turned the pumps back on. Normal operation observed. Down time: None.
3/9-23/2021	Pumphouse B1. At the pumphouse, the pump was off. Troubleshooting indicated a failed VFD. Arcadis obtained a replacement and installed it. Restarted the pump and observed normal operation. B1 remained off during troubleshooting. The flow rates at B5, B8, and B9 were increased during this time to account for B1 being shut down. Down time: 327 hours.
6/6-7/2021	Pumphouse B1. During remote monitoring it was discovered that B1 was down due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and B5, B8, and B9 flow rates increased. B1 was reset at 0650 on 6/7/2021 and B5, B8, and B9 flow rates back to normal. Observed normal operation. Down time: 31.0 hours.

Appendix G.3

Maintenance Activities By Location
Fiscal Year 2021
TGRS, OU2
Arden Hills, Minnesota

Pumphouse B8

6/7-8/2021	Pumphouse B1. B1 was discovered down at 1713 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged. Reset VFD at the pumphouse and control panel. Left B1 shut down and B5, B8, and B9 flow rates were increased. Restarted B1 on 6/8/2021. Observed normal operation. Down time: 18 hours.
6/17-18/2021	Pumphouse SC5. SC5 was discovered down at 1936 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and B8 flow rate increased. SC5 was reset on 6/18/2021 and observed normal operation. SC5 was discovered down again at 1035 due to VFD Faulted, UPS Power, and Pump Failed to Start alarms. Alarms acknowledged and pump restarted. Observed normal operation in the pumphouse and system ok light on. Down time: 20.0 hours.
7/5/2021	Pumphouse B8. Received multiple alarm emails for the B8 pumphouse: Building High Temp, Building Low Temp, UPS Power, AC Power, and Building Entry Alarm. Upon arrival to the B8 pumphouse, B8 was running but flow meter showed 0.0 gpm. VFD was running at full speed. It was discovered that Fuse FU-314 was blown, fuse was replaced but did not resolve the flow rate issue. Troubleshooted flow rate issue. No solution determined. Left B8 running with no recorded flow rate (0.0 gpm). Continued to troubleshoot in following days. Down time: 0.5 hour.
7/6/2021	Pumphouse B8. Upon arrival for inspection, B8 was still running on the well field panel, but had 0.0 gpm. The VFD was still running at full speed. Meter at pumphouse had B8 flow rate at 205 gpm. Appeared to be an issue in communication between the pumphouse and PLC. Reviewed wire connections for flow rate meter on analog card. Shut down well at well field panel, rechecked wire connections for flow rate meter in analog card. Shut down and restarted power to pump house, and restarted well at well field panel. Flow rate on well field panel was still 0.0 gpm. Shut down well at well field panel, checked if signal from flow rate meter wire to positive connection. Positive signal worked. Determined issue was with analog card signal. Turned well back on with flow rate of 205 gpm at pumphouse, and flow rate of 0.0 gpm on well field panel. Down time: 1 hour.
7/7/2021	Pumphouse B8. At B8 pumphouse to replace analog card. Shut down B8 at well field panel, removed faulty analog card and installed new analog card. Restarted B8 and saw normal flow rate in pumphouse meter and on well field panel. Normal operation observed. Down time: 0.5 hour.
8/17-8/19/21	Treatment System and Pumphouses B13, B3, B8, and B9. Pump 4 motor repair pending, operating pump 3 only. Wells B8, B9, B3, and B13 turned off. Down time: B13, B3, B8, and B9 down for 72 hours.
9/24-30/2021	Pumphouse B8. While conducting monthly preventative maintenance on 9/24/2021 a leak in a riser pipe at B8 was discovered. Shut down B8 at 16:30 on 9/24/2021. Repair to third piece of riser pipe with leak completed on 9/30/2021. B8 restarted at 12:30 on 9/30/2021. Observed normal operation. Down time: 140.0 hours.

Pumphouse B9

1/26-28/2021	Pumphouses B8 and B9. Increased their flow rates while B3 was off. Lowered their flow rates when B3 was turned back on. Down time: None.
2/15/2021	Pumphouses B8 and B9. Turned the pumps off to change oil in Pump 4 in the treatment system so that the well field would not cycle with only Pump 3 operating. Following the work, turned the pumps back on. Normal operation observed. Down time: None.
3/9-23/2021	Pumphouse B1. At the pumphouse, the pump was off. Troubleshooting indicated a failed VFD. Arcadis obtained a replacement and installed it. Restarted the pump and observed normal operation. B1 remained off during troubleshooting. The flow rates at B5, B8, and B9 were increased during this time to account for B1 being shut down. Down time: 327 hours.
5/14/2021	Pumphouse B9. B9 building entry alarm. Building inspected and it appears to be a result of a bad door lock. Alarm acknowledged. Down time: None.

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Maintenance Activities By Location
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TGRS, OU2
Arden Hills, Minnesota

Pumphouse B9

5/24/2021	Pumphouse B9. During preventative maintenance a leak from the riser pipe was discovered at B9. Contacted project team and vendor to set up repairs. Repairs will be completed during early June. Down time: None.
6/2/2021	Pumphouse B9. Pump was shut down at 0932 for riser pipe repairs. Upon removal of the riser pipes, leaks were observed at the bottom of the fourth pipe at the check valve and at the bottom of the fifth stick at the pump. The other three pipes showed considerable wear/corrosion on the threads and were replaced as well. The pump and motor were also replaced due to being in use for four years. Restarted pump at 1415. Observed normal operation. Down time: 5.0 hours.
6/6-7/2021	Pumphouse B1. During remote monitoring it was discovered that B1 was down due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and B5, B8, and B9 flow rates increased. B1 was reset at 0650 on 6/7/2021 and B5, B8, and B9 flow rates back to normal. Observed normal operation. Down time: 31.0 hours.
6/7-8/2021	Pumphouse B1. B1 was discovered down at 1713 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged. Reset VFD at the pumphouse and control panel. Left B1 shut down and B5, B8, and B9 flow rates were increased. Restarted B1 on 6/8/2021. Observed normal operation. Down time: 18 hours.
8/17-8/19/21	Treatment System and Pumphouses B13, B3, B8, and B9. Pump 4 motor repair pending, operating pump 3 only. Wells B8, B9, B3, and B13 turned off. Down time: B13, B3, B8, and B9 down for 72 hours.

Pumphouse B13

1/27/2021	Pumphouse B13. The limit switch on the ECV would not turn the pump off when activated. Performed troubleshooting work but to no avail. Possible programming issue. Down time: 2 hours.
8/17-8/19/21	Treatment System and Pumphouses B13, B3, B8, and B9. Pump 4 motor repair pending, operating pump 3 only. Wells B8, B9, B3, and B13 turned off. Down time: B13, B3, B8, and B9 down for 72 hours.

Pumphouse SC1

10/13/2020	Treatment System. Pumphouses B1, SC1 and SC5. Turned the pumps off to perform monthly maintenance. Following the work, turned the pumps back on and observed normal operation. Down time:1.5 hours at B1 and SC5. 4.5 hours at SC1.
10/29/2020	Pumphouse SC1. Arcadis pumped water from the work they were completing into the SC1 forcemain piping which reduced flow from the SC1 pump. Down time. 5.5 hours.
1/14-18/2021	Pumphouse SC1. The meter stopped totaling. Removed the meter, cleaned it and reinstalled the meter. Normal operation observed. Meter readings were estimated. Down time: None.
1/19-22/2021	Pumphouse SC1. The meter stopped totaling again. Replaced the meter with a meter from inventory. Restarted the pump and observed normal operation. Meter readings were estimated. Down time: None.
3/22/2021	Pumphouses SC1 and SC5. During the daily inspection, the iPad glitched and kicked out the previous data. Following the inspection, revisited the pumphouses and obtained the readings. Down time: None.
4/23-26/2021	Pumphouse SC1. Flow rate meter was not operational, pump was still operating normally. Pump was shut off. Flow meter was repaired and reinstalled. Pump was turned back on. Observed normal operation for the flow meter and pump. Down time: 1.5 hours.

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Maintenance Activities By Location
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TGRS, OU2
Arden Hills, Minnesota

Pumphouse SC1

5/17/2021	Pumphouse SC1. Pumping hose hooked up in SC1 pumphouse for well drilling supervised by Arcadis. Down time: None.
5/24/2021	Pumphouse SC1. Leak from one of the flow meter gaskets was discovered upon arrival. Pump was shut off. The bolts were tighten on the gasket. The tighten bolts did not resolve the leak. Both gaskets were removed and inspected. Gaskets were reinstalled and pump turned back on. Normal operation observed. Down time: 2.0 hours.
7/1/2021	Pumphouse SC1. Flow meter was discovered to not be rotating at 1702. Shut down pump, removed and cleaned flow meter. Reinstalled flow meter and restarted pump. Down time: 0.5 hour.
9/9-13/2021	SC1 Pumphouse. SC1 flow meter not turning, pump still operating. Flow meter cleaned and reinstalled. Observed normal operation. Down time: 0.5 hour.

Pumphouse SC5

10/13/2020	Treatment System. Pumphouses B1, SC1 and SC5. Turned the pumps off to perform monthly maintenance. Following the work, turned the pumps back on and observed normal operation. Down time:1.5 hours at B1 and SC5. 4.5 hours at SC1.
3/22/2021	Pumphouses SC1 and SC5. During the daily inspection, the iPad glitched and kicked out the previous data. Following the inspection, revisited the pumphouses and obtained the readings. Down time: None.
5/31/2021	Pumphouse SC5. Low low level alarm at SC5, alarm was acknowledged and flow rate was decreased. Normal operation observed. Down time: None.
6/5-11/2021	Pumphouse SC5. Low low level alarm at SC5, alarm was acknowledged. Normal operation observed. Down time: None.
6/14/2021	Pumphouse SC5. Low low level alarm at SC5, alarm was acknowledged. Lower SC5 low level standpoint to 4 ft. Normal operation observed. Down time: None.
6/17-18/2021	Pumphouse SC5. SC5 was discovered down at 1936 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and B8 flow rate increased. SC5 was reset on 6/18/2021 and observed normal operation. SC5 was discovered down again at 1035 due to VFD Faulted, UPS Power, and Pump Failed to Start alarms. Alarms acknowledged and pump restarted. Observed normal operation in the pumphouse and system ok light on. Down time: 20.0 hours.
6/19/2021	Pumphouse SC5. SC5 was discovered down at 0800 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and pump restarted. Observed normal operation. Down time: 23.5 hours.
6/20/2021	Pumphouse SC5. SC5 was discovered down at 0900 due to VFD Faulted and Pump Failed to Start alarms. Alarms acknowledged and pump restarted. Observed normal operation. Down time: 8.0 hours.
6/26/2021	Pumphouse SC5. Low low level alarm at SC5, alarm was acknowledged. Normal operation observed. Down time: None.
6/28/2021	Pumphouse SC5. Low low level alarm at SC5, alarm was acknowledged. Normal operation observed. Down time: None.

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Maintenance Activities By Location
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TGRS, OU2
Arden Hills, Minnesota

Pumphouse SC5

6/30/2021	Pumphouse SC5. SC5 was discovered down due to VFD Faulted, UPS Power, and Pump Failed to Start alarms. Alarms acknowledged and pump reset at 0745. Observed normal operation in the pumphouse and system ok light on. Down time: 20.5 hours.
7/2/2021	Pumphouse SC5. Upon arrival SC5 was off due to High-High Level, VFD Fault, and Pump Failed Start alarms. Alarms were acknowledged at 11:20, pump automatically restarted and operating normally. Alarms (VFD Fault and Pump Failed to Start) were triggered again at 11:57, the alarms were acknowledged and pump automatically restarted. Alarms (VFD Fault, Pump Failed to Start, and High-High Level) were triggered again, the alarms were acknowledged and the pump automatically restarted. The VFD Fault alarm triggered again at 12:30, went to SC5 pumphouse, the pump was off. Reset SC5 at pumphouse. Acknowledged alarms via remote connection, reset SC5 on control panel. Observed normal operation. Down time: 13.5 hours.
9/29-30/2021	Pumphouse SC5. SC5 shut down at 0810 on 9/29/2021 to complete electrical work needed for SGRS construction. Alarms disabled. SC5 restarted at 12:30 on 9/30/2021. Observed normal operation. Down time: 28.5 hours.

Treatment System

10/1/2020	Treatment System. Pump 3 starts but does not continue to operate normally. Contacted Preferred Electric. Turned the TGRS off. They diagnosed the problem was located in the motor control center (MCC) where the Pump 3 starter bucket contacts the MCC bus bar. The two were shorted and welded together. The parts were removed and taken to a vendor to be rebuilt. Following the work, the TGRS was restarted and normal operation was observed. Down time: 2 hours at B1 and B13. 1.5 hours at B6, B9, SC1 and SC5.
10/7/2020	Treatment System. Turned the TGRS off to install the motor control center parts for Pump 3. Following the work, turned the TGRS on and observed normal operation. While the TGRS was down, Preferred Electric installed wire runs from the blower pressure switches on the air ducts to Towers 3 and 4 to the main control panel. Arcadis programmed the new pressure switches to turn the TGRS off should either blower turn off. Down time: 7.5 hours at B1 and SC5. 7 hours at B3, B6 and SC1. 6 hours at B13. 5.5 hours at B9 and 4.5 hours at B8.
10/13/2020	Treatment System. Pumphouses B1, SC1 and SC5. Turned the pumps off to perform monthly maintenance. Following the work, turned the pumps back on and observed normal operation. Down time:1.5 hours at B1 and SC5. 4.5 hours at SC1.
11/1/2020	Treatment System and Well Field. Daylight Savings occurred. Modified the meter readings by one hour. Down time: None.
12/17/2020	Building 116. The buildings main power transformer failed which shut down power to the TGRS main control panel. Contacted Preferred Electric and they removed and replaced the transformer. Following the work, restarted the TGRS and observed normal operation. Down time: 24 hours at B1, B13, B3, B6, B8, SC1 and SC5; 20 hours at B4 and B5; 3 hours at B9.
12/25/2020	Christmas Day holiday. The daily inspection was not performed. Meter readings were estimated. Down time: None.
1/1/2021	New Years Day Holiday. The daily inspection was not performed. Meter readings were estimated. Down time: None.
1/5/2021	Treatment System and Well Field. Call from Time Communication - TGRS fail. At the site there was no power to the treatment system or the pumphouses. Xcel Energy was on site and working on a power pole across County Highway 10 from Scherer Brothers Lumber. A vehicle slid into a power pole and snapped it in half which stopped power from reaching the Site. Xcel Energy installed a new power pole and restored power to the site at 5 PM. The TGRS was restarted at 6 PM. Down time: 7 hours at B13; 9 hours at B9; 10 hours at B3; 11 hours at B6, B8, SC1 and SC5; 11.5 hours at B1.

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Maintenance Activities By Location
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TGRS, OU2
Arden Hills, Minnesota

Treatment System

1/13/2021	Treatment System and Well Field. At the PLC, observed the uninterruptable power supply (UPS) was off and would not reset. Turned the TGRS off and removed and inspected the UPS and determined it was not repairable. Restarted the TGRS and ordered a replacement UPS. Down time: 2 hours at B1 and 2 hours at SC5.
1/28/2021	Treatment System. Turned the TGRS off and installed a new UPS in the Main Control Panel. Following the work, turned the TGRS on and observed normal operation. Down time: 1 hour.
1/30-31/2021	The weekend daily inspections were performed remotely by logging into software to view the real time status of the PLC and by reviewing hourly data collected by the on-site data logger, which is compiled within an automated daily email. With the ability to remotely monitor the TGRS, it has been determined that, going forward, on-site inspections will be performed on Mondays, Wednesdays and Fridays of each week. GHD will be doing at least a virtual inspection of the TGRS components every day and respond on Site if anything the requires immediate action. Down time: None.
2/18/2021	Treatment System. Turned the TGRS off as part of the monthly maintenance work. Following the work, turned the system back on and observed normal operation. Down time: None.
3/31/2021	Treatment System. Turned the TGRS off as part of the monthly maintenance work. Following the work, turned the system back on and observed normal operation. Down time: None.
4/16/2021	Treatment System. 1,400-gallons of drilling water was poured into Wet Well 1 by Arcadis. Drilling water is awaiting treatment. Down time: None.
4/20/2021	Treatment System. 500-gallons of drilling water was poured into Wet Well 1 by Arcadis. Drilling water is awaiting treatment. Down time: None.
4/30/2021	Treatment System. Turned the TGRS off as part of the monthly maintenance work. Following the work, turned the system back on and observed normal operation. Down time: None.
6/15/2021	Treatment System and Well Field. GHD on site with Preferred Electric conducting annual electrical inspection. Treatment system and wells off. Down time: 6 hours at SC5, SC1, B1, B13, B3, B4, B5, B6, B8, and B9
7/19/2021	Treatment System and Well Field. Site-wide power outage. Various alarms at each well. Reset treatment system and wells. Normal operation observed. Down time: 2.0 hours at B1, 2.0 hours at B4, 1.5 hours at B5, 2.0 hours at B6, 2.0 hours at B8, 2.0 hours at B9, 1.5 hours at SC1, and 1.5 hours at SC5.
7/21/2021	Treatment System. Installed WWP-2 power tub in the MCC. Tested pump and electric check valve operation, operation was normal. Treated the drilling water in wet well 2 (dumped by Arcadis in June) through AST #3. Tripped wet well 1,2 low level alarm. Disabled alarm for now. Down time: 2.0 hours at B1, 2.0 hours at B4, 2.0 hours at B5, 2.0 hours at B6, 2.0 hours at B8, 2.0 hours at B9, and 2.0 hours at SC5.
7/29/2021	Treatment System and Well Field. Normal monthly preventative maintenance was conducted. Down time: None.

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Maintenance Activities By Location
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TGRS, OU2
Arden Hills, Minnesota

Treatment System

8/14/2021	Treatment System and Well Field. CP AC Power Fail and UPS Fail alarms along with other various failed to start alarms resulting in the entire treatment system and well field to shut down. Acknowledged alarms and reset PLC firewall. Attempted to reset system, Pump 3 and Pump 4 failed to start. Reset system and cycled power to pumps, pumps failed to started. Determined there was an issue with a UPS power supply or fuses. Called Preferred Electric to assist with repairs. Left treatment system and well field shut down. Down time: B1, B13, B3, B4, B5, B6, B8, B9, SC1, and SC5 for 12.5 hours.
8/15/2021	Treatment System and Well Field. Preferred Electric on site with GHD. Through some testing, it was determined that there was no issue with the fuses, but that the PLC control panel was receiving high power voltages (144v instead of 120v). The high incoming power resulted in the UPS in the PLC control panel to fail. A replacement UPS is needed for the treatment system to operate normally. Left treatment system and well field shut down until replacement UPS can be installed. Down time: B1, B13, B3, B4, B5, B6, B8, B9, SC1, and SC5 for 24.0 hours.
8/16/2021	Treatment System and Well Field. A replacement UPS with higher voltage capacity was purchased and installed in the PLC control panel. Replacement UPS kept switching from battery to line voltage. Connected PLC to generator for alternate power source. Restarted PLC and reset firewall. Restarted Pump 4, pump would not start. Restarted Pump 3, pump would not start. Shut down PLC. Called Preferred Electric and Xcel to assist. Preferred Electric on site at 1445. Verified that the incoming power is very unbalanced and the phase to phase volts are very high. MCC WWP-4 cabinet A and C phase fuses are blown. Xcel determined that there was an open fuselink straight west of Building 116. The fuselink was closed and incoming power dropped to normal range. Restarted PLC and treatment system. Pump 4 not operational due to motor issues. Pump 4 motor has a dead short or short to ground and must be rebuilt. Restarted PLC and Pump 3. Started wells B1, B4, B5, B6, SC1 and SC5. System operating normally at low flow (~1,400 gpm). Down time: B1, B4, B5, and SC5 for 20.5 hours, B13 and B3 for 19.5 hours, B6 for 21.5 hours, B8 and B9 for 24 hours, and SC1 for 15 hours.
8/17-8/19/21	Treatment System and Pumphouses B13, B3, B8, and B9. Pump 4 motor repair pending, operating pump 3 only. Wells B8, B9, B3, and B13 turned off. Down time: B13, B3, B8, and B9 down for 72 hours.
8/20/2021	Treatment System. System down due to Pump 4 motor repairs. Pump 4 motor repaired and treatment system and entire well field back running at 1700. Observed normal operation. Down time: B1, B4, B5, B6, SC1, and SC5 for 4.5 hours, B13 for 2.0 hours, B3 for 13.0 hours, and B8 and B9 for 18.0 hours.
8/26/2021	Treatment System and Well Field. Normal monthly preventative maintenance was conducted. Down time: None.
9/7/2021	Treatment System. Alarms MCP P203 Failed to Start, MCP WW3 LSHH 301, and MCP P203 PS Failed to Close. Alarms acknowledged and cleared. Restarted treatment system. Autodialer called out due to WWP4 off for more than 30 minutes. WWP3 and 4 operating normally. Alarm MCP P203 PS Failed to Close, adjusted opening/closing speed values. Observed normal operation. Down time: None.
9/9/2021	Treatment System and Well Field. Received autodialer call at 04:38 and no alarm emails. Alarms P203 Failed to Start and WW3 LSHH 301 on main control panel. Treatment system and well field down. Acknowledged alarms. Started treatment system. Received alarm emails MCP P203 Valve Failed to Open and WW3 LSHH 301 at 17:07. Adjusted opening/closing speed values and restarted system. Observed normal operation. Down time: B1, B4, B5, B6, and B9 for 3.5 hours, B8 and SC5 for 3.0 hours, B13 and B3 for 1.5 hours, and SC1 for 9 hours.
9/12/2021	Treatment System. Received autodialer call at 05:25 and no alarm emails. Alarms P203 Failed to Start and WW3 LSHH 301 on main control panel. Treatment system and well field down. Checked WWP3 overloads and determined they were tripped. Reset WWP3 overloads. Acknowledged alarms. Started treatment system. Observed normal operation. Down time: None.

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Arden Hills, Minnesota

Treatment System

9/14/2021	Treatment System. Shut down treatment system and WWP3 at 08:54. Disabled autodialer. Replaced overloads for WWP3. Restarted system and observed normal operation. Down time: None.
9/24/2021	Treatment system and Well Field. Conducted routine monthly preventative maintenance. Down time: None.

Appendix H

TGRS Chemical Data

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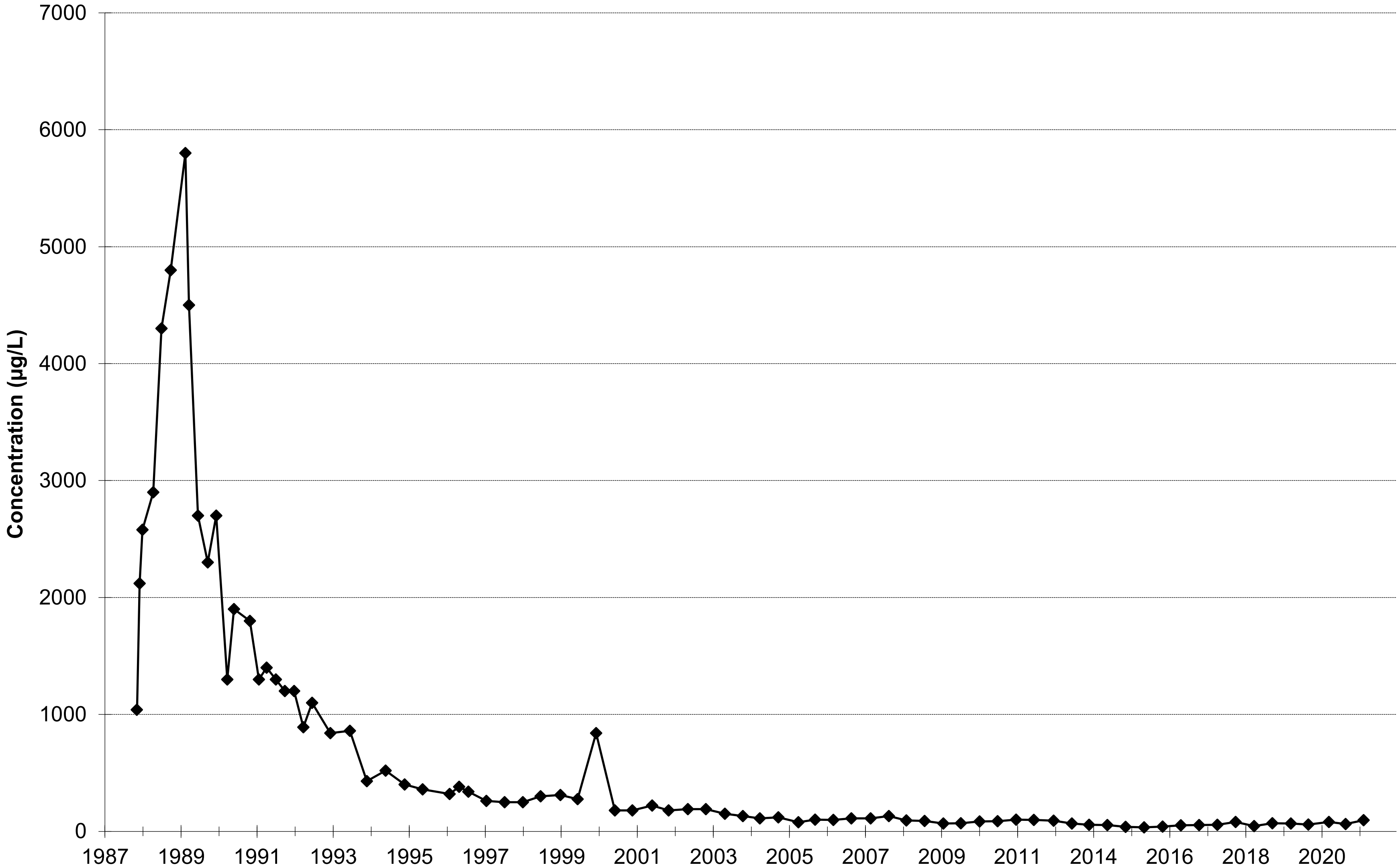
APPENDIX H.1

EXTRACTION WELL B1 - TCE VS.TIME

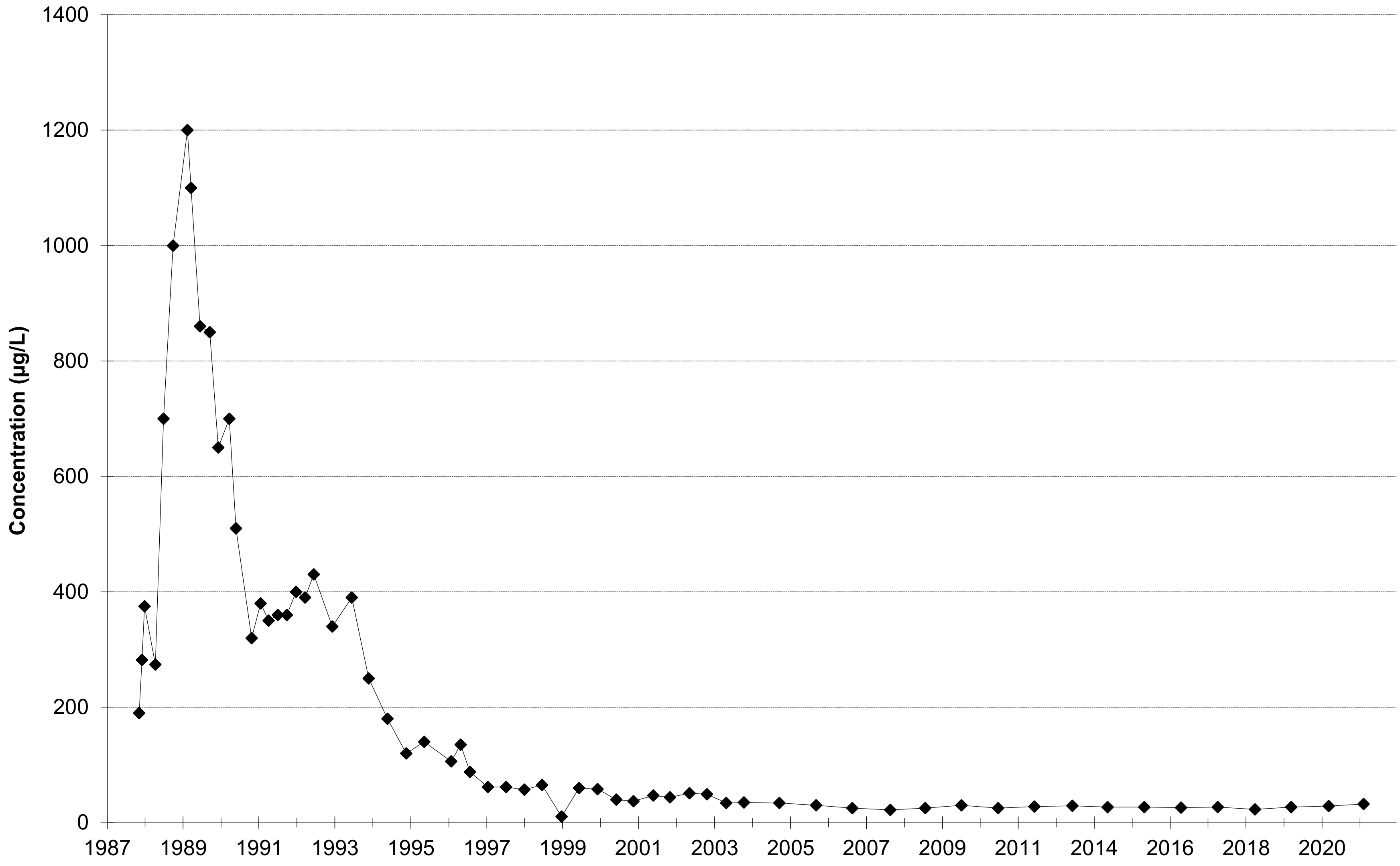


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL B2 - TCE VS. TIME

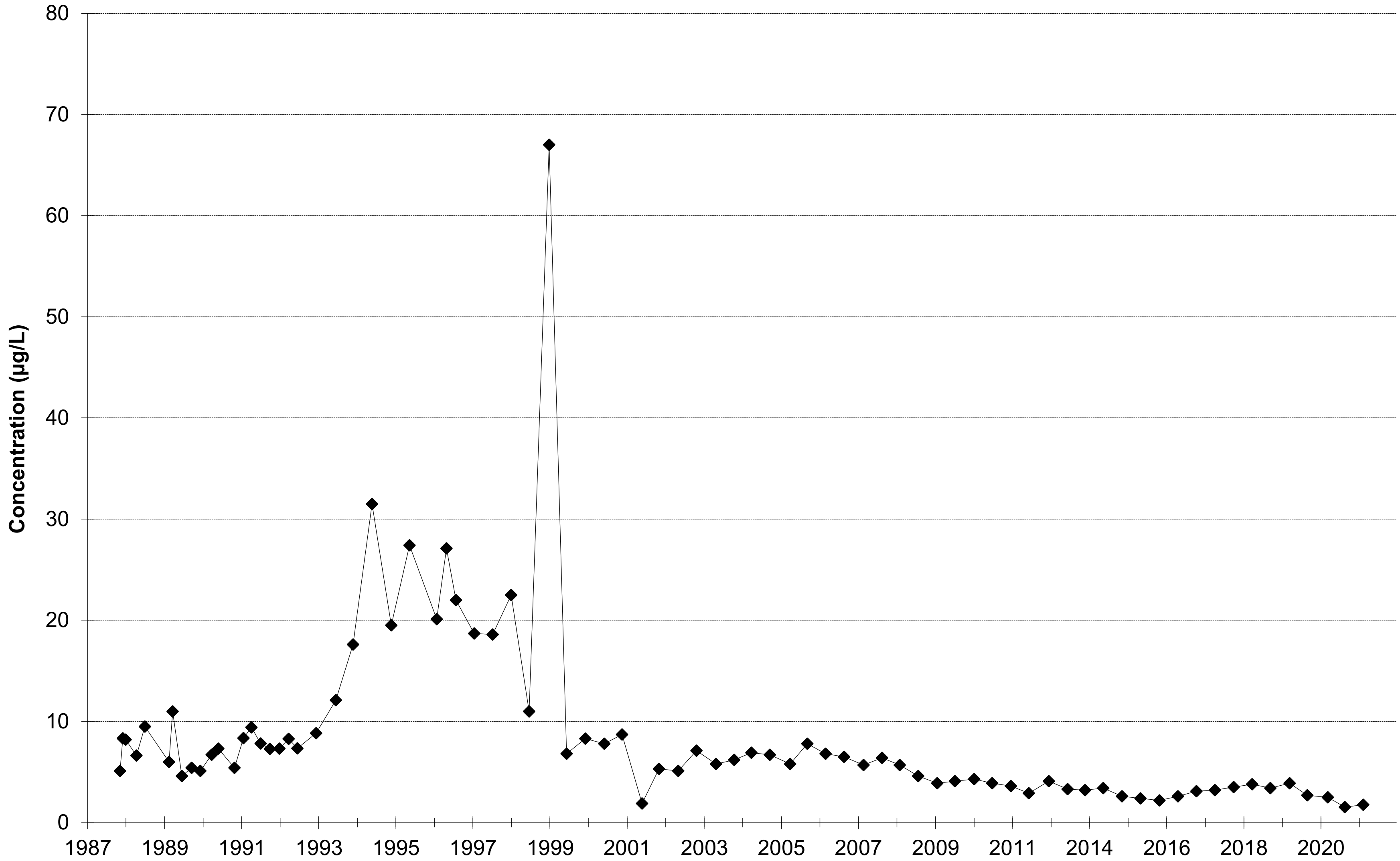


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL B3 - TCE VS. TIME

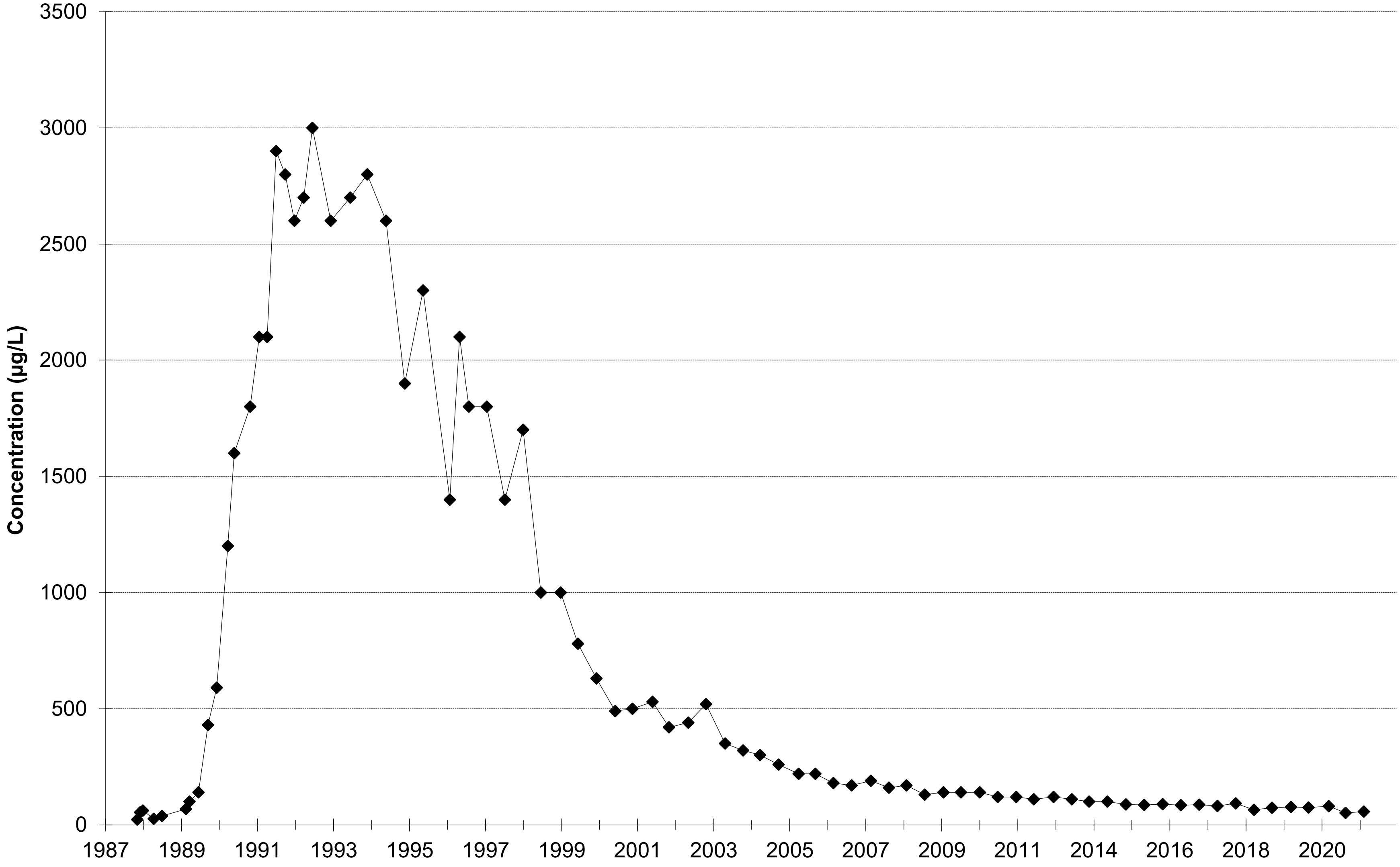


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL B4 - TCE VS. TIME

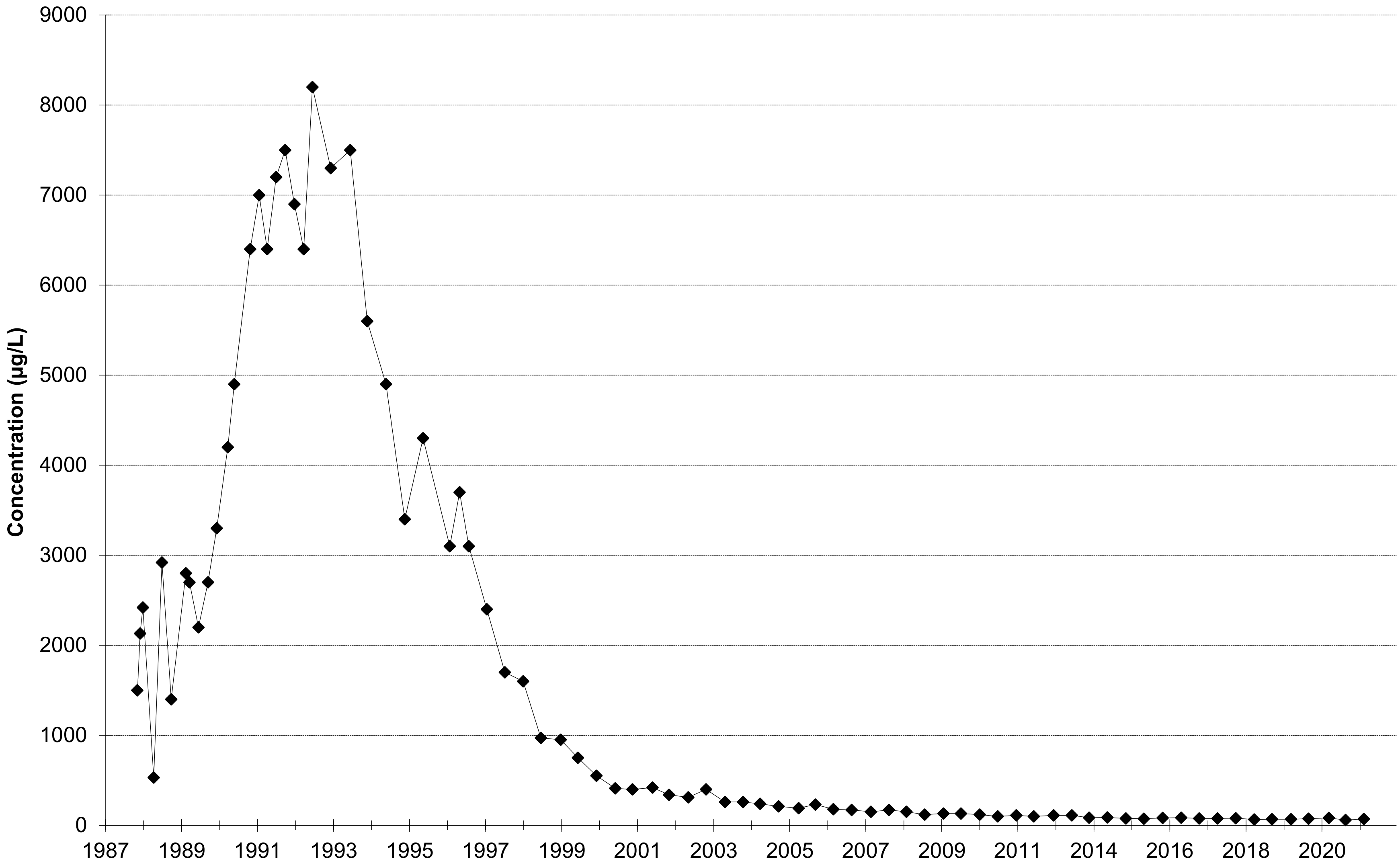


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL B5 - TCE VS. TIME

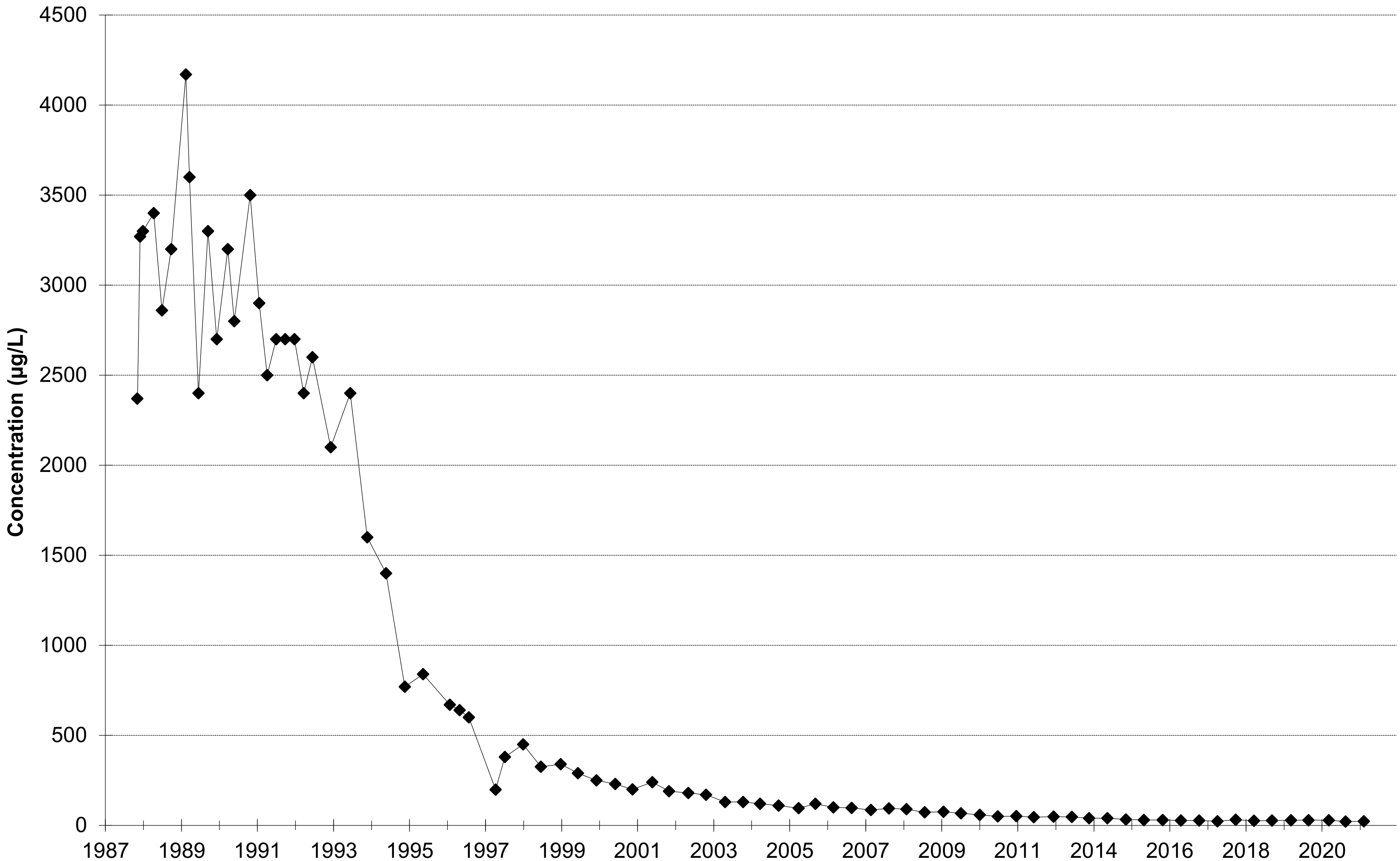


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL B6 - TCE VS. TIME

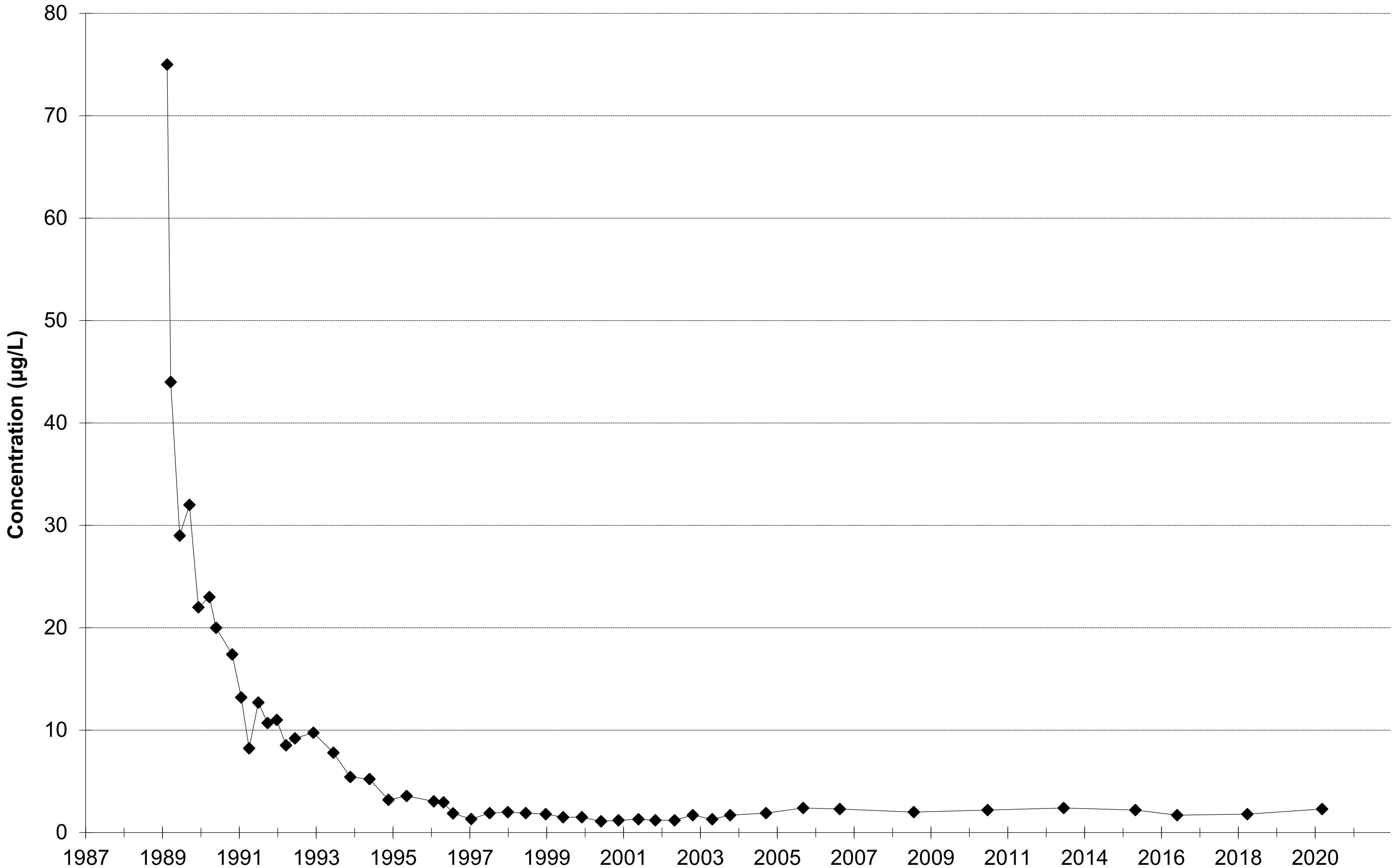


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL B7 - TCE VS. TIME

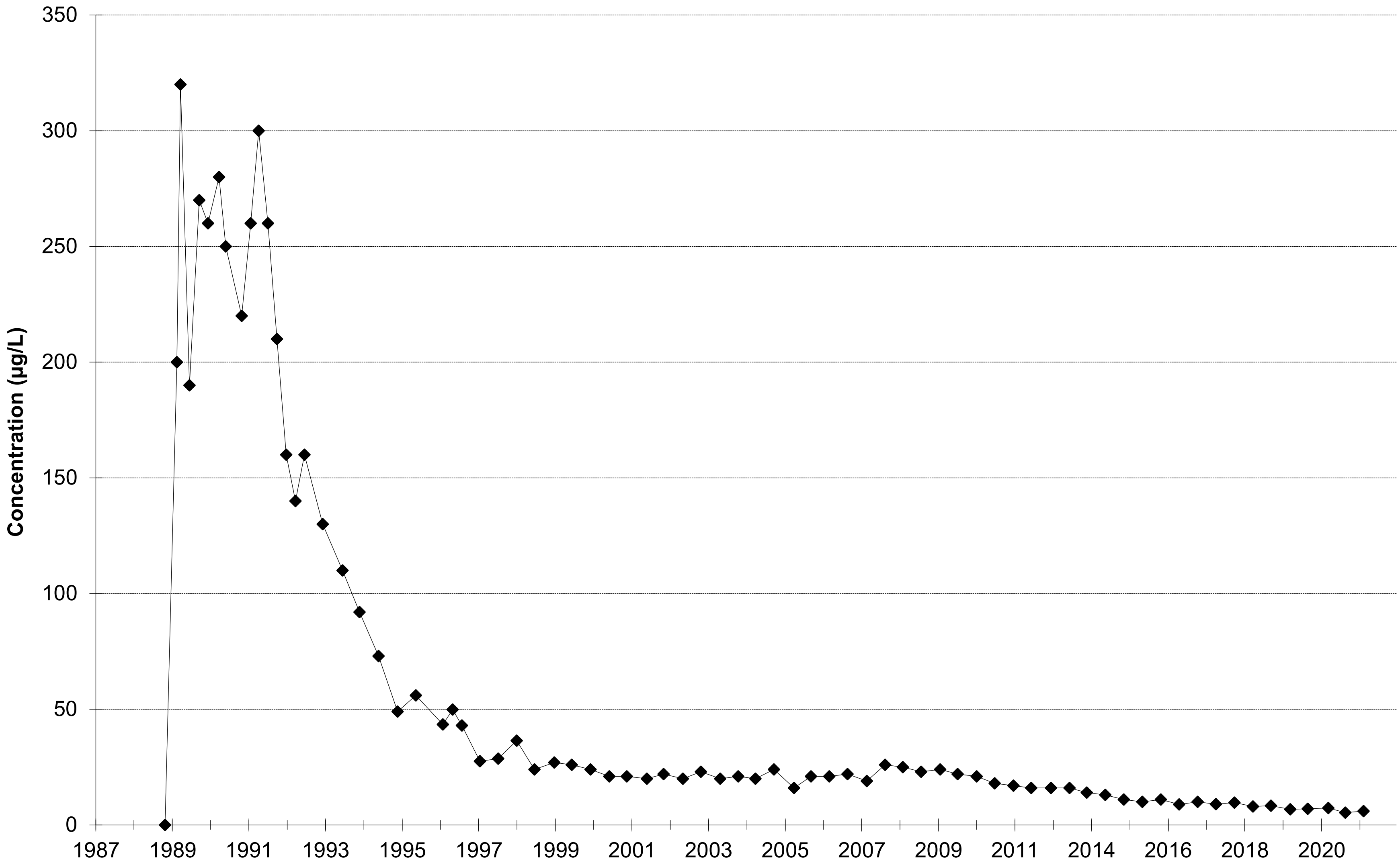


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL B8 - TCE VS. TIME

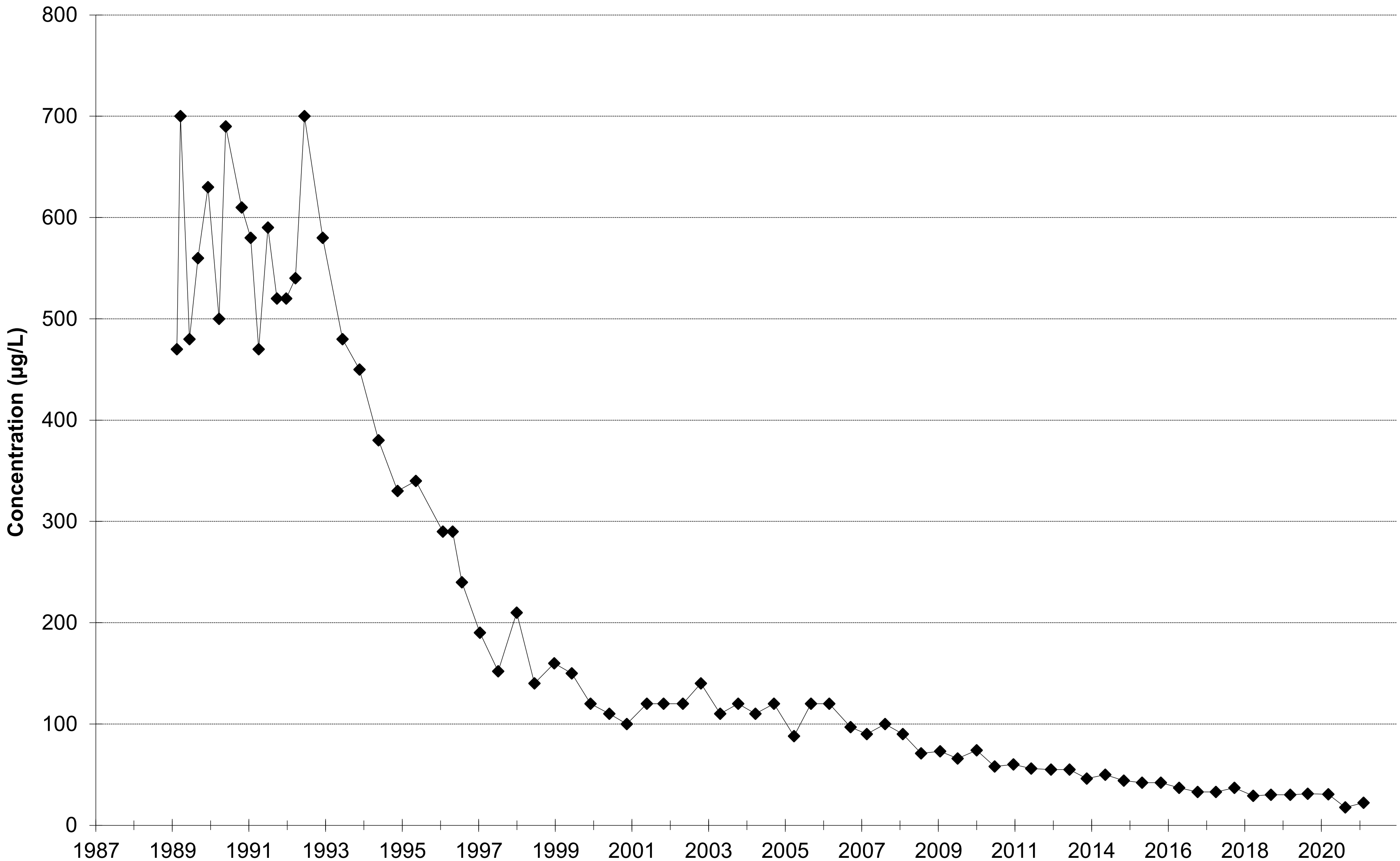


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL B9 - TCE VS. TIME

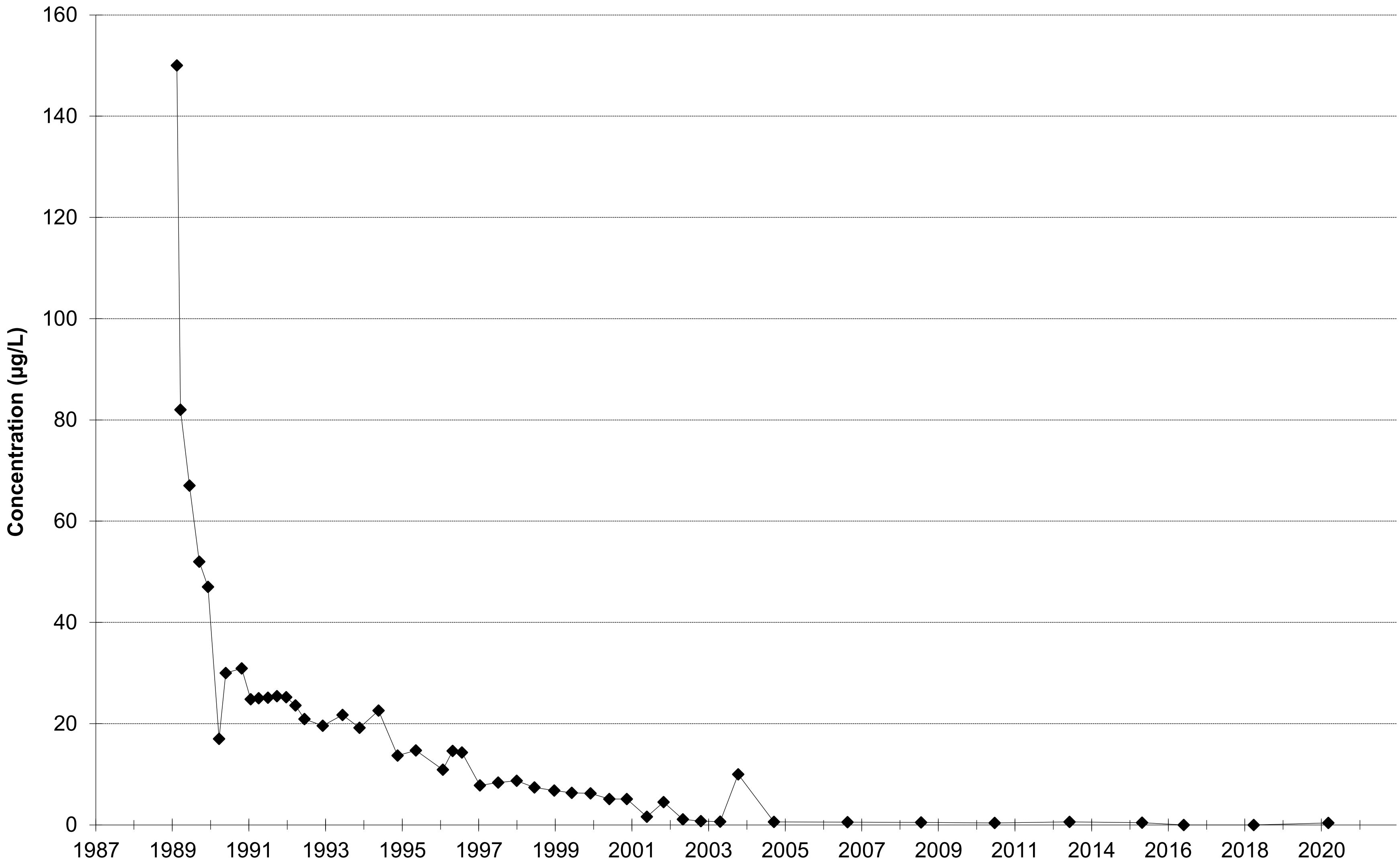


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL B10 - TCE VS. TIME

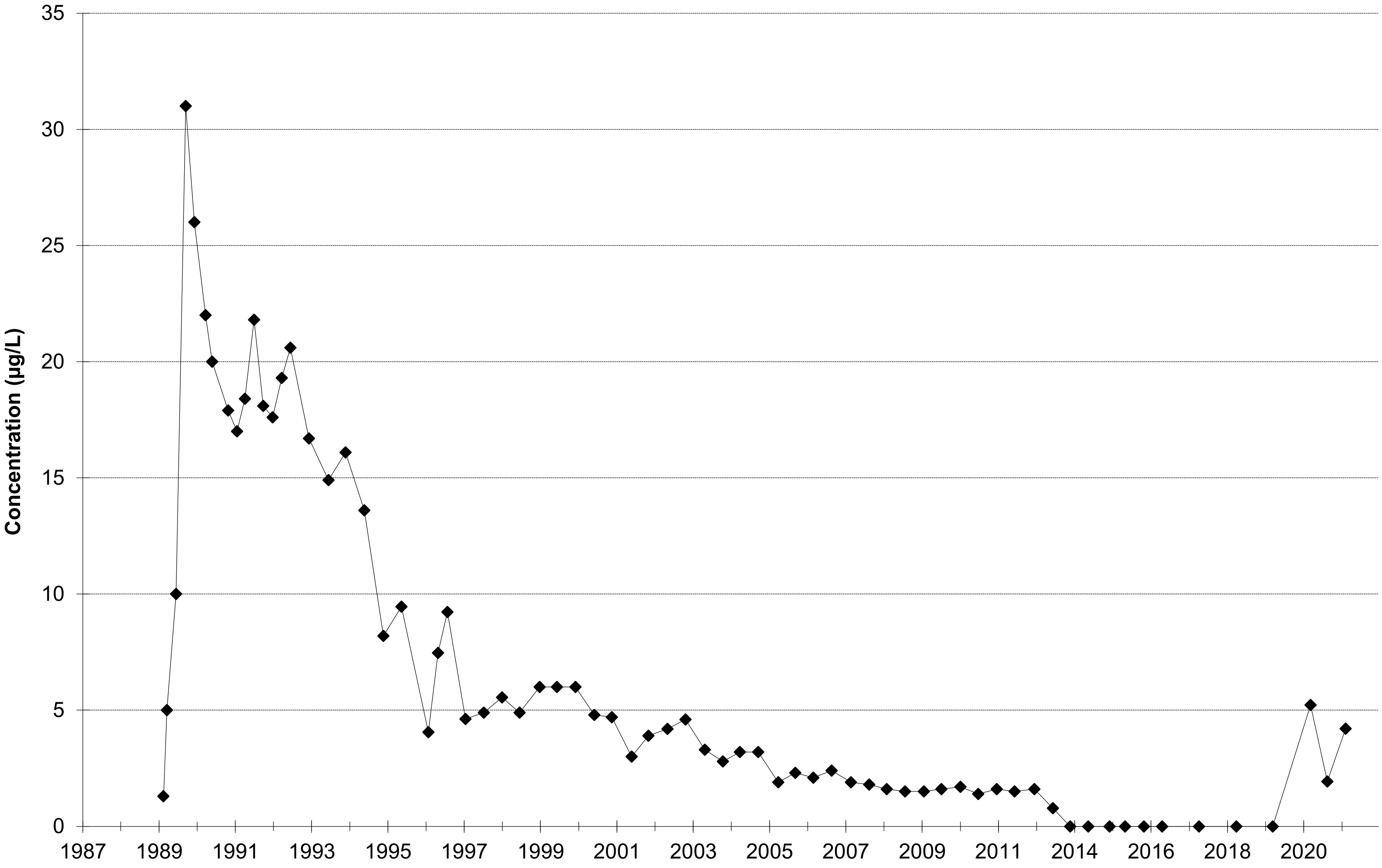


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL B11 - TCE VS. TIME

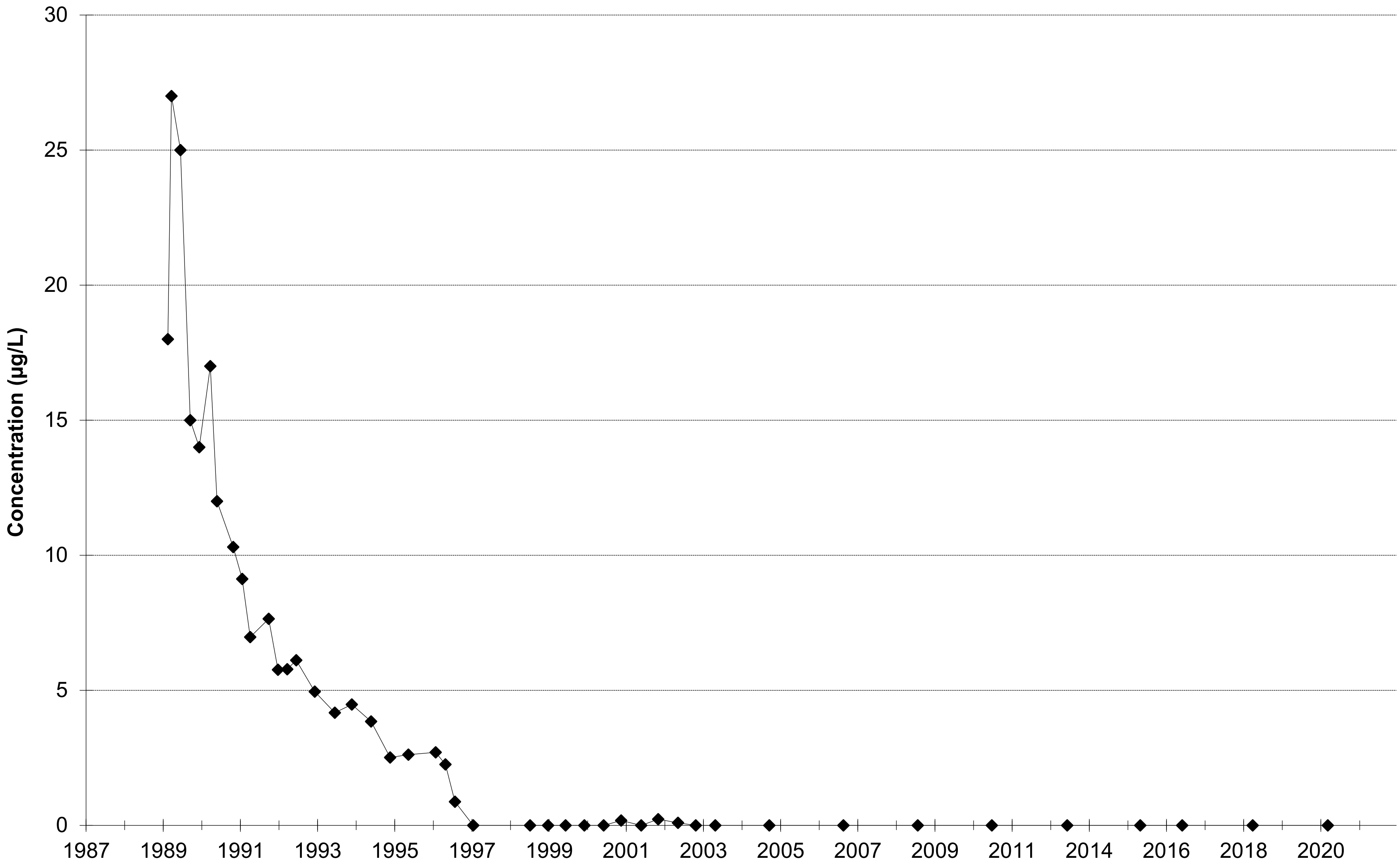


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL B12 - TCE VS. TIME

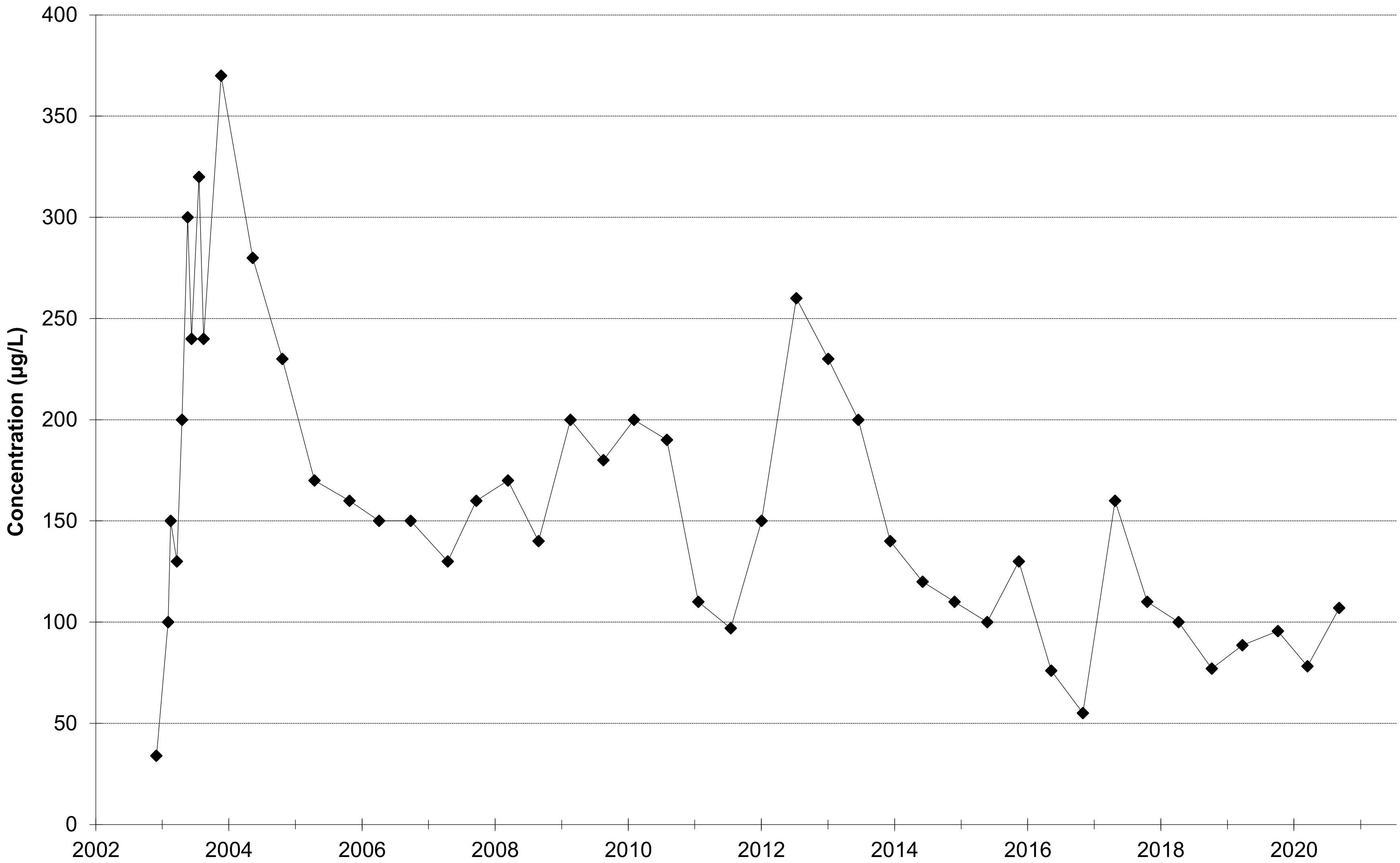


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL B13 - TCE VS. TIME

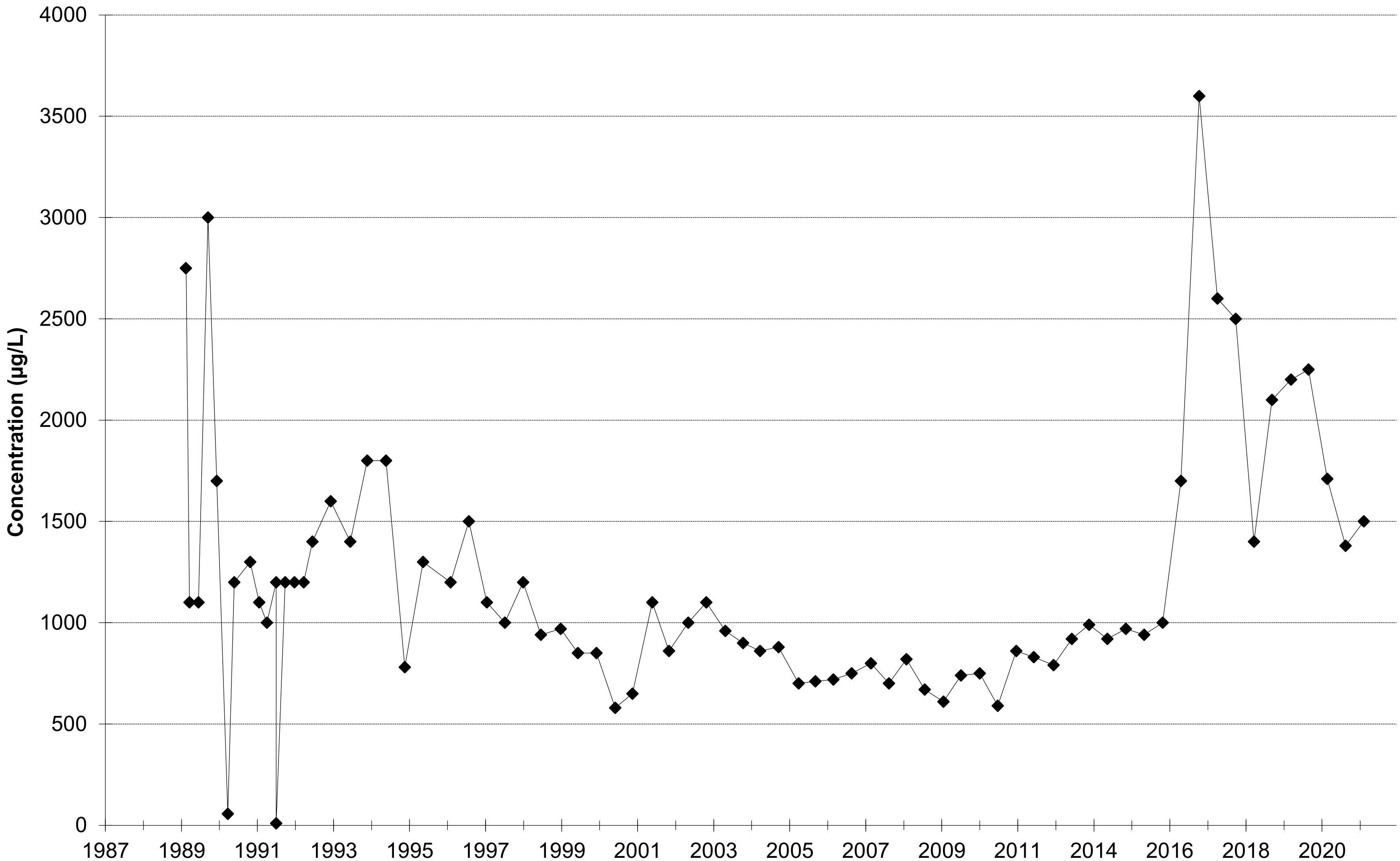


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL SC1 - TCE VS. TIME

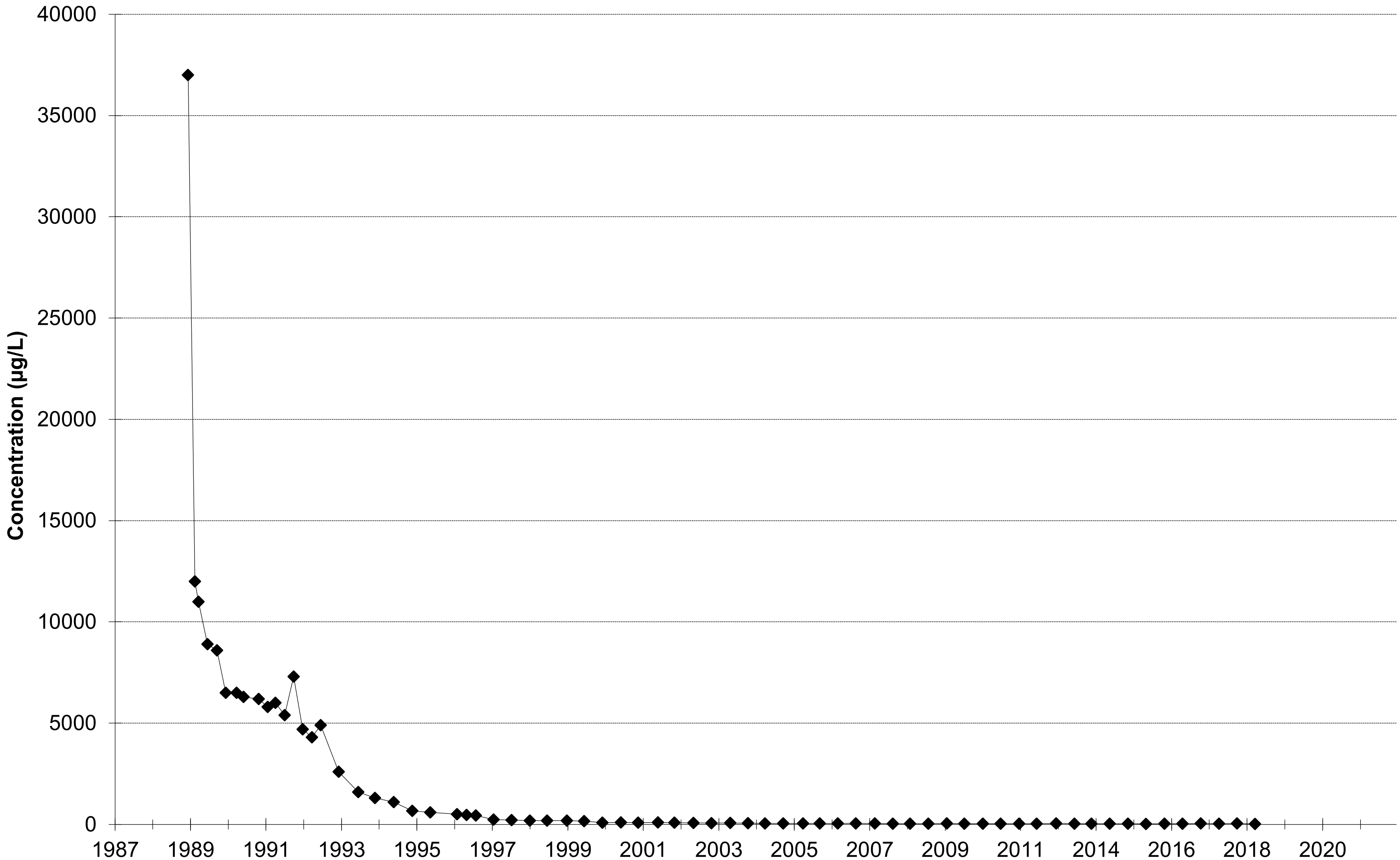


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL SC2 - TCE VS. TIME

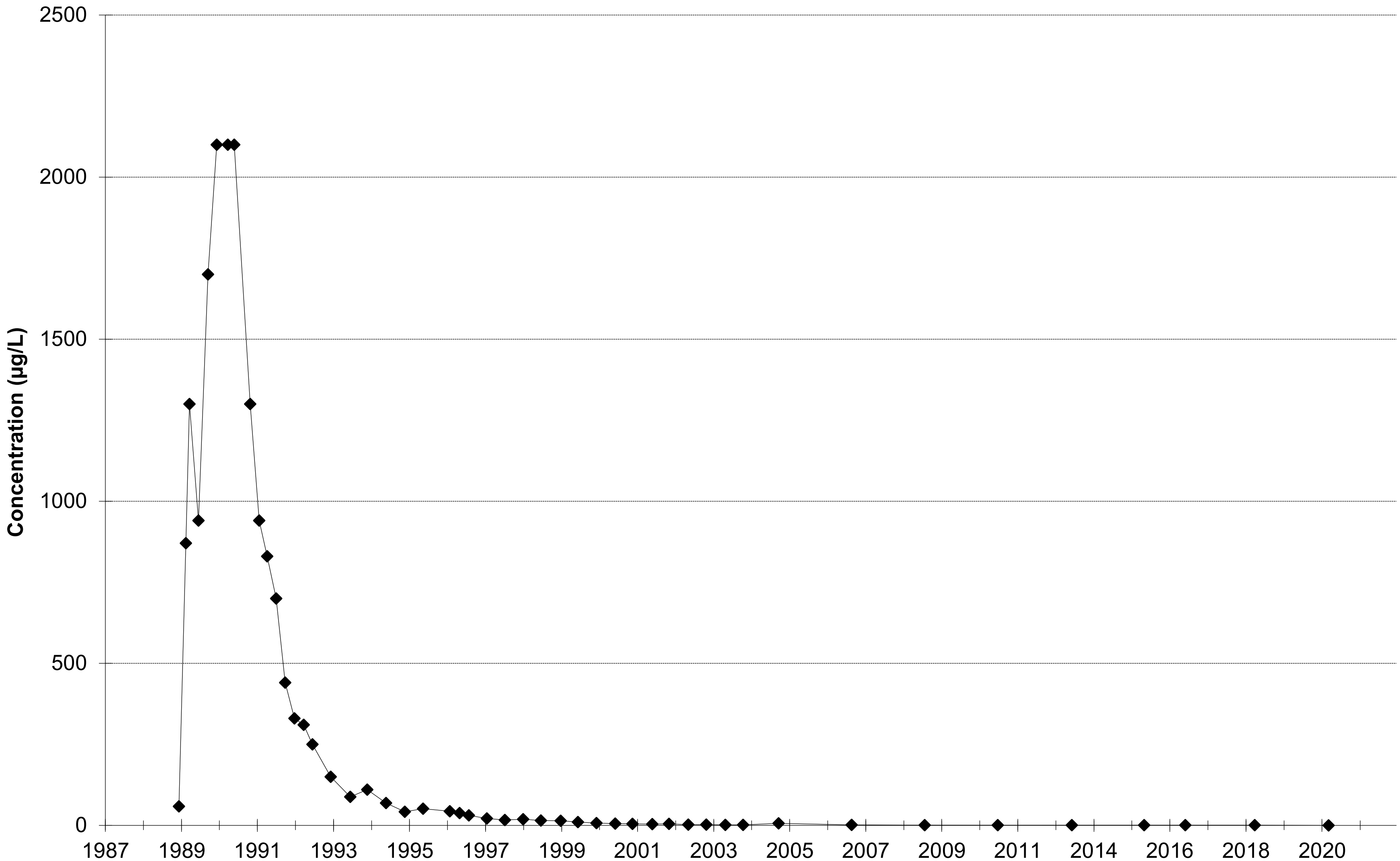


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL SC3 - TCE VS. TIME

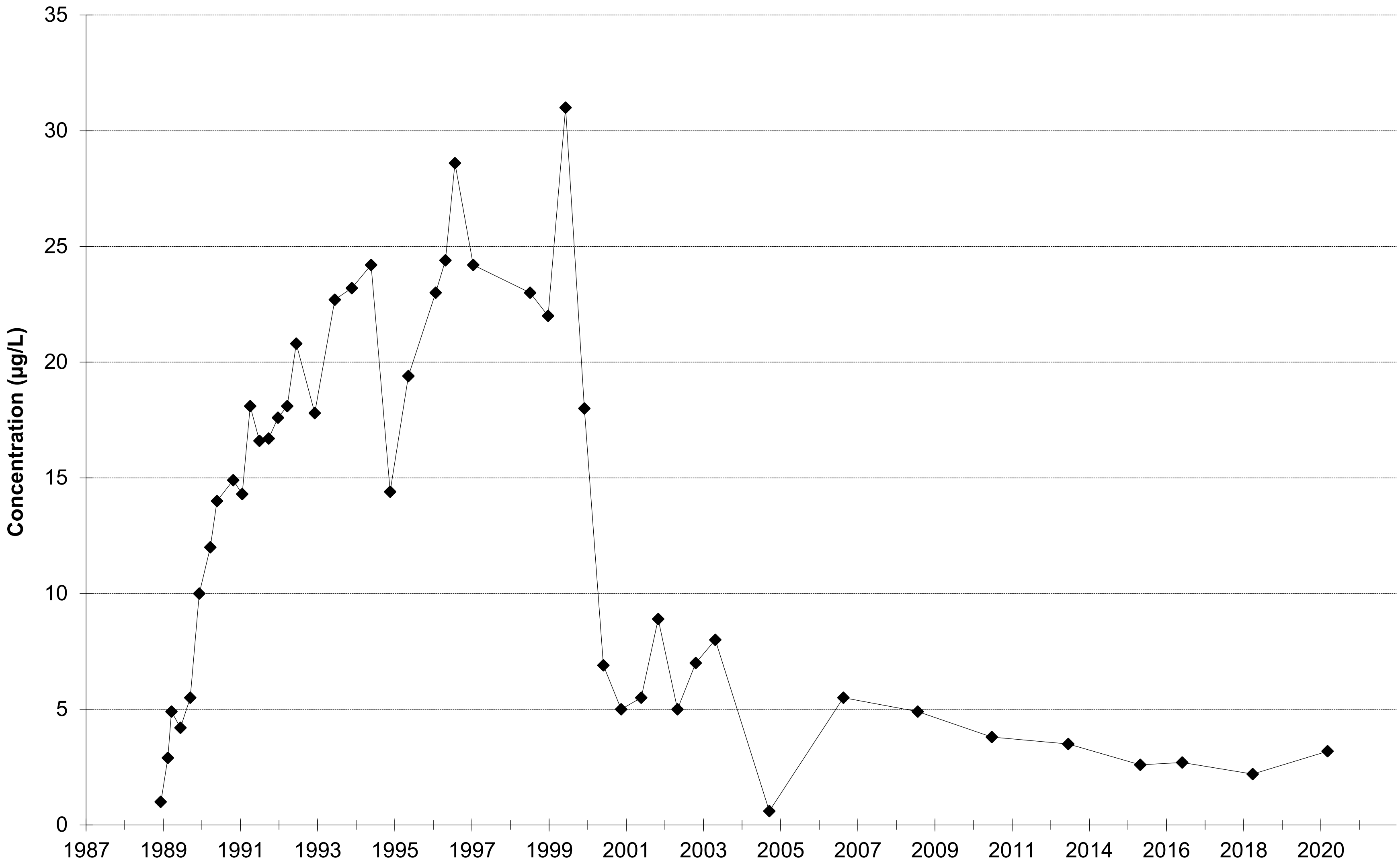


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL SC4 - TCE VS. TIME

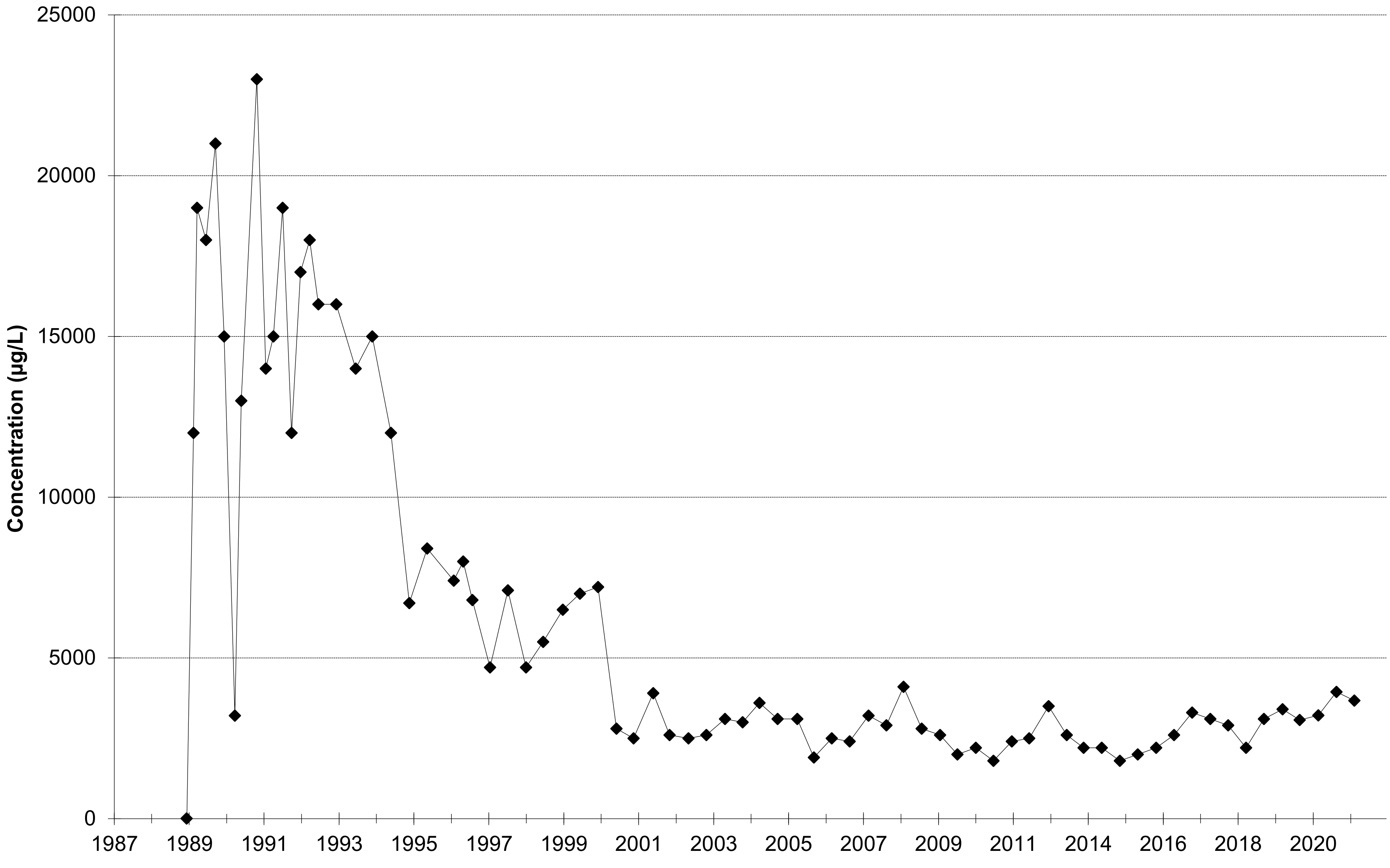


Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

APPENDIX H.1

EXTRACTION WELL SC5 - TCE VS. TIME



Note: Samples reporting concentrations less than the detection limit were plotted as zero.

GHD 11221407 (1)

Appendix H.2

Influent/Effluent Database
Fiscal Year 2021
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	7.0	5.0	5.0
Location	Date		ug/L	ug/L	ug/L	ug/L	ug/L	ug/L	ug/L
TGRSE	10/08/2020		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	2.80 JPJL126
TGRSE	11/04/2020		0.284 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	2.17
TGRSE	11/04/2020	D	0.302 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	2.27
TGRSE	12/09/2020		0.320 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.96
TGRSE	12/09/2020	D	0.272 JP	< 1.00	< 4.00	< 1.00	< 1.00	< 1.00	1.92
TGRSE	01/08/2021		0.325 JP	< 1.00	< 4.00	< 1.00	< 1.00	< 1.00	2.53
TGRSE	01/08/2021	D	0.299 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	2.50
TGRSE	02/03/2021		0.311 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	2.18
TGRSE	03/04/2021		0.550 JP	< 1.00	< 1.00	< 1.00	0.132 JP	< 1.00	2.53
TGRSE	03/04/2021	D	0.490 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	2.36
TGRSE	04/01/2021		0.219 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	2.13
TGRSE	04/01/2021	D	0.226 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.98
TGRSE	05/03/2021		0.220 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.74
TGRSE	05/03/2021	D	0.248 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.68
TGRSE	06/01/2021		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.43
TGRSE	07/02/2021		< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.15
TGRSE	07/02/2021	D	< 1.00	< 1.00	< 1.00	< 1.00	0.146 JP	< 1.00	1.29
TGRSE	08/05/2021		0.245 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	2.17
TGRSE	08/05/2021	D	0.228 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	1.98
TGRSE	09/01/2021		0.271 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	2.28
TGRSE	09/01/2021	D	0.289 JP	< 1.00	< 1.00	< 1.00	< 1.00	< 1.00	2.27

Appendix H.2

Influent/Effluent Database
Fiscal Year 2021
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 ug/L	70 ug/L	6.0 ug/L	4.0 ug/L	7.0 ug/L	5.0 ug/L	5.0 ug/L
Location	Date								
TGRSI	10/08/2020		44.5	2.11	4.20	< 1.00	3.39	2.08	254
TGRSI	10/08/2020	D	34.5	1.96 JP	< 5.00	< 5.00	3.10 JP	< 5.00	234 JPJL126
TGRSI	11/04/2020		39.1	2.27 JP	3.18 JP	< 5.00	3.42 JP	< 5.00	200
TGRSI	12/09/2020		38.0	2.12 JP	2.28 JP	< 5.00	2.41 JP	1.53 JP	167
TGRSI	01/08/2021		37.5	2.01 JP	2.19 JP	< 5.00	2.72 JP	< 5.00	207
TGRSI	02/03/2021		47.5	2.25	3.45	< 1.00	2.97	1.49	203
TGRSI	02/03/2021	D	37.0	1.88 JP	2.62 JP	< 5.00	3.04 JP	< 5.00	191
TGRSI	03/04/2021		46.1	2.49	3.78	< 1.00	3.61	1.36	168
TGRSI	04/01/2021		37.1	1.99	2.94	< 1.00	2.74	1.29	200
TGRSI	05/03/2021		32.9	1.78	2.53	0.131 JP	2.33	1.31	184
TGRSI	06/01/2021		30.0	1.55	2.36	< 1.00	2.46	1.26	154
TGRSI	06/01/2021	D	30.2	1.52	2.40	0.123 JP	2.50	1.30	145
TGRSI	07/02/2021		8.35	1.32 JP	1.79 JP	< 5.00	5.89	< 5.00	114
TGRSI	08/05/2021		34.2	1.72	2.63	< 1.00	2.93	1.50	171
TGRSI	09/01/2021		40.4	2.03	3.07	< 1.00	2.82	1.42	197

Notes:
(1) Cleanup levels for TGRS are from the OU2 ROD

D - Field Duplicate

JP - Report is qualified as estimated; the detection is below the laboratory reporting limit and greater than the method detection limit

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

Appendix I

Maros Decision Matrix

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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

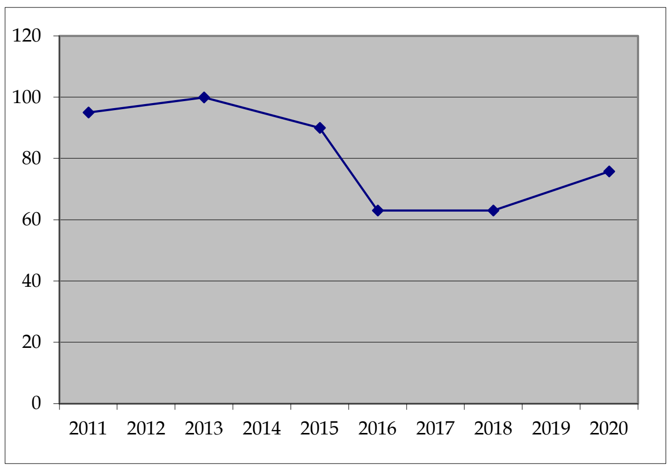
Kendall S	Confidence
1	50.00%
3	64.00%
5	76.50%
7	86.40%
9	93.20%
11	97.20%
13	99.17%
15	99.86%

WELL 03L673
MANN-KENDALL STATISTICAL ANALYSIS
OU3 - 2020

Date	TCE (µg/l)	Mann-Kendall Calculation:							
6/24/2011	**95**	1							
6/27/2013	**100**	1	1						
6/12/2015	**90**	1	-1	-1					
7/26/2016	**63**	1	-1	-1	-1				
8/29/2018	**63**	1	-1	-1	-1	0			
6/4/2020	**75.8**	1	-1	-1	-1	1	1		

N	6	5	4	3	2	1	0		15
sum		-3	-4	-3	1	1	0	Kendall S	-8
Possibles	15								
								Kendall tau	-0.533

Mean	81.13
STNDEV	16.2045
COV	0.1997
Trend:	Negative
Confidence (lookup)	89.81%



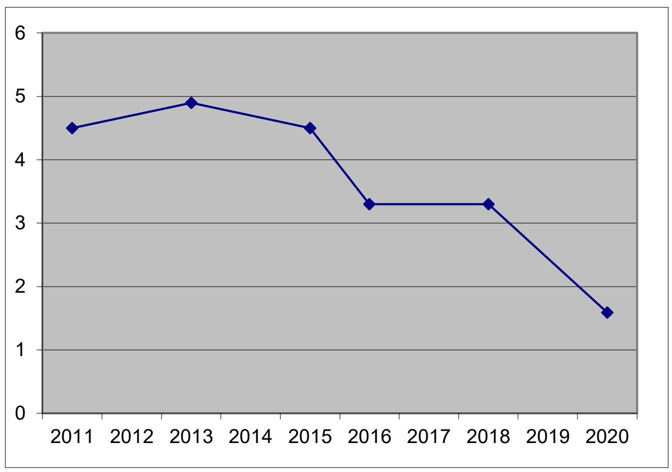
Raw Data
03L673

Date	TCE		Date	TCE	
11/12/1987	1200		6/21/2007	110	
5/2/1990	3200		6/18/2009	110	
3/11/1991	2000		6/24/2011	95	
3/11/1991	1900	D	6/27/2013	100	
6/17/1991	5500		6/27/2013	100	D
3/12/1992	3900		6/12/2015	90	
3/3/1993	2100		7/26/2016	63	
3/4/1994	3300		6/29/2018	63	
6/6/1994	2000		6/4/2020	75.8	
6/6/1994	2000	D			
9/14/1994	1600				
12/8/1994	1400				
3/15/1995	910				
6/12/1996	650				
6/12/1997	240				
6/25/1998	270				
6/4/1999	280				
6/12/2001	24				
6/1/2003	6.3				
6/1/2004	180				
6/22/2005	150				

WELL 03L848
MANN-KENDALL STATISTICAL ANALYSIS
OU3 - 2020

Date	TCE (µg/l)	Mann-Kendall Calculation:								
6/24/2011	**4.5**	1								
6/27/2013	**4.9**	1	1							
6/11/2015	**4.5**	1	0	-1						
7/27/2016	**3.3**	1	-1	-1	-1					
6/28/2018	**3.3**	1	-1	-1	-1	0				
6/4/2020	**1.59**	1	-1	-1	-1	-1	-1			
	N	6	5	4	3	2	1	0		15
	sum		-2	-4	-3	-1	-1	0	Kendall S	-11
	Possibles	15								
									Kendall tau	-0.733

Mean	3.68
STNDEV	1.2239
COV	0.3324
Trend:	Negative
Confidence (lookup)	97.20%



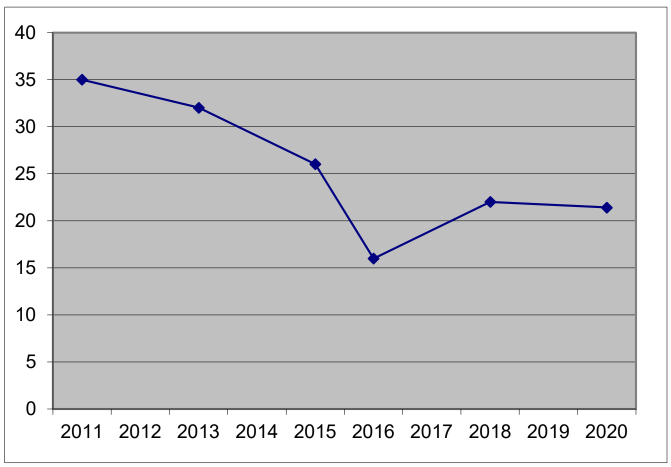
Raw Data
03L848

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	6/4/2020	1.59
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 - 2020

Date	TCE (µg/l)	Mann-Kendall Calculation:								
6/24/2011	**35**	1								
6/24/2013	**32**	1	-1							
6/12/2015	**26**	1	-1	-1						
7/26/2016	**16**	1	-1	-1	-1					
6/29/2018	**22**	1	-1	-1	-1	1				
6/4/2020	**21.4**	1	-1	-1	-1	1	-1			
	N	6	5	4	3	2	1	0		15
	sum		-5	-4	-3	2	-1	0	Kendall S	-11
	Possibles	15								
									Kendall tau	-0.733

Mean	25.40	
STNDEV	7.0993	
COV	0.2795	
Trend:		Negative
Confidence (lookup)		97.20%



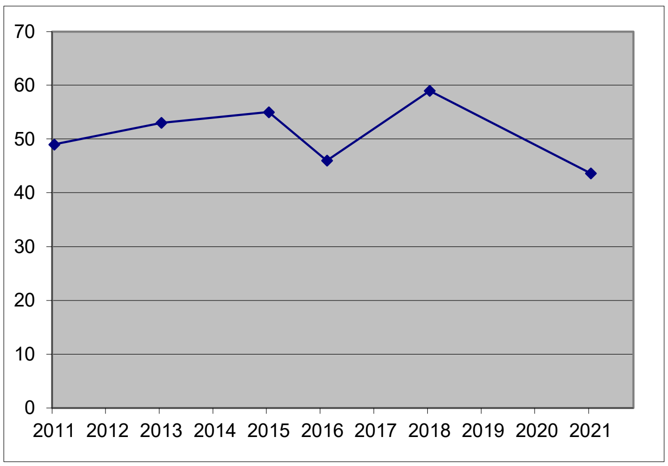
Raw Data

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	6/4/2020	21.4	
	12/8/1994	190			

WELL 04U832
MANN-KENDALL STATISTICAL ANALYSIS
OU3 - 2021

Date	TCE (µg/l)	Mann-Kendall Calculation:							
6/23/2011	**49**	1							
6/27/2013	**53**	1	1						
6/10/2015	**55**	1	1	1					
7/27/2016	**46**	1	-1	-1	-1				
6/28/2018	**59**	1	1	1	1	1			
6/2/2021	**43.6**	1	-1	-1	-1	-1	-1		
	N	6	5	4	3	2	1	0	15
	sum		1	0	-1	0	-1	0	Kendall S -1
	Possibles	15							
									Kendall tau -0.067

Mean	50.93
STNDEV	5.7919
COV	0.1137
Trend:	Negative
Confidence (lookup)	50.00%



Raw Data
04U832

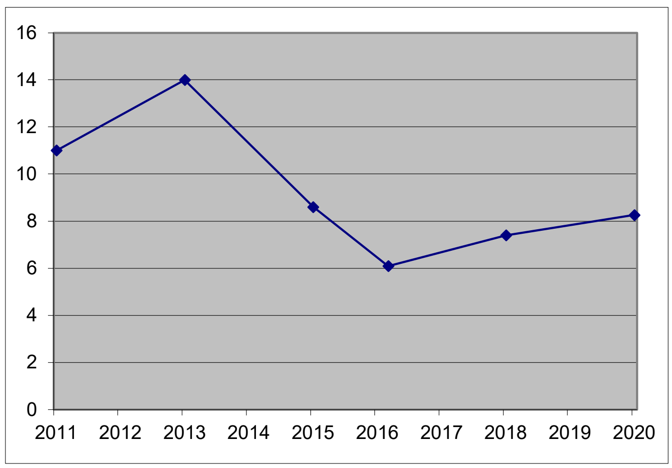
Date	TCE	Date	TCE
11/24/1987	100	6/17/2008	48
12/16/1988	65	6/19/2009	46
4/25/1990	69.53	6/23/2011	49
3/19/1991	47.6	6/27/2013	53
3/25/1992	52.5	6/10/2015	55
3/16/1993	42	7/27/2016	46
3/16/1993	45.9	6/28/2018	59
6/10/1994	49	6/2/2021	43.6
9/13/1994	49.5		
12/7/1994	43.3		
12/7/1994	47.1		
3/10/1995	56		
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 - 2020

Date	TCE (µg/l)	Mann-Kendall Calculation:					
6/23/2011	**11**	1					
6/25/2013	**14**	1	1				
6/11/2015	**8.6**	1	-1	-1			
8/2/2016	**6.1**	1	-1	-1	-1		
6/27/2018	**7.4**	1	-1	-1	-1	1	
6/3/2020	**8.26**	1	-1	-1	-1	1	1

N	6	5	4	3	2	1	0		15
sum		-3	-4	-3	2	1	0	Kendall S	-7
Possibles	15								
								Kendall tau	-0.467

Mean	9.23
STNDEV	2.84
COV	0.3080
Trend:	Negative
Confidence (lookup)	86.40%



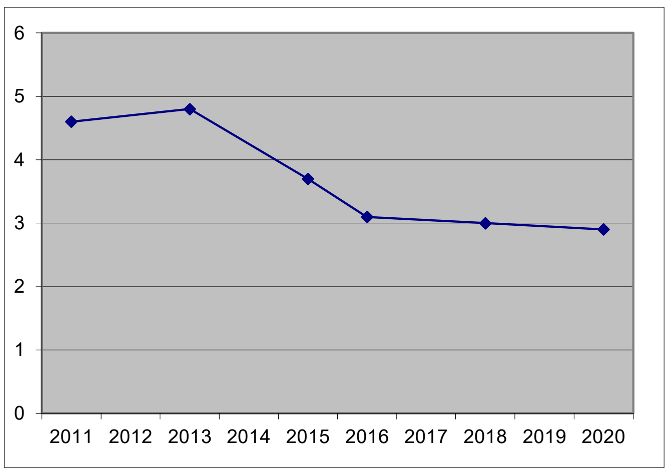
Raw Data
04U845

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	6/3/2020	8.26
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 - 2020

Date	TCE (µg/l)	Mann-Kendall Calculation:							
6/24/2011	**4.6**	1							
6/27/2013	**4.8**	1	1						
6/11/2015	**3.7**	1	-1	-1					
7/27/2016	**3.1**	1	-1	-1	-1				
6/28/2018	**3**	1	-1	-1	-1	-1			
6/4/2020	**2.90**	1	-1	-1	-1	-1	-1		
	N	6	5	4	3	2	1	0	15
	sum		-3	-4	-3	-2	-1	0	Kendall S -13
	Possibles	15							
									Kendall tau -0.867

Mean	3.68
STNDEV	0.8377
COV	0.2274
Trend:	Negative
Confidence (lookup)	99.17%



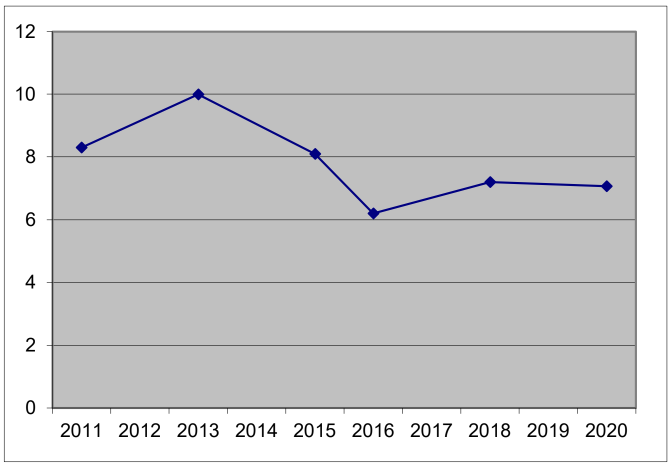
Raw Data
04U848

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	6/4/2020	2.90
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 04U854
MANN-KENDALL STATISTICAL ANALYSIS
OU3 - 2020

Date	TCE (µg/l)	Mann-Kendall Calculation:								
6/23/2011	**8.3**	1								
6/25/2013	**10**	1	1							
6/11/2015	**8.1**	1	-1	-1						
7/28/2016	**6.2**	1	-1	-1	-1					
6/28/2018	**7.2**	1	-1	-1	-1	1				
6/3/2020	**7.07**	1	-1	-1	-1	1	-1			
	N	6	5	4	3	2	1	0		15
	sum		-3	-4	-3	2	-1	0	Kendall S	-9
	Possibles	15								
									Kendall tau	-0.6

Mean	7.81
STNDEV	1.3139
COV	0.1682
Trend:	Negative
Confidence (lookup)	93.20%



Raw Data

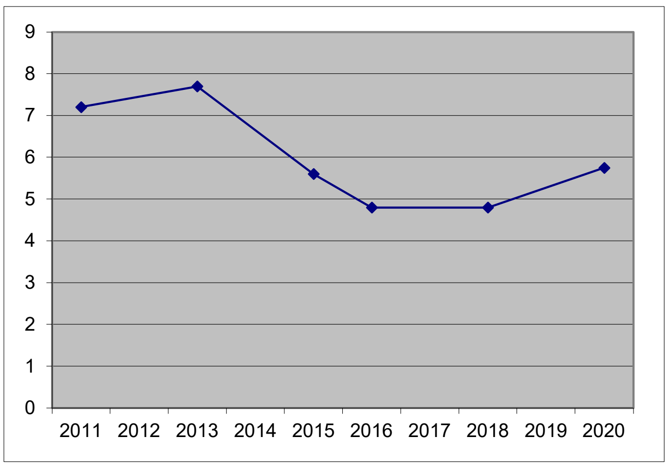
04U854	Date	TCE		Date	TCE	
	10/20/1987	48.4		6/23/2011	8.3	
	11/13/1987	50.7		6/25/2013	10	
	12/16/1988	140		6/11/2015	8.1	
	5/4/1989	27.3		7/28/2016	6.2	
	7/20/1989	360		7/28/2016	6.0	D
	10/17/1989	89		6/28/2018	7.2	
	4/30/1990	67		6/3/2020	7.07	
	3/13/1992	83				
	3/15/1993	70				
	6/8/1994	35.3				
	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				

WELL 03L859
MANN-KENDALL STATISTICAL ANALYSIS
OU3 - 2020

Date	TCE (µg/l)	Mann-Kendall Calculation:							
6/24/2011	**7.2**	1							
6/27/2013	**7.7**	1	1						
6/10/2015	**5.6**	1	-1	-1					
7/29/2016	**4.8**	1	-1	-1	-1				
6/28/2018	**4.8**	1	-1	-1	-1	0			
6/3/2020	**5.75**	1	-1	-1	1	1	1		

N	6	5	4	3	2	1	0		15
sum		-3	-4	-1	1	1	0	Kendall S	-6
Possibles	15								
								Kendall tau	-0.4

Mean	5.98
STNDEV	1.2189
COV	0.2040
Trend:	Negative
Confidence (lookup)	81.46%



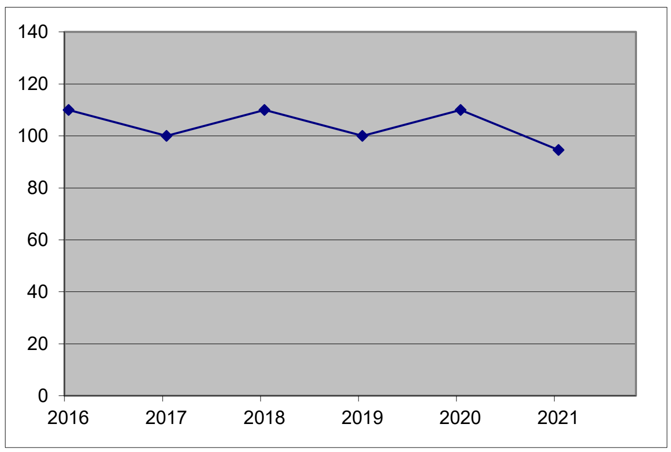
Raw Data
03L859

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		6/3/2020	5.75
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 03M848
MANN-KENDALL STATISTICAL ANALYSIS
OU3 - 2021

Date	TCE (µg/l)	Mann-Kendall Calculation:								
6/14/2016	**110**	1								
6/8/2017	**100**	1	-1							
6/28/2018	**110**	1	0	1						
6/20/2019	**100**	1	-1	0	-1					
6/4/2020	**110**	1	0	1	0	1				
6/2/2021	**94.5**	1	-1	-1	-1	-1	-1			
	N	6	5	4	3	2	1	0		15
	sum		-3	1	-2	0	-1	0	Kendall S	-5
	Possibles	15								
									Kendall tau	-0.333

Mean	104.08
STNDEV	6.7854
COV	0.0652
Trend:	Negative
Confidence (lookup)	76.50%



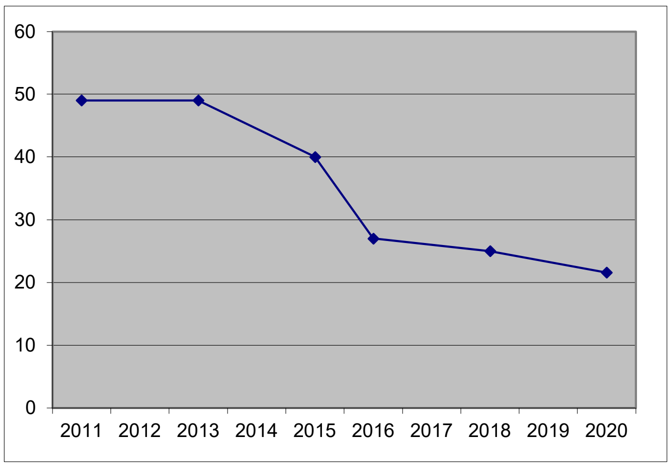
Raw Data
03M848

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	6/20/2019	100	
6/12/2001	370		6/4/2020	110	
			6/2/2021	94.5	

WELL 04U859
MANN-KENDALL STATISTICAL ANALYSIS
OU3 - 2020

Date	TCE (µg/l)		Mann-Kendall Calculation:							
6/24/2011	**49**	1								
6/27/2013	**49**	1	0							
6/10/2015	**40**	1	-1	-1						
7/29/2016	**27**	1	-1	-1	-1					
6/28/2018	**25**	1	-1	-1	-1	-1				
6/3/2020	**21.6**	1	-1	-1	-1	-1	-1			
	N	6	5	4	3	2	1	0		15
	sum		-4	-4	-3	-2	-1	0	Kendall S	-14
	Possibles	15								
									Kendall tau	-0.933

Mean	35.27
STNDEV	12.3299
COV	0.3496
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	6/3/2020	21.6
	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		