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**UNIFORM FEDERAL POLICY  
QUALITY ASSURANCE PROJECT PLAN  
ADDENDUM  
CORRECTIVE MEASURES IMPLEMENTATION  
FINAL**

**Operations and Maintenance and  
Long-Term Monitoring  
Former Scotia Navy Depot, Glenville, New York**

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***PREPARED FOR:***

**U.S. ARMY CORPS OF ENGINEERS, ENGINEERING AND  
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HUNTSVILLE  
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**CONTRACT NO.       W912DY20D0073  
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***PREPARED BY:***

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**January 2026**

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\*EA Engineering and Geology, P.C. is affiliated with EA Engineering, Science, and Technology, Inc., PBC (EAEST, Inc. PBC) who does business as EA Science and Technology in the State of New York. EAEST, Inc. PBC is executing the task order on behalf of the EA-Wood Joint Venture.

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**Uniform Federal Policy  
Quality Assurance Project Plan Addendum  
Corrective Measures Implementation  
Operations and Maintenance and  
Long-Term Monitoring  
Former Scotia Navy Depot, Glenville, New York**

Contract No. W912DY20D0073  
Task Order No. W912DY22F0104

*Prepared for*

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**LIST OF ACRONYMS AND ABBREVIATIONS**

$^{13}\text{C}/^{12}\text{C}$	Carbon-13/Carbon-12
°C	degrees Celsius
µg/L	microgram(s) per liter
%	percent
3D	three-dimensional
APP	Accident Prevention Plan
bgs	below ground surface
CAWP	Corrective Action Work Plan
CENAN	U.S. Army Corps of Engineers–New York District
CMQ/OE	Certified Manager of Quality/Organizational Excellence
CVOC	chlorinated volatile organic compound
CSIA	compound specific isotope analysis
CSM	conceptual site model
DO	dissolved oxygen
DoD	Department of Defense
DQI	data quality indicator
DQO	data quality objective
EA	EA Engineering, Science, and Technology, Inc., PBC
EWP	Evaluation Work Plan
ft/ft	feet per foot
GC	gas chromatograph
GSA	U.S. General Services Administration
HCl	hydrochloric acid
IDW	investigation-derived waste
IRMS	isotope ratio mass spectrometer
L	liter(s)
LCS	laboratory control sample
MDL	method detection limit
mg/L	milligram(s) per liter
mL	milliliter(s)
MNA	monitored natural attenuation
MS	matrix spike
MSD	matrix spike duplicate

NA No.	not applicable number
NYSDEC	New York State Department of Environmental Conservation
ORP	oxidation-reduction potential
PAL	project action limit
PCE	tetrachloroethene
PCR	polymerase chain reaction
PE	Professional Engineer
PG	Professional Geologist
PhD	Doctor of Philosophy
PID	photoionization detector
PRB	permeable reactive barrier
PVC	polyvinyl chloride
QA	quality assurance
QAPP	Quality Assurance Project Plan
QC	quality control
qPCR	quantitative polymerase chain reaction
RPD	relative percent difference
Site	Former Scotia Navy Depot
SOP	Standard Operating Procedure
TBD	to be determined
TCE	trichloroethene
TOC	total organic carbon
UFP	Uniform Federal Policy
USACE	U.S. Army Corps of Engineers
VOA	volatile organic analyte
VOC	volatile organic compound
ZVI	zero valent iron

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## INTRODUCTION

1.1 This document is an addendum to the Uniform Federal Policy (UFP) Quality Assurance Project Plan (QAPP) for the Operations and Maintenance and Long-Term Monitoring at the Former Scotia Navy Depot (Site), Glenville, New York (EA Engineering, Science, and Technology, Inc., PBC [EA] 2022a). An Evaluation Work Plan (EWP) (EA 2022b) was previously developed to investigate the efficiency of the on-site zero valent iron (ZVI) permeable reactive barrier (PRB) installed at the Site in November 2016 as part of the remedy outlined in the March 2010 Record of Decision (New York State Department of Environmental Conservation [NYSDEC] 2010). The Permeable Reactive Barrier (PRB) Evaluation Report (EA 2024) was prepared to present the results and conclusions of the investigation.

1.2 Based on discussion between EA, USACE, NYSDEC, and GSA in the 30 September 2024 Corrective Measures call, further work to characterize the groundwater plume was proposed following the completion of the PRB Evaluation Report to determine the actions necessary to address the site as the PRB was determined to not be functioning as an effective remedy. The following corrective measures are proposed as part of this UFP-QAPP Addendum (which constitutes a “Corrective Measures Work Plan” per discussion with USACE and NYSDEC) to improve site characterization and inform remedy optimization at the Site:

- Installation of supplemental monitoring wells midplume, downgradient, and sidegradient of the plume
- Vertical aquifer groundwater grab sample profiling
- Updates to groundwater modeling
- Sitewide groundwater sampling event to include volatile organic compounds (VOCs), and monitored natural attenuation (MNA) parameters at select monitoring wells
- Laboratory analyses of groundwater samples for 13C/12C Compound Specific Isotope Analysis (CSIA) of chlorinated volatile organic compounds (CVOCs) in groundwater
- Laboratory analyses of in situ microcosm experiments to evaluate microbial communities present at the Site at a variety of geochemical conditions

1.3 This UFP-QAPP Addendum contains modifications to select worksheets found in the UFP-QAPP (EA 2022a), and the previous UFP-QAPP Addendum (EA 2023) to address field activities and laboratory analyses that are to be conducted at the Site.

1.4 Field activities to be conducted to further characterize the dissolved CVOC groundwater plume include the following:

- Installation and development of additional monitoring wells to supplement the existing monitoring well network used to monitor the seasonal variability and potential degradation of the VOC plume.

- Vertical aquifer groundwater grab sample profiling using rotosonic drilling methods, along with a combination of “push-ahead” sampling and IsoFlow™ sampling methods, to provide real-time groundwater contaminant and physiochemical parameter (temperature, pH, dissolved oxygen [DO], specific conductance, and oxidation-reduction potential [ORP]) concentrations/values [from in situ samples] and qualitative conductivity information (from lithologic logging)
- Vertical aquifer groundwater grab sample profiling by collecting in situ groundwater samples for tetrachloroethene (PCE), trichloroethene (TCE), *cis*-1,2-dichloroethene, and vinyl chloride using a field gas chromatograph (i.e., FROG-5000™) to prioritize and modify vertical aquifer groundwater grab sample profiling locations and follow-on sample intervals, and to determine screened intervals for permanent monitoring wells
- Laboratory analysis of groundwater samples for VOCs for confirmation of field analyses.
- Groundwater sampling of all site monitoring wells for the analysis of VOCs and select monitoring wells for MNA parameters, consisting of alkalinity, anions (chloride, nitrate, and sulfate), total organic carbon (TOC), dissolved iron, dissolved manganese, and dissolved gases (methane, ethane, and ethene).
- Groundwater sampling at select monitoring wells for CSIA of VOCs in groundwater to evaluate the contribution of abiotic versus biotic processes to VOC degradation in select wells with historic contaminant of concern concentrations above the method detection limit (MDL). CSIA will entail measurement of the ratios of different carbon isotopes (Carbon-13/Carbon-12 [ $^{13}\text{C}/^{12}\text{C}$ ]) present in the CVOCs measured in collected groundwater samples.
- Deployment and laboratory analysis of in situ microcosm reactors that will be evaluated with quantitative polymerase chain reaction (qPCR) to characterize the microbial community present within the groundwater plume and the presence of *Dehalococcoides* as an indicator for favorable conditions for reductive dechlorination.
- Sitewide survey of all monitoring wells to include any newly installed or repaired monitoring wells.

1.5 The laboratory analysis of groundwater for VOCs and MNA parameters will be performed by Chemtech in accordance with the UFP-QAPP (EA 2022a). The analysis of qPCR will be performed by Microbial Insights in accordance with this UFP-QAPP Addendum. The analysis of carbon isotopes in groundwater will be performed by the University of Waterloo in accordance with this UFP-QAPP Addendum.

1.6 This UFP-QAPP Addendum, in conjunction with the original UFP-QAPP (EA 2022a) and previous UFP-QAPP Addendum (EA 2023), documents the following:

- Specific investigative procedures and data collection activities
- Laboratory analytical and reporting procedures

- Quality assurance (QA) and quality control (QC) measures and assessments that will be used to confirm that data are of known quality sufficient to meet project objectives.

1.7 This UFP-QAPP Addendum, in conjunction with the UFP-QAPP (EA 2022a), and the previous UFP-QAPP Addendum (EA 2023), functions as the “Corrective Measures Work Plan” to implement field activities and laboratory analyses to further characterize the groundwater plume located at the Site. A summary of the changes and appendixes is provided below and is followed by the revised versions of selected worksheets and appendixes on subsequent pages. Remaining worksheets are included in the UFP-QAPP (EA 2022a), and previous UFP-QAPP Addendum (EA 2023) in their original format and content.

### **WORKSHEET #1 and #2 – TITLE AND APPROVAL PAGE**

1.8 Worksheet #1 and #2 presents the title and approval page for this UFP-QAPP Addendum.

### **WORKSHEET #9 – PROJECT PLANNING SESSION SUMMARY**

1.9 Worksheet #9 has been updated to include the corrective measures work plan meeting held on 30 September 2024.

### **WORKSHEET #10 – CONCEPTUAL SITE MODEL**

1.10 Worksheet #10 in this addendum includes updates to the conceptual site model (CSM) following the completion of the PRB Evaluation Report (EA 2024), outcomes of the meeting between EA, NYSDEC, and U.S. Army Corps of Engineers (USACE) on 23 May 2024, and the latest annual groundwater monitoring activities performed at the Site between 11 and 14 November 2024 (17<sup>th</sup> groundwater sampling event after the completion of the construction of the PRB) (EA 2025).

### **WORKSHEET #11 – PROJECT QUALITY OBJECTIVES/SYSTEMATIC PLANNING PROCESS STATEMENTS**

1.11 Worksheet #11 has been updated to include data quality objectives (DQOs) for corrective measures work.

### **WORKSHEET #12 – MEASUREMENT PERFORMANCE CRITERIA**

1.12 Worksheet #12 has been updated to include measurement performance criteria for the qPCR analysis of the field In Situ Microcosm Study, and for laboratory analysis of carbon isotopes in groundwater samples by the University of Waterloo. Measurement performance criteria for the analysis of VOC and MNA parameters in groundwater are presented in Worksheet #12 of the UFP-QAPP (EA 2022a).

## WORKSHEET #14 AND #16 – PROJECT TASKS AND SCHEDULE

1.13 Worksheets #14 and #16 have been updated to include additional tasks that will be completed as part of the PRB evaluation, as follows:

- In Situ Microcosm Study
- Laboratory analysis of carbon isotopes in groundwater

1.14 In addition, the following tasks presented in the UFP-QAPP (EA 2022a) have been updated to reflect changes associated with field activities and laboratory analyses that will be completed as part of the PRB evaluation:

- Health and safety tasks to incorporate the Accident Prevention Plan (APP) Addendum (to be submitted under a separate cover)
- Laboratory reporting tasks to incorporate reporting of CSIA results
- Laboratory reporting tasks to incorporate reporting of qPCR results

1.15 Tasks associated with monitoring well sampling and laboratory analysis for VOCs and MNA parameters, including the calibration of field equipment, groundwater elevation and synoptic measurements, groundwater purging, and the collection of groundwater samples and field QC samples, laboratory analysis and reporting, and data review (including data verification and validation) are presented in Worksheet #14/16 of the UFP-QAPP (EA 2022a).

1.16 Additional tasks presented in the UFP-QAPP (EA 2022a) are applicable to the field and analytical effort that will be being conducted to further characterize the plume. These tasks include the following:

- Mobilization and demobilization tasks
- Sample collection tasks
- Sample handling and management tasks
- Field documentation and records tasks
- Assessment/audit tasks
- Data management tasks
- Data evaluation tasks
- Reporting tasks

1.17 Additional tasks presented in the previous UFP-QAPP Addendum (EA 2023) are applicable to the field and analytical effort that will be being conducted to further characterize the site. These tasks include the following:

- Utility clearance
- Vertical aquifer groundwater grab sample profiling
- Field screening of in situ groundwater samples
- Monitoring well installation and development

**WORKSHEET #15 – REFERENCE LIMITS AND EVALUATION TABLES**

1.18 Project action limits (PALs) and achievable laboratory limits for groundwater VOC and MNA parameters are presented in Worksheet #15 of the UFP-QAPP (EA 2022a).

1.19 Worksheet #15 has been updated to include the detection limits for analysis of carbon isotopes in water samples by the University of Waterloo and detection limits for analysis of microbes from in situ microcosm samplers by Microbial Insights. There are no PALs for analysis of groundwater carbon isotopes or for analysis of microbial samplers by qPCR.

**WORKSHEET #17 – SAMPLING DESIGN AND RATIONALE**

1.20 Worksheet #17 has been updated to present the overall process for the design and rationale of the Corrective Measures activities and laboratory analyses.

**WORKSHEET #18 – SAMPLING LOCATIONS AND METHODS**

1.21 Worksheet #18 has been updated to include locations to be sampled for parameters listed in this UFP-QAPP Addendum.

**WORKSHEET #19 and #30 – SAMPLE CONTAINERS, PRESERVATION, AND HOLD TIMES**

1.22 Worksheets #19 and #30 have been updated to present sample containers, preservation requirements, and hold time for aqueous carbon isotope samples, as presented in University of Waterloo's Standard Operating Procedures (SOPs), and microbial samples as presented in Microbial Insights' SOPs.

1.23 Sample containers, preservation requirements, and hold times for groundwater VOC and MNA parameters are presented in Worksheet #19/30 of the UFP-QAPP (EA 2022a).

**WORKSHEET #20 – FIELD QUALITY CONTROL**

1.24 Worksheet #20 has been updated to present field QC samples that will be collected during the Corrective Measures activities.

**WORKSHEET #23 – ANALYTICAL STANDARD OPERATING PROCEDURE REFERENCES TABLE**

1.25 Worksheet #23 has been updated to present University of Waterloo's SOPs for the analysis of carbon isotopes in water samples and Microbial Insights' SOPs for the analysis of qPCR in water samples. SOPs for VOC and MNA parameters are presented in Worksheet #23 of the UFP-QAPP (EA 2022a).

**WORKSHEET #24 – ANALYTICAL INSTRUMENT CALIBRATION TABLE**

1.26 Worksheet #24 has been updated to present analytical instrument calibration information for analysis of carbon isotopes in water samples as presented in the University of Waterloo’s SOPs, and for analysis of qPCR in water samples as presented in Microbial Insights’ SOPs.

**WORKSHEET #25 – ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION TABLE**

1.27 Worksheet #25 has been updated to present instrument and equipment maintenance, testing, and inspection information for analysis of carbon isotopes as presented by Microbial Insights.

1.28 Instrument calibration information for groundwater VOC and MNA parameters are presented in Worksheet #25 of the UFP-QAPP (EA 2022a).

**WORKSHEET #26 AND #27 – SAMPLE HANDLING, CUSTODY, AND DISPOSAL**

1.29 Worksheet #26 and #27 has been updated to present sample handling and custody information for CSIA of CVOCs in groundwater and soil samples. Sample handling, custody, and disposal requirements for groundwater VOC and MNA parameters are presented in Worksheet #26 and #27 of the UFP-QAPP (EA 2022a).

**WORKSHEET #28 – QUALITY CONTROL SAMPLES TABLES**

1.30 Worksheet #28 has been updated to present corrective action information for analysis of aqueous carbon isotopes, as presented in University of Waterloo’s SOPs, and analysis for qPCR, as presented in Microbial Insights’ SOPs. QC samples tables for groundwater VOC and MNA parameters are presented in Worksheet #28 of the UFP-QAPP (EA 2022a).

**WORKSHEET #36 – DATA VALIDATION PROCEDURES**

1.31 Worksheet #36 has been updated to present validation information for analysis of aqueous carbon isotopes by the University of Waterloo. Validation information for groundwater VOC and MNA parameters is presented in Worksheet #36 of the UFP-QAPP (EA 2022a). Data from microbial samplers will not be validated.

**APPENDIX A – LABORATORY STANDARD OPERATING PROCEDURES**

1.32 The following University of Waterloo – Environmental Isotope Laboratory and Microbial Insights SOPs are included in **Appendix A** at the end of this UFP-QAPP Addendum:

- Screening-Level Gas Chromatograph Treatability Study Approach
- Laboratory Health and Safety Manual and Chemical Hygiene Plan
- MI SOP-QuantArray

**Worksheet #1 and #2 Title and Approval Page**

<b>Site Name/Project Name:</b>	Former Scotia Navy Depot/PRB and Soil Vapor Intrusion Remedy Operation and Maintenance and Long-Term Monitoring	
<b>Site Location:</b>	Schenectady County, New York	
<b>Contract/Work Assignment</b>	Contract No. W912DY-20-D-0073 Task Order No. W912DY22F0104	
<b>Document Title:</b>	UFP QAPP Addendum Corrective Measures Implementation Operation and Maintenance and Long-Term Monitoring, Former Scotia Navy Depot, Glenville, New York	
<b>Lead Organization Project Manager</b>	Amy Doss USACE, Engineering and Support Center, Huntsville	
	<b>Signature:</b>	<b>Date:</b>
<b>Lead Organization Project Manager</b>	Thomas Heins USACE–New York District (CENAN)	
	<b>Signature:</b>	<b>Date:</b>
<b>Corporate Director of Quality Control Printed Name/Title Signature/Date</b>	Frank Barranco, PhD, PE, PG, CMQ/OE EA	
	<b>Signature:</b>	<b>Date:</b> 30 January 2026
<b>Site Project Manager Printed Name/Title Signature/Date</b>	James Hayward, PE EA	
	<b>Signature:</b>	<b>Date:</b> 30 January 2026

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## Worksheet #9 Project Planning Session Summary

9.1 A meeting was conducted on 30 September 2024 to discuss the proposed Corrective Measures associated with further characterization and delineation of VOCs at the Site (e.g., proposed monitoring points, planning docs, coordination/logistics, drilling/sampling, etc.). The meeting attendees and minutes are provided below.

	Name of Attendee	Role	Contact Information
USACE New York District			
X	Thomas Heins	Project Manager (as of June 2022)	<a href="mailto:Thomas.R.Heins@usace.army.mil">Thomas.R.Heins@usace.army.mil</a>
USACE New England District			
X	Jeffrey Kadegis	Engineering Technical Lead	<a href="mailto:Jeffrey.M.Kadegis@usace.army.mil">Jeffrey.M.Kadegis@usace.army.mil</a> 978-318-8144
X	Jennifer Apell	Project Chemist/Engineer	<a href="mailto:Jennifer.N.Apell@usace.army.mil">Jennifer.N.Apell@usace.army.mil</a>
GSA			
X	David Baker	Project Manager	<a href="mailto:David.Baker@gsa.gov">David.Baker@gsa.gov</a> 212-577-7920
X	Tom Burke	Technical Lead	<a href="mailto:Thomas.W.Burke@gsa.gov">Thomas.W.Burke@gsa.gov</a>
NYSDEC			
X	Bob Corcoran	Section Chief	<a href="mailto:Bob.corcoran@dec.ny.gov">Bob.corcoran@dec.ny.gov</a>
X	Jolene Lozewski	Project Manager	<a href="mailto:Jolene.Lozewski@dec.ny.gov">Jolene.Lozewski@dec.ny.gov</a>
X	Rich Mustico	Bureau B Director	<a href="mailto:Richard.mustico@dec.ny.gov">Richard.mustico@dec.ny.gov</a>
EA-Wood-2 MP JV			
X	James Hayward	Project Manager	<a href="mailto:jhayward@eaest.com">jhayward@eaest.com</a> 315-565-6555
X	Thomas Robinson	Project Engineer, Support	<a href="mailto:trobenson@eaest.com">trobenson@eaest.com</a> 315-565-6559

- **Corrective Measures Study Presentation**

- **Slide 4:** It was emphasized that the goal of the Corrective Measures Study would be to collect the data needed to determine what the next steps may be for the site.
- **Slide 5:** The Corrective Action Work Plan (CAWP) would include an updated conceptual site model, the installation of additional monitoring points, and a comprehensive sampling event.
- **Slide 6:** The objectives for the CAWP would be to further delineate the downgradient plume, to determine whether the Former Scotia Navy Depot plume influences the Rotterdam and Schenectady production wells, and to evaluate the plume with respect to monitored natural attenuation.
- **Slide 7:** It was discussed that there are no receptors within the footprint of the plume except for indoor air. It was indicated that General Services Administration (GSA)/USACE/EA-Wood will follow NYSDEC recommendation on the path forward for indoor air mitigation systems.

- **Slide 8:** It was further emphasized that all residents within or near the footprint of the plume are on public water, and that there is not expected to be any substantial deviations from the current CSM with respect to hydrogeology.
- **Slide 9:** Additional monitoring points are recommended to further delineate the plume along the axis towards the Mohawk River, and sidegradient to the south to determine whether the plume is influencing the production wells. The local park south of the Site (Maalwyck Park) is favorable for installation of a potential new monitoring point as it is perpendicular and side-gradient to the plume in the direction of the production wells.
- **Slide 10:** More specifically, four potential monitoring points were discussed: 1) a new monitoring well located west of the Site in the residential area which is the highest priority, however, it is anticipated that it would be the most difficult to gain access and to install; 2) a new monitoring well located near MW-27 and MW-7 but installed deeper than the previous points while using the FROG-5000™ to vertically profile the plume during drilling activities; 3) A new monitoring well located near MW-16 but installed deeper while using the FROG-5000™ to vertically profile the plume; and 4) a new monitoring well located in Maalwyck Park to evaluate potential sidegradient migration of the plume. Additional discussion of the proposed depths of these monitoring points. PRO-10 was previously advanced to 140 feet below ground surface (bgs) and it is anticipated that these additional points would be installed to a similar depth at a minimum. The Maalwyck Park location would be at a lower topographic point, because of the terraced nature of the park, which would require less drilling to reach a similar depth. For the proposed point located west of the plume, it was discussed that not only would access likely be a challenge, but that the topography is steep approaching the Mohawk which would also make drilling logistically difficult. USACE noted that a right of entry would also be needed for both the residential and Maalwyck Park areas.
- **Slide 11:** The path forward largely depends on the results from a comprehensive sampling event to determine VOC concentrations, as well as the geochemical conditions present in the aquifer that may or may not be favorable for aerobic/anaerobic natural attenuation across the entire plume.
- **Slide 12:** The proposed parameters to evaluate MNA include TOC which was identified by USACE/EA-Wood as the main parameter to evaluate the favorability of biotic activity. A subset of monitoring wells should be sufficient to evaluate MNA conditions across the site in both the aerobic (shallower) and anaerobic (deeper) regions of the site. Additional samples were proposed to evaluate the site which will include CSIA and an in situ microcosm study.
- **Slide 13:** The three-dimensional (3D) model prepared as part of the PRB Evaluation would be updated to include all monitoring wells and the results from the proposed comprehensive sampling event. Because the plume is inferred downgradient of MW-27 and MW-7 the goal would be to further refine the model by installing additional monitoring points.
- **Slide 14:** The CSIA results collected during the PRB Evaluation indicated that VOC transformation is occurring in overburden groundwater at the site along a transect that intercepts the PRB. It remains unclear what the transformation rate is, and whether transformation is occurring sitewide or just along the plume axis.

- **Open Discussion/Questions**

- Corrective Measures Next Steps

- In agreement with NYSDEC/GSA/USACE/EA-Wood, the goal will be to submit a workplan by the end of the year (December 2024) in preparation for the next phase of fieldwork proposed to occur during the Spring/Summer. USACE emphasized that this schedule is heavily dependent upon contractual discussions which may delay the workplan submittal.
- NYSDEC commented that the proposed plan appears to be a good path forward and that the project team was interested in the Microbial Insights in situ microcosm and microbial analyses.

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## Worksheet #10 Conceptual Site Model

10.1 This worksheet presents updates to the CSM presented in the UFP-QAPP (EA 2022a) and the previous UFP-QAPP Addendum (EA 2023) based on work completed since that document was prepared, including the completion of the PRB Evaluation Report (EA 2024) and completion of the November 2024 annual sampling event (17<sup>th</sup> groundwater sampling event after construction of the PRB) (EA 2025).

### PERMEABLE REACTIVE BARRIER EVALUATION REPORT

10.2 The PRB Evaluation Report (EA 2024) was prepared to address documented NYSDEC concerns regarding the PRB effectiveness in addressing the on-site TCE plume, as presented in a letter dated 6 July 2021. The Evaluation Report concluded the following:

- Downgradient CVOC concentrations have not substantially decreased over the past 7 years. In addition, historic trend analysis suggests concentrations are already decreasing upgradient of the PRB which make any reductions downgradient difficult to attribute to abiotic transformation within the PRB.
- Geochemical parameters have not changed as expected subsequent to the PRB installation in 2016. Specifically, nitrate and sulfate concentrations have not differed substantially at the compliance monitoring well pairs upgradient and downgradient of the PRB. Similarly, ORP measurements did not exhibit different conditions upgradient and downgradient of the wall as would be expected.
- Although CSIA results along the plume do demonstrate that some transformation is occurring at the Site, the lack of substantial 13/12C isotope ratio changes across the PRB itself suggests that the PRB is not performing as designed or expected, and that any observed transformation is unlikely to be caused by abiotic pathways.
- Mass flux analyses used to determine the percent differences in TCE mass discharge across the PRB between 2015 and 2022 indicates that no substantial change has occurred since PRB installation in 2016.
- Physical samples of soil/ZVI material collected to intercept the PRB in the subsurface exhibited a significantly lower amount of magnetic material than expected based on the original design parameters (i.e., ZVI thickness), which suggests a lack of integrity along the PRB. The results of the passivation study of the ZVI material obtained from the subsurface suggest that magnetic material present in the PRB remains reactive towards CVOCs, which further supports that the PRB has not proven effective because of the poor integrity.

10.3 The proposed Corrective Measures Implementation activities to further characterize the site following the PRB Evaluation Report include the following:

- Update the CSM

- Vertical aquifer groundwater grab sample profiling
- Groundwater modeling
- Installation of supplemental monitoring wells midplume, downgradient, and sidegradient
- Laboratory analyses of groundwater samples for VOCs, MNA parameters, and CSIA of CVOCs in groundwater
- Laboratory analyses of groundwater samples for qPCR of microbial communities in groundwater

10.4 Field activities associated with Corrective Measures Implementation are anticipated to begin in Fall 2025.

#### **PERMEABLE REACTIVE BARRIER EVALATION REPORT MEETING – 23 MAY 2024**

10.5 As part of the review process for the PRB Evaluation Report (EA 2024) a meeting was held between EA, USACE, GSA, and NYSDEC in Albany, New York on 23 May 2024. As part of the meeting, USACE presented additional analysis of local hydrogeologic conditions and their expected influence on plume geometry and flow. The updates to the CSM as part of that presentation are as follows:

- Plume geometry and flow direction appears to be stable and is consistent with previous investigations.
- Groundwater flux is more complex than previously expected and differs from previous investigations that demonstrated that minimal changes to VOC concentrations occur across the location of the PRB. The higher resolution mass flux analysis performed as part of the PRB Evaluation Report (EA 2024) identified a new hydrogeologic regime; VOC concentrations and plume geometry differ between the shallow and deeper overburden aquifer.
- Plume geochemistry is more heterogeneous than previously identified with much of the plume exhibiting more aerobic conditions, particularly in the shallow sandy geology encountered down to approximately 80 feet bgs.
- The Mohawk River and nearby Lock 8 act as groundwater divides that are expected to bound the plume and limit flow towards the well fields for the Town of Rotterdam and the City of Schenectady.

#### **NOVEMBER 2024 ANNUAL SAMPLING EVENT (EA 2025)**

10.6 VOCs at the Site have been monitored since 2015, with groundwater sampling currently conducted at the Site on an annual basis. The latest annual groundwater sampling was conducted

between 11 and 14 November 2024. This event was the 17<sup>th</sup> overall sampling event completed since the installation of the PRB.

10.7 Consistent with the PRB Evaluation Report (EA 2024), the results of the November 2024 groundwater monitoring event indicate that the PRB has not been effective at reducing contaminant of concern concentrations (primarily TCE) in some portions of the PRB, specifically at two monitoring well series (MW-29/MW-28 and MW-33/MW-32) and that plume geometry is stable. Of note, one of the newly installed monitoring wells (MW-EVAL-1D) as part of the PRB Evaluation exhibited the greatest TCE concentration (310 micrograms per liter [ $\mu\text{g/L}$ ]).

10.8 Groundwater field data and MNA data do not show consistency across the site. Historical results suggest that there may be two separate degradation pathways occurring at the Site (biotic and abiotic); the expected degradation reaction when impacted groundwater flows through a PRB is abiotic (i.e., beta-elimination). The November 2024 monitoring data indicate that the groundwater conditions at the Site are predominantly aerobic with 27 of 36 monitoring wells exhibiting an ORP  $> 0$  millivolts (mV), and 29 of 36 monitoring wells exhibiting a DO  $> 1$  milligrams per liter (mg/L). Anaerobic conditions were observed at some monitoring wells with 9 of 36 monitoring wells exhibiting an ORP  $< 0$  mV, and 7 of 36 monitoring wells exhibiting a DO  $< 1$  mg/L.

10.9 Groundwater flow conditions observed at the Site indicate that the hydraulic gradient is generally consistent with previous observations, with the November 2024 event showing slightly lower groundwater elevations compared with the other sampling events. The hydraulic gradient calculated as part of the November 2024 event was 0.0030 feet per foot (ft/ft) which is greater than the calculated hydraulic gradient of 0.0022 ft/ft measured in October 2022. Groundwater velocity calculated from November 2024 static gauging data is approximately 1.4 to 1.6 feet per day across the two major lithological groups.

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## Worksheet #11 Project/Data Quality Objectives

11.1 This worksheet is used to develop and document DQOs using a systematic planning process in accordance with the Guidance on Systematic Planning Using the Data Quality Objectives Process (U.S. Environmental Protection Agency 2006). The specific QA/QC requirements developed for the Site are consistent with those presented in the Department of Defense (DoD) Quality Systems Manual, Version 5.4 (DoD 2021).

11.2 This UFP-QAPP Addendum outlines the Corrective Measures Implementation for the Former Scotia Navy Depot Site.

### Further Characterization of a Dissolved CVOC Plume

#### Step 1: State the Problem

11.3 **Describe the Problem**—Long-term monitoring data, including the results of the most recent November 2024 groundwater monitoring event, indicate that a dissolved phase CVOC plume remains at the Site, and the PRB Evaluation Report (EA 2024) concluded that the previously installed remedy is not performing as expected. The TCE plume appears to be stable and a CVOC trend analysis indicates a combination of increasing and decreasing concentration trends across the plume. Concentrations in many of the compliance well pairs show little reduction of CVOC concentrations across the PRB. Additionally, concentrations of TCE in many wells downgradient of the PRB are of the same order of magnitude (or in some instances, greater than) upgradient concentrations, showing no decreasing trends. Current data show minimal sidegradient transport and no lateral extension of the plume; however, further monitoring points are needed to evaluate potential impact on the drinking water well fields for the Town of Rotterdam and the City of Schenectady. In addition, CVOCs were detected at depth downgradient (135 feet bgs at MW-EVAL-03D) which suggests there may be a deeper component to the plume that is not captured by the existing monitoring network.

#### Step 2: Identify the Goals of the Study

11.4 **Principal Study Question**—The objectives and principal questions to be addressed by this work are as follows:

- Evaluate whether CVOC degradation is occurring across the plume and whether there are native microbial populations contributing to the degradation.
- Determine if CVOCs are being transported towards the Town of Rotterdam/City of Schenectady production wells.
- Confirm the lower vertical boundary of the plume near the PRB (midplume).
- Confirm the lower vertical boundary of the plume downgradient of the Site.
- Evaluate if the CVOC plume is discharging to the Mohawk River.

### Step 3: Identify Information Inputs

11.5 The following activities will be conducted to collect data necessary for the additional characterization efforts:

- Advancement of vertical aquifer groundwater grab sample profiling points for the collection of in situ groundwater samples for field screening of PCE, TCE, *cis*-1,2-dichloroethene, vinyl chloride, and off-site laboratory analysis of VOCs.
- Installation of monitoring wells with screened intervals selected based on in situ screening data.
- Sampling of each newly installed monitoring wells for VOCs and MNA parameters consisting of alkalinity, anions (chloride, nitrate, and sulfate), TOC, dissolved iron, dissolved manganese, and dissolved gases (methane, ethane, and ethene).
- Sampling of the entire monitoring well network for VOCs, as well as a select set of previously existing monitoring wells for MNA parameters
- Sampling of new monitoring wells and select existing monitoring wells with historic VOC concentrations greater than the MDL for <sup>13</sup>C/<sup>12</sup>C CSIA to collect carbon isotope data.
- Deployment and laboratory analysis of in situ microcosm reactors to evaluate existing microbial communities present at the Site.
- Review publicly available data (e.g., surface water elevations) for the Mohawk River to incorporate into an updated plume model.

11.6 **Types of Information**—Primary information inputs include the following:

- Lithologic information and field data collected during vertical aquifer groundwater grab sample profiling, including photoionization detector (PID) readings, groundwater depth, borehole depth, sample collection depths, water quality parameters (i.e., temperature, pH, specific conductivity, DO, ORP, and turbidity), and groundwater field screening results (PCE and daughter products [TCE, *cis*-1,2-dichloroethene, and vinyl chloride])
- Groundwater VOC analytical results from samples collected during vertical aquifer groundwater grab sample profiling
- Groundwater elevations at existing and newly installed monitoring wells
- Groundwater quality parameter field screening data (e.g., temperature, pH, specific conductivity, DO, ORP, total suspended solids, and turbidity) and groundwater VOC and

MNA analytical results from samples collected from newly installed and existing monitoring wells

- Groundwater contaminant carbon isotope data (CSIA)
- Cell counts for many microbes and functional genes as presented in **Table 15-2**

11.7 **Determination of Action Level(s)**—Action levels for VOCs in groundwater are presented in Worksheet #15 of the UFP-QAPP (EA 2022a). There are no action levels for CSIA of CVOCs in groundwater; however, laboratory-specific detection and quantitation limits have been included in Worksheet #15. There are no action levels for qPCR in groundwater; however, laboratory-specific detection and quantitation limits have been included in Worksheet #15.

#### **Step 4: Define the Boundaries of the Study (borings to advance, wells to install)**

11.8 Field activities are anticipated to be conducted in Fall (September-November) 2025.

11.9 Up to four vertical aquifer groundwater grab sample profiling points (PRO-11 through PRO-14) will be advanced up to a depth of 155 feet bgs (**Figure 11-1**). Groundwater samples will be collected vertically every 10 feet once groundwater is encountered (estimated to be 65 feet bgs). Samples will be screened in the field for PCE and daughter products and submitted for off-site laboratory analysis of VOCs.

11.10 Up to eight 2-inch monitoring wells, each comprised of a nested shallow-deep pair, will be installed in existing boreholes of all vertical aquifer groundwater grab sample profiling points to supplement the midplume, downgradient, and sidegradient monitoring well network. The monitoring well screen intervals for each monitoring well will be selected based on the on-site screening data and in consultation with USACE and GSA.

11.11 Groundwater samples will be collected from each newly installed monitoring well for off-site laboratory analysis of VOCs and MNA parameters. The on-site screening data will be used to inform whether groundwater samples will be collected for off-site laboratory analysis of carbon isotopes.

#### **Step 5: Develop the Analytic Approach**

11.12 The extent of downgradient and sidegradient transport will be evaluated with collected data from the newly installed locations as part of a comprehensive sampling of the entire monitoring well network.

11.13 Groundwater samples will be collected during vertical aquifer groundwater grab sample profiling using push-ahead sampling and/or IsoFlow™ sampling methods. Groundwater samples will be screened in the field for water quality parameters (i.e., temperature, pH, specific conductivity, DO, ORP, and turbidity) using a calibrated water quality meter and analyzed in the field for PCE, TCE, *cis*-1,2-dichloroethene, and vinyl chloride using a calibrated gas chromatography field tool (i.e., FROG-5000™). In addition, groundwater samples will be

submitted to an off-site laboratory for the analysis of VOCs to further delineate the plume boundaries. Field analysis data will be used to determine screened intervals for monitoring wells.

11.14 Each existing and newly installed monitoring well will be sampled in accordance with the UFP-QAPP (EA 2022a) following the completion of monitoring well installation and development. Groundwater quality parameters (e.g., temperature, pH, specific conductivity, DO, ORP, and turbidity) will be monitored during purging of newly installed monitoring wells using a calibrated water quality meter and flow-through cell. Groundwater samples collected from all monitoring wells will be submitted to Chemtech of Mountainside, New Jersey for analysis of VOCs. Select monitoring wells will be sampled for MNA parameters including TOC, alkalinity, anions (chloride, nitrate, and sulfate), dissolved gases (methane, ethane, and ethene), and dissolved manganese and iron.

11.15 Additional groundwater samples will be collected from select existing and newly installed monitoring wells in accordance with this UFP-QAPP Addendum for CSIA of CVOCs in groundwater by EIL-TP38.0. CSIA will entail measurement of the ratios of different carbon isotopes ( $^{13}\text{C}/^{12}\text{C}$ ) in the CVOCs in groundwater samples. Samples will be submitted to the University of Waterloo for analysis. Laboratory SOPs are listed in Worksheet #23 and provided in **Appendix A** of this UFP-QAPP Addendum.

#### **Step 6: Specify Performance or Acceptance Criteria**

11.16 The data need to be of adequate quality to make decisions established for the project. The purpose is to minimize the possibility of making erroneous conclusions or failing to keep uncertainty estimates to within acceptable levels. Worksheet #12 and Worksheet #28 of this UFP-QAPP Addendum, in conjunction the UFP-QAPP (EA 2022a), and previous UFP-QAPP Addendum (EA 2023) presents the analytical measurement performance criteria for groundwater VOC, MNA, carbon isotope, and microbial samples applicable to the analytical sampling associated with additional site characterization.

11.17 Field screening data for PCE and daughter products will be used to determine screened intervals for newly installed monitoring wells; data quality must be good enough to support decision making. A calibrated field gas chromatograph (i.e., FROG-5000™) will be used to screen groundwater samples. Calibration and field screening groundwater monitoring well samples for VOCs and MNA parameters will be collected and screened in the field using a calibrated gas chromatography field tool (i.e., FROG-5000™) consistent with the procedures and SOPs identified in Worksheet #14 and #16 and Worksheet #21 of the UFP-QAPP (EA 2022a), and the previous UFP-QAPP Addendum (EA 2023). Field screening data will be verified as detailed in Worksheets #34 and #35 of the UFP-QAPP (EA 2022a). In addition, confirmatory VOC groundwater samples will be collected for off-site laboratory analysis to evaluate the accuracy of the field screening data.

11.18 Groundwater samples for VOC and MNA parameter analysis will be collected during vertical aquifer groundwater grab sample profiling in a manner consistent with the procedures and SOPs identified in Worksheet #14 and #16 of the UFP-QAPP (EA 2022a). Laboratory analysis for groundwater will be provided by a DoD-accredited laboratory in accordance with the DoD Quality

Systems Manual. Laboratory detection limits (method detection limits, limits of detection, and limits of quantitation) are provided in Worksheet #15 of the UFP-QAPP alongside the PALs. VOC data will be verified and validated as detailed in Worksheets #34, #35, and #36 of the UFP-QAPP. Data usability will be assessed as described in Worksheet #37 of the UFP-QAPP (EA 2022a).

11.19 CSIA samples will be collected consistent with methods presented in Worksheet #14 and #16 of this UFP-QAPP Addendum and supplemented by the previous UFP-QAPP Addendum (EA 2023). There are no DoD-accredited laboratories for CSIA of CVOCs in groundwater. However, the University of Waterloo specializes in CSIA and has provided laboratory-specific measurement performance criteria, detection limits, instrument calibration and maintenance information, and QC sample information. This information is presented in Worksheets #12, #15, #24, #25, and #28 of this UFP-QAPP Addendum. CSIA data will be verified as detailed in Worksheets #34 and #35 of the UFP-QAPP (EA 2022a). Data usability will be assessed in terms of whether study goals have been achieved.

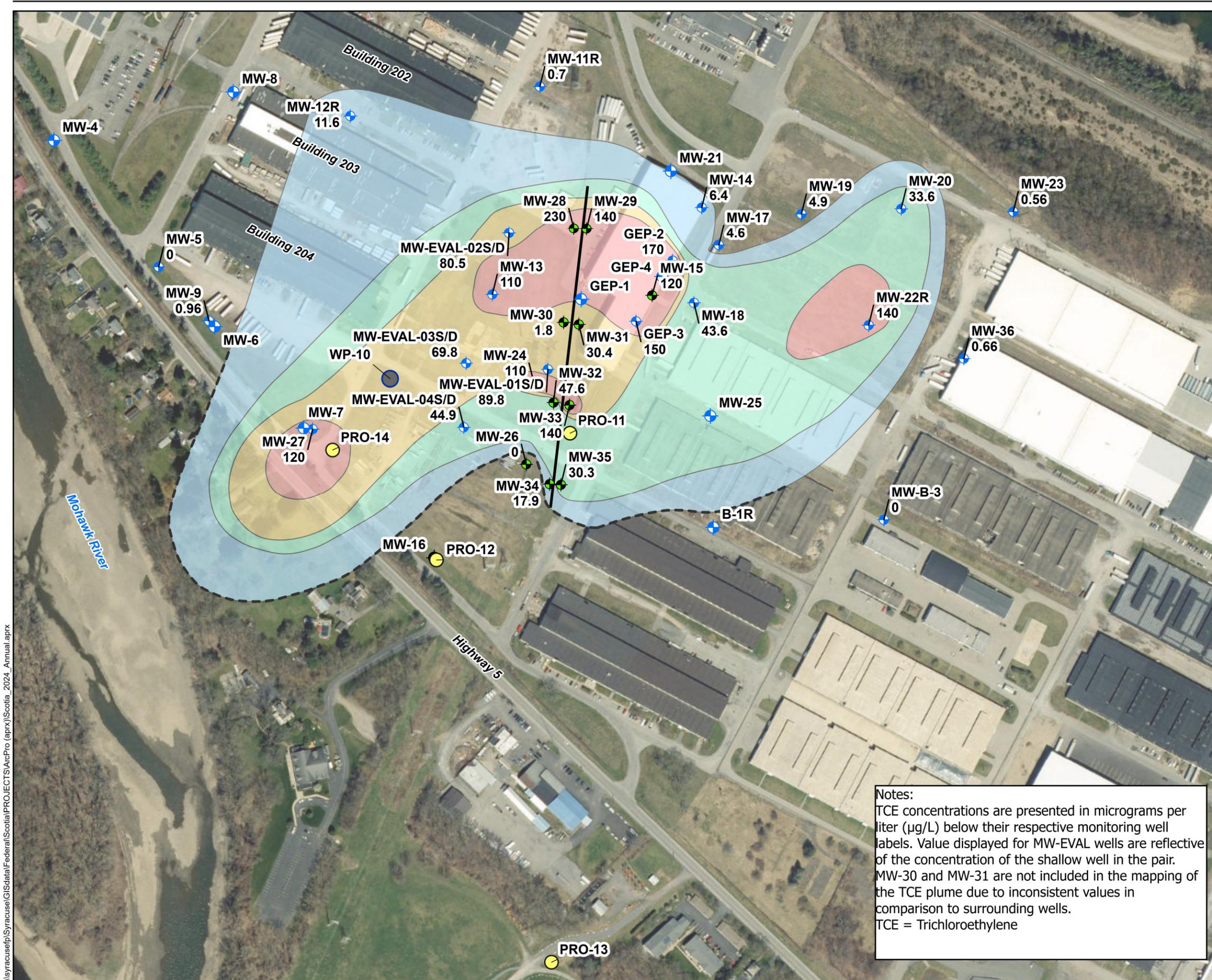
### **Step 7: Develop the Detailed Plan for Data Collection**

11.20 The detailed plan for obtaining data is defined in this UFP-QAPP Addendum, supplemented by the UFP-QAPP (EA 2022a) and the previous UFP-QAPP Addendum (EA 2023).

11.21 Additional details are provided about the data collection plan in subsequent worksheets as follows:

- Worksheet #14 and #16 in this UFP-QAPP Addendum, supplemented by the UFP-QAPP (EA 2022a), and the previous UFP-QAPP Addendum (EA 2023) provide the project tasks and schedule.
- Worksheet #17 in this UFP-QAPP Addendum provides the sample design and rationale.
- Worksheets #24 and #28 in this UFP-QAPP Addendum, supplemented by the UFP-QAPP (EA 2022a), and the previous UFP-QAPP Addendum (EA 2023) provide specific details on the analytical requirements.
- Worksheets #26 and #27 in this UFP-QAPP Addendum, supplemented by the UFP-QAPP (EA 2022a), and the previous UFP-QAPP Addendum (EA 2023) provide information on sample nomenclature, packaging, shipment, and delivery to the analytical laboratory.

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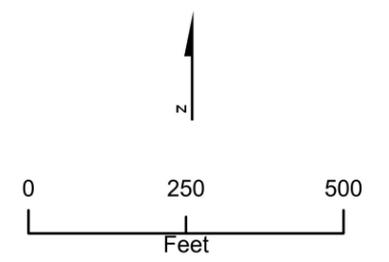
VICINITY MAP



**Legend**

- ★ Site Location
- TCE Concentration (µg/L)  
(November 2024)
- 5-25
- 25-50
- 50-100
- > 100
- - - Inferred Plume Boundary
- Proposed Profiling Location
- Historic Sample - Stone PDI 2013
- ◆ Compliance Well
- ◆ Monitoring Well
- PRB Location

Map Date: 10/24/2025  
 Source: ESRI, 2011  
 Projection: NAD 1983 State Plane New York East



**Notes:**  
 TCE concentrations are presented in micrograms per liter (µg/L) below their respective monitoring well labels. Value displayed for MW-EVAL wells are reflective of the concentration of the shallow well in the pair. MW-30 and MW-31 are not included in the mapping of the TCE plume due to inconsistent values in comparison to surrounding wells.  
 TCE = Trichloroethylene

**Figure 11-1**  
**PROPOSED CORRECTIVE MEASURES**  
**PROFILING LOCATIONS**  
 Former Scotia Navy Depot  
 Glenville, New York

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## Worksheet #12 Measurement Performance Criteria

12.1 This worksheet is intended to update the quantitative measurement performance criteria in terms of precision, accuracy, and sensitivity for laboratory analysis included in this UFP-QAPP Addendum. Measurement performance criteria are developed to ensure that the collected data will satisfy the DQOs documented on Worksheet #11. Measurement performance criteria for groundwater VOC and MNA analyses are provided in the UFP-QAPP (EA 2022a). Measurement performance criteria for field screening of VOC samples using the field gas chromatograph (i.e., FROG-5000™) are provided in the previous UFP-QAPP Addendum (EA 2023). Measurement performance criteria for CSIA of CVOCs in groundwater are provided in **Table 12-1** of this UFP-QAPP Addendum. Measurement performance criteria for qPCR of microbial samples are provided in **Table 12-2** of this UFP-QAPP Addendum.

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**Table 12-1. Measurement Performance Criteria – Compound Specific Isotope Analysis (University of Waterloo – Environmental Isotope Laboratory)**

<b>Matrix</b>	Water				
<b>Analytical Group</b>	Carbon CSIA				
<b>Concentration Level</b>	Low				
<b>Sampling Procedure</b>	<b>Analytical Method/SOP</b>	<b>Data Quality Indicators</b>	<b>Measurement Performance Criteria</b>	<b>QC Sample and/or Activity Used to Assess Measurement Performance</b>	<b>QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&amp;A)</b>
SOPs 001, 002, 004, 005, 010, 011, 013, 016, 039, 042, 043, and 048	EIL-TP38.0 (University of Waterloo – Environmental Isotope Laboratory)	Accuracy	Target peaks < Limit of Detection	Method Blank	A
		Precision	Standard Deviation of $\delta^{13}\text{C} \leq 0.3\text{‰}$	Laboratory Sample Replicate	A
	EIL-TP42.0 (University of Waterloo – Environmental Isotope Laboratory)	Precision	Standard Deviation of $\delta^{13}\text{C} \leq 0.3\text{‰}$	Field Duplicate	S&A
		Accuracy	Average $\delta^{13}\text{C}$ value within $\pm 0.3\text{‰}$ of true $\delta^{13}\text{C}$ value	Laboratory control sample (LCS)	A
		Precision	Standard Deviation of $\delta^{13}\text{C} \leq 0.3 \text{ ‰}$	LCS	A

**Table 12-2. Measurement Performance Criteria – QuantArray-Chlor Analysis (Microbial Insights)**

<b>Matrix</b>	Water				
<b>Analytical Group</b>	QuantArray-Chlor				
<b>Concentration Level</b>	Low				
<b>Sampling Procedure</b>	<b>Analytical Method/SOP</b>	<b>Data Quality Indicators</b>	<b>Measurement Performance Criteria</b>	<b>QC Sample and/or Activity Used to Assess Measurement Performance</b>	<b>QC Sample Assesses Error for Sampling (S), Analytical (A) or both (S&amp;A)</b>
SOPs 001, 002, 004, 005, 010, 011, 013, 016, 039, 042, 043, and 048	MI-SOP-CSIA-PREP (Microbial Insights)	Accuracy	Cycle Threshold (CT) ≤ Assay Negative Control	--	A
	MI-SOP-CSIA-C-INST (Microbial Insights)				
	MI-SOP-CSIA-C-DATA (Microbial Insights)	Accuracy	Average δ <sup>13</sup> C value within ± 0.5 ‰ of true δ <sup>13</sup> C value	--	A

## Worksheet #14 and #16 Project Tasks and Schedule

14/16.1 This worksheet provides an overview of project tasks to be performed in support of further characterization and delineation of VOCs. A general project schedule presenting the tasks and planned start and end dates will be included at the end of this worksheet as **Table 14-1**. The schedule will be modified as necessary during the field activities based on weather or any access issues.

14/16.2 Field and analytical tasks will be conducted in accordance with this UFP-QAPP Addendum, supplemented by the previous UFP-QAPP Addendum (EA 2023), and the UFP-QAPP (EA 2022a). The following tasks are presented in this UFP-QAPP Addendum:

- Health and safety tasks
- Laboratory analysis tasks

14/16.3 The following tasks presented in the previous UFP-QAPP Addendum (EA 2023) are applicable to further characterization of the Site:

- Health and safety tasks
- Instrument calibration tasks
- Utility clearance
- Vertical aquifer groundwater grab sample profiling
- Monitoring well installation and development
- Sample collection tasks
- Equipment decontamination tasks
- Investigation-derived waste (IDW) tasks
- Field screening of in situ groundwater samples
- Laboratory analysis tasks

14/16.4 The following tasks presented in the UFP-QAPP (EA 2022a) are applicable to further characterization of the site:

- Mobilization and demobilization tasks
- Synoptic gauging tasks
- Sample collection tasks
- Sample handling and management tasks
- Field documentation and records tasks
- Assessment/audit tasks
- Data management tasks
- Data evaluation tasks
- Reporting tasks

## HEALTH AND SAFETY TASKS

14/16.5 Field activities will be conducted in accordance with the Accident Prevention Plan (EA 2022c), which has been updated to cover additional activities that will be conducted in support of the Corrective Measures Implementation Health and safety tasks are further discussed in the UFP-QAPP (EA 2022a).

## INSTRUMENT CALBRATION TASKS

14/16.6 Field equipment including PIDs and water quality meters will be calibrated in accordance with the UFP-QAPP (EA 2022a) and the previous UFP-QAPP Addendum (EA 2023).

## UTILITY CLEARANCE

14/16.7 Utility clearance will be conducted as described in the previous UFP-QAPP Addendum (EA 2023). Dig Safely New York will be contacted at least 48 hours prior to well installation to obtain a routine ticket for utility location. Dig Safely New York ticket requests will be made by calling 811 (if inside New York) or 800-962-7962 if outside of New York or by placing a request online at <http://www.digsafelynewyork.com> using i-Notice. Utilities/communications lines will be marked before the exact well locations are determined. Additional methods to identify utilities may be used including geophysical survey and hand clearing. Proposed locations may be adjusted in the field based on utility clearance, as needed.

## VERTICAL IN SITU GROUNDWATER SAMPLING

### Advancement and Sampling of Vertical Aquifer Groundwater Grab Sample Profiling Boreholes

14/16.8 Vertical aquifer groundwater grab sample profiling boreholes will be advanced and sampled as described in the previous UFP-QAPP Addendum (EA 2023).

### Groundwater Field Screening

14/16.9 Groundwater field screening will be conducted as described in the previous UFP-QAPP Addendum (EA 2023).

## MONITORING WELL INSTALLATION

14/16.10 Up to eight monitoring wells will be installed in accordance with SOP-019 which was included as Appendix A in the previous UFP-QAPP Addendum (EA 2023). The monitoring wells will be installed in up to four vertical aquifer groundwater grab sample profiling boreholes as shallow-deep pairs. The profiling locations have been selected (midplume, downgradient, near sidegradient, and far sidegradient) to further bound the plume and characterize the vertical depth and linear extent of plume transport towards the Mohawk River (**Figure 11-1**). It is expected that all vertical aquifer groundwater grab sample profiling boreholes will have monitoring wells installed.

14/16.11 Monitoring wells will be constructed of 2-inch diameter Schedule 40 polyvinyl chloride (PVC) casing and No. 010 slotted PVC well screen. Schedule 80 PVC casing and well screen will be used in wells over 100 feet deep. Monitoring wells will be installed in accordance with the drilling and installation procedures described in SOP-005, and SOP-019 provided in Appendix A of the previous UFP-QAPP Addendum (EA 2023). Following the completion of well installation, a record of monitoring well construction will be completed for each monitoring well.

### **MONITORING WELL DEVELOPMENT**

14/16.12 Monitoring well development will be conducted as described in the previous UFP-QAPP Addendum (EA 2023).

### **MONITORING WELL SAMPLING TASKS**

14/16.13 Groundwater sampling of existing and newly installed monitoring wells will be conducted in accordance with the procedures presented in Worksheet #14 and #16 of the UFP-QAPP (EA 2022a). Off-site laboratory samples will be analyzed for VOCs and MNA parameters in accordance with the UFP-QAPP (EA 2022a).

### **SAMPLE COLLECTION TASKS**

14/16.14 Prior to collecting field samples, samplers will don clean, protective gloves. Samples will be collected for constituents listed in Worksheet #18 of this UFP-QAPP Addendum. A sample collection log provided in Appendix B of the UFP-QAPP (EA 2022a) will be completed for each field and off-site laboratory analytical sample collected and will provide the following information about the sample: sample location and identity, sample location identification, sample number, sample depth interval, analytical parameters, sample containers, QA/QC information, and any comments or observations.

14/16.15 Sample containers for off-site laboratory analysis will be provided by the analytical laboratory and will be pre-preserved for those constituents that require chemical preservation. Sample containers for groundwater VOC and MNA samples are detailed in Worksheet #19 and #30 of the UFP-QAPP (EA 2022a). Sample containers for carbon isotope samples and qPCR samples are detailed in Worksheet #19 and #30 of this UFP-QAPP Addendum.

14/16.16 Samples will be handled and managed following the procedures included in Worksheet #14 and #16 of the UFP-QAPP (EA 2022a).

### **FIELD QUALITY CONTROL SAMPLE TASKS**

14/16.17 Field QC samples for the field gas chromatograph (i.e., FROG-5000™) will consist of instrument verification checks and equipment blanks as presented in Worksheet #20 of the previous UFP-QAPP Addendum (EA 2023). Field QC samples for VOC samples submitted for laboratory analysis collected during vertical aquifer groundwater grab sample profiling will consist

of field duplicates, matrix spike (MS)/matrix spike duplicate (MSD), equipment blanks, and trip blanks as presented in Worksheet #20 of this UFP-QAPP Addendum.

14/16.18 Field QC samples for groundwater monitoring well VOC samples will be collected and analyzed at the rate presented in the UFP-QAPP (EA 2022a).

14/16.19 No field QC samples will be collected for CSIA or the in situ microcosms.

## **EQUIPMENT DECONTAMINATION TASKS**

14/16.20 Environmental sampling supplies will be dedicated whenever possible. Downhole drilling equipment used during monitoring well installation activities and non-dedicated/non-disposable sampling equipment that contacts or potentially could contact samples will be decontaminated prior to and between drilling/sampling locations in accordance with SOP 005 as presented in Appendix A of the previous UFP-QAPP Addendum (EA 2023). Non-dedicated/non-disposable equipment including submersible pumps used during well development and purging activities and electric water level tapes will be decontaminated prior to starting work on the first location, and between locations. Decontamination fluid contained in 5-gallon buckets will be properly disposed of at the end of the day or more frequently as presented under the IDW tasks presented below.

14/16.21 Purging and sampling equipment will be protected from contamination until ready for use. In addition, care will be taken to prevent samples from coming into contact with potentially contaminating substances, such as tape, oil, engine exhaust, corroded surfaces, and dirt.

## **INVESTIGATION-DERIVED WASTE TASKS**

14/16.22 IDW is anticipated to include drill cuttings generated during advancement of vertical aquifer groundwater grab sample profiling boreholes and installation of monitoring wells; and purge water and decontamination fluids generated during well development and groundwater sampling. A subcontractor will be procured to handle and dispose of IDW. Other generated waste such as plastic tubing, gloves, etc., will be disposed of as general refuse. Additionally, areas impacted during advancement of vertical aquifer groundwater grab sample profiling boreholes, monitoring well installation, and sampling activities will be restored to their original condition.

14/16.23 The bulk of environmental waste including liquid and soil will be containerized in frac tanks and roll offs, respectively. Roll offs and frac tanks will be staged on-site at a safe location approved by USACE. If required, smaller quantities of liquid and/or solid environmental IDW will be stored in Department of Transportation-approved 55-gallon drums. IDW drums will be stored on pallets at the Site and labeled as non-hazardous pending analysis.

14/16.24 It is anticipated that IDW will be classified as non-hazardous. Following the receipt and review of analytical results required by the disposal facility (i.e., Toxicity Characteristic Leaching Procedure analysis), IDW will be transported by the IDW subcontractor to an off-site treatment and disposal facility for proper disposal. The IDW subcontractor will prepare waste manifests for USACE signature.

## **LABORATORY ANALYSIS TASKS**

### **Sample Analysis**

14/16.25 Groundwater VOC and MNA parameter samples will be processed and analyzed according to the sample chain-of-custody documents, and the requirements of the UFP-QAPP (EA 2022a). Groundwater carbon isotope samples and microbial samples will be processed and analyzed according to the sample chain-of-custody documents and the requirements of the UFP-QAPP (EA 2022a) and this UFP-QAPP Addendum.

14/16.26 The planned analyses of samples are presented in Worksheet #18 of this UFP-QAPP Addendum.

### **Laboratory Quality Control Tasks**

14/16.27 Laboratory QC tasks for groundwater VOC and MNA samples are provided in the UFP-QAPP (EA 2022a).

14/16.28 Details regarding analytical method QC for CSIA of CVOCs and microbial samples in groundwater are provided in Worksheet #28 of this UFP-QAPP Addendum. Calibration and instrument maintenance will be conducted as summarized in Worksheet #24 and #25. Measurement performance criteria is specified in Worksheet #12.

## **LABORATORY REPORTING TASKS – LABORATORY**

14/16.29 Groundwater VOC and MNA analytical data will be reported in accordance with Worksheet #14 and #16 of the UFP-QAPP (EA 2022a).

14/16.30 The analytical laboratory (University of Waterloo – Environmental Isotope Laboratory) contracted to perform CSIA of CVOCs in groundwater will provide a summary report of the methods and results of CSIA of groundwater samples.

14/16.31 The analytical laboratory (Microbial Insights) contracted to analyze the in situ microcosms will provide a summary report of the methods and results from qPCR samples.

## **DATA REVIEW TASKS**

14/16.32 Groundwater VOC and MNA analytical data will be reviewed and validated in accordance with the UFP-QAPP (EA 2022a) and previous UFP-QAPP Addendum (EA 2023).

14/16.33 In situ microbial analytical data and CSIA analytical data will not be validated.

**REPORTING TASKS**

14/16.34 A Corrective Measures Report will be drafted to address the activities proposed in this UFP-QAPP Addendum, such as:

- Updates to the conceptual site model
- Evaluation of midplume conditions
- Evaluation of downgradient plume conditions
- Evaluation of sidegradient plume conditions
- Evaluation of VOC transformation across the site using CSIA
- Evaluation of microbial communities present at the site in a variety of geochemical conditions

14/16.35 A Draft version of the Corrective Measures Report will be provided for USACE/GSA, and a Draft Final version will be provided for NYSDEC.

**Table 14-1. Project Tasks and Schedule**

Task	Subtask	Planned Start Date	Planned Completion Date
NTP	--	TBD	TBD
Kickoff Meeting	--		
QAPP Addendum	Draft (USACE/GSA/NYSDEC)		
	Review Period		
	Final		
Revised APP/SSHP	Submit (USACE)		
	Review Period		
	Approval		
Field Activities	Procurement (Driller/laboratories)		
	Excavation Permit		
	Vertical aquifer groundwater grab sample profiling		
	Well Installation/Development		
	Well Sampling		
	Laboratory analysis		
	Data Validation		
	Weekly meetings (TBD)		
Corrective Measures Report	Draft (USACE/GSA)		
	Review Period		
	Draft Final (NYSDEC)		
	Review Period		
	Final		

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### Worksheet #15 Project Action Levels and Laboratory Quantitation Limits

**Table 15-1. Detection/Quantitation Limits – Compound Specific Isotope Analysis**

**Matrix:** Water  
**Analytical Group:** Carbon CSIA by EIL-TP38.0 and EIL-TP42.0  
**Concentration Level:** Low

Analyte	Analytical Method Limits (Laboratory -Specific)	
	Detection Limit (µg/L)	Limit of Quantitation (µg/L)
<sup>13</sup> C/ <sup>12</sup> C of PCE, TCE, <i>cis</i> -1,2-dichloroethylene, and vinyl chloride	40.0	40.0

**Table 15-2. Detection/Quantitation Limits – Microbiological**

**Matrix:** Water  
**Analytical Group:** Microbiological by MI-SOP-QuantArray  
**Concentration Level:** Low

Analyte	Analytical Method Limits (Laboratory-Specific)	
	Detection Limit (cells/sample)	Limit of Quantitation (cells/sample)
Dehalococcoides (DHC), tceA Reductase (TCE), BAV1 Vinyl Chloride Reductase (BVC), Vinyl Chloride Reductase (VCR) Dehalobacter spp. (DHBt) Dehalobacter DCM (DCM) Dehalogenimonas spp. (DHG) cerA Reductase (CER) trans-1,2-DCE Reductase (TDR) Desulfitobacterium spp. (DSB) Dehalobium Chlorocoercia (DECO) Desulfuromonas spp. (DSM) PCE Reductase (PCE-1) PCE Reductase (PCE-2) Chloroform Reductase (CFR) 1,1 DCA Reductase (DCA) 1,2 DCA Reductase (DCAR) Soluble Methane Monooxygenase (SMMO) Toluene Dioxygenase (TOD) Phenol Hydroxylase (PHE) Trichlorobenzene Dioxygenase (TCBO) Toluene Monooxygenase 2 (RDEG) Toluene Monooxygenase (RMO) Ethene Monooxygenase (EtnC) Epoxyalkane Transferase (EtnE) Dichloromethane Dehalogenase (DCMA) Total Eubacteria (EBAC) Sulfate Reducing Bacteria (APS) Methanogens (MGN)	10	250

## Worksheet #17 Sample Design and Rationale

17.1 This worksheet provides the sampling design and rationale for the collection of samples for the analyses presented in this UFP-QAPP Addendum.

### Rationale for Sampling Approach

17.2 The objective of the sample collection is to evaluate the nature and extent of COCs and degradation products, to better understand the groundwater plume, particularly with respect to midplume, downgradient, and sidegradient transport of COCs and degradation products. Vertical aquifer groundwater grab sample profiling boreholes will be advanced and sampled to determine the spatial variability of contamination midplume, downgradient, and sidegradient and further delineate the depth of contamination.

### Sampling Design and Rationale

17.3 The proposed sampling design is presented in **Table 17-1**.

17.4 The sampling rationale for each vertical aquifer groundwater grab sample profiling location is presented in **Table 17-2**.

17.5 Corrective Measures Implementation activities presented in this UFP-QAPP Addendum will be completed to further characterize the site, including the following:

- Update the Conceptual Site Model
- Vertical aquifer groundwater grab sample profiling
- Groundwater modeling
- Installation of supplemental monitoring wells midplume, downgradient, and sidegradient
- Laboratory analyses of groundwater samples for CSIA of CVOCs in groundwater
- Laboratory analyses of groundwater samples for qPCR of microbial communities in groundwater

17.6 Four vertical aquifer groundwater grab sample profiling points (PRO-11 through PRO-14) will be advanced midplume, downgradient, and sidegradient of the VOC plume to an approximate depth of 155 feet bgs (**Figure 11-1**). Groundwater samples will be collected vertically every 10 feet once groundwater is encountered (estimated to be 65 feet bgs). Samples will be screened in the field for PCE and daughter products and submitted for off-site laboratory analysis of VOCs.

17.7 Proposed vertical aquifer groundwater grab sample profiling point locations are presented on **Figure 11-1**; however, actual locations may vary based on utility locations and field screening results.

17.8 Up to eight monitoring wells will be installed in existing boreholes of vertical aquifer groundwater grab sample profiling points to supplement the existing monitoring well network. These monitoring wells will be installed as shallow-deep pairs and the screen placements will be determined based upon field results from the profiling efforts (i.e., FROG data) and following conversations with USACE.

17.9 To further characterize the plume, groundwater samples will be collected from all monitoring wells, including the four newly installed shallow/deep well pairs and analyzed for VOCs. In addition, samples will be collected from select monitoring wells and analyzed for the following MNA parameters: total organic carbon, alkalinity, anions (chloride, nitrate, and sulfate), dissolved gases (methane, ethane, and ethene), and metals (dissolved iron and manganese).

17.10 CSIA groundwater samples will be collected to measure carbon isotope ratios ( $^{13}\text{C}/^{12}\text{C}$ ) in the CVOCs. CSIA samples will be collected from select monitoring wells that exhibit historical concentrations of CVOCs above 40  $\mu\text{g}/\text{L}$  for  $^{13}\text{C}/^{12}\text{C}$  CSIA. Note that only select PRB compliance well pairs were selected for CSIA as pairs MW-30/31 and MW-34/35 have decreasing concentrations across the PRB and total CVOCs generally around or below the 40  $\mu\text{g}/\text{L}$  MDL for CSIA. CSIA sampling is planned for all new monitoring wells; however, given that the CSIA has a minimum detection limit of 40  $\mu\text{g}/\text{L}$ , EA will use the field screening obtained during the vertical profiling (via FROG) to determine whether CSIA is appropriate for a given well location. EA will confirm with USACE before eliminating a CSIA planned sampling point.

17.11 In situ microcosm reactors will be deployed in six monitoring wells. Microcosm reactors will contain one unamended reactor, and one reactor amended with a carbon source. The unamended microcosms will be analyzed with qPCR to investigate the microbial community present at the site. The amended microcosms will also be analyzed with qPCR to evaluate changes, if any, in the microbial community in the presence of a carbon source. The six monitoring wells selected for this analysis are detailed in Worksheet #18 and were selected based on high historic CVOC concentrations, location in the plume, and range in dissolved oxygen concentrations and ORP. The range in dissolved oxygen concentrations and ORP is proposed to evaluate the microbial community present in various oxidative/reductive areas of the plume, and to evaluate if the microbial community will develop in an oxidative environment given the presence of a carbon source.

**Table 17-1. Summary of Tasks**

Task	Number of Locations	Analysis
Update Conceptual Site Model	Current CSM will be updated to include additional characterization data	
Further Plume Delineation	<ul style="list-style-type: none"> <li>• 1 vertical aquifer groundwater grab sample profiling borehole midplume near MW-33 and the location of the historic PRO-07 boring to fill data gaps onsite.</li> <li>• 1 vertical aquifer groundwater grab sample profiling borehole deeper than, and near, MW-16</li> <li>• 1 vertical aquifer groundwater grab sample profiling borehole sidegradient of the plume in Maalwyck Park.</li> <li>• 1 vertical aquifer groundwater grab sample profiling borehole placed near MW-7 and MW-27 to fill downgradient data gaps onsite.</li> <li>• Sampling at 10-foot depth intervals starting at groundwater table (anticipated at 65 feet bgs)</li> <li>• Install shallow and deep monitoring well pairs at 4 profiling locations (8 wells total)</li> </ul>	<ul style="list-style-type: none"> <li>• FROG-5000™</li> <li>• pH, DO, specific conductivity, turbidity, and ORP</li> <li>• VOCs (1 sample from each vertical interval)</li> <li>• Updates to 3D Plume model</li> </ul>
Nature of CVOC Degradation (biotic versus abiotic processes)	<ul style="list-style-type: none"> <li>• 53 samples from existing and new wells for VOCs</li> <li>• 8 new wells sampled for <sup>13</sup>C/<sup>12</sup>C CSIA</li> <li>• 23 existing wells with historic CVOC concentrations greater than <sup>13</sup>C/<sup>12</sup>C CSIA MDL (40 parts per billion)</li> </ul>	<ul style="list-style-type: none"> <li>• VOCs (1 sample from each existing and new monitoring well)</li> <li>• CSIA of CVOCs in groundwater (31 wells)</li> <li>• pH, DO, specific conductivity, turbidity, and ORP</li> </ul>
Monitored Natural Attenuation	<ul style="list-style-type: none"> <li>• 8 new monitoring wells</li> <li>• 23 existing monitoring wells</li> </ul>	31 wells sampled for: <ul style="list-style-type: none"> <li>• TOC</li> <li>• Alkalinity</li> <li>• Anions</li> <li>• Dissolved Gases</li> <li>• Dissolved Metals</li> <li>• pH, DO, specific conductivity, turbidity, and ORP</li> </ul>
Enhanced Aerobic/Anaerobic Bioremediation Evaluation	<ul style="list-style-type: none"> <li>• 6 existing monitoring wells, 2 BioFlo filters per well.</li> </ul>	<ul style="list-style-type: none"> <li>• In Situ Microcosms (Unamended and amended in both aerobic and anaerobic conditions); total of 12 microcosms.</li> </ul>

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**Table 17-2. Summary of Proposed Vertical Aquifer Groundwater Grab Sample Profiling Borings**

<b>Profile Location</b>	<b>Sampling Interval (feet bgs)</b>	<b>Rationale for Location</b>
PRO-11-1	65-75 <sup>1</sup>	Assess depth of groundwater contamination midplume near the PRB and historic PRO-07.
PRO-11-2	75-85	
PRO-11-3	85-95	
PRO-11-4	95-105	
PRO-11-5	105-115	
PRO-11-6	115-125	
PRO-11-7	125-135	
PRO-11-8	135-145	
PRO-11-9	145-155	
PRO-12-1	65-75 <sup>1</sup>	Assess depth of groundwater plume sidegradient near MW-16.
PRO-12-2	75-85	
PRO-12-3	85-95	
PRO-12-4	95-105	
PRO-12-5	105-115	
PRO-12-6	115-125	
PRO-12-7	125-135	
PRO-12-8	135-145	
PRO-12-9	145-155	
PRO-13-1	15-25 <sup>2</sup>	Assess the sidegradient transport of the plume towards the Mohawk River (located in Maalwyck Park).
PRO-13-2	25-35	
PRO-13-3	35-45	
PRO-13-4	45-55	
PRO-13-5	55-65	
PRO-13-6	65-75	
PRO-13-7	75-85	
PRO-14-1	65-75 <sup>1</sup>	Assess depth of groundwater plume downgradient near the edge of the site property towards the Mohawk River (near the MW-7/MW-27 pair).
PRO-14-2	75-85	
PRO-14-3	85-95	
PRO-14-4	95-105	
PRO-14-5	105-115	
PRO-14-6	115-125	
PRO-14-7	125-135	
PRO-14-8	135-145	
PRO-14-9	145-155	

## Notes:

TBD = to be determined

- 1) 65 feet bgs is the assumed groundwater table based on historical data. Vertical aquifer groundwater grab sample profiling borehole depths will be adjusted in the field as needed based on actual water table depths at the time of the investigation.
- 2) The Maalwyck Park location is approximately 50 feet below in elevation from the monitoring locations on the Former Scotia Navy Depot property and the assumed groundwater table is 15 feet bgs. Vertical aquifer groundwater grab sample profiling borehole depths will be adjusted in the field as needed based on actual water table depths at the time of the investigation.

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### Worksheet #18 Sampling Locations and Methods

18.1 This worksheet documents the updated samples planned for collection under this UFP-QAPP Addendum and will serve as a completeness check for field personnel and QC review. There are three tables included in this worksheet. The first table (**Table 18-1**) provides specifics about each proposed profiling location onsite. The second table (**Table 18-2**) includes analytes for each groundwater sample. The third table (**Table 18-3**) includes details for microcosm sampling.

**Table 18-1. Vertical Aquifer Groundwater Grab Sample Profiling Boreholes Specifications**

Profile Location	Sampling Interval (feet bgs)	Laboratory Analysis	Field Monitoring	Northing	Easting
PRO-11-1	65-75 <sup>1</sup>	VOC (8260D) samples at each vertical interval.	<ul style="list-style-type: none"> <li>FROG 5000™</li> <li>Temperature, pH, DO, specific conductivity, turbidity, and ORP</li> </ul>	1460262.92964	628839.794709
PRO-11-2	75-85				
PRO-11-3	85-95				
PRO-11-4	95-105				
PRO-11-5	105-115				
PRO-11-6	115-125				
PRO-11-7	125-135				
PRO-11-8	135-145				
PRO-11-9	145-155				
PRO-12-1	65-75 <sup>1</sup>			1459883.06306	628438.602896
PRO-12-2	75-85				
PRO-12-3	85-95				
PRO-12-4	95-105				
PRO-12-5	105-115				
PRO-12-6	115-125				
PRO-12-7	125-135				
PRO-12-8	135-145				
PRO-12-9	145-155				
PRO-13-1	15-25 <sup>2</sup>			1458680.24317	628784.126226
PRO-13-2	25-35				
PRO-13-3	35-45				
PRO-13-4	45-55				
PRO-13-5	55-65				
PRO-13-6	65-75				
PRO-13-7	75-85				
PRO-14-1	65-75 <sup>1</sup>			1460212.46966	628126.816014
PRO-14-2	75-85				
PRO-14-3	85-95				
PRO-14-4	95-105				
PRO-14-5	105-115				
PRO-14-6	115-125				
PRO-14-7	125-135				
PRO-14-8	135-145				
PRO-14-9	145-155				

## Notes:

- 1) 65 feet bgs is the assumed groundwater table based on historical data. Vertical aquifer groundwater grab sample profiling borehole depths will be adjusted in the field as needed based on actual water table depths at the time of the investigation.
- 2) The Maalwyck Park location is approximately 50 feet below in elevation from the monitoring locations on the Former Scotia Navy Depot property and the assumed groundwater table is 15 feet bgs. Vertical aquifer groundwater grab sample profiling borehole depths will be adjusted in the field as needed based on actual water table depths at the time of the investigation.

**Table 18-2. Well Identification, Frequency, and Applicable Low-Flow Sampling Analytes/Methods**

Well ID	Sample ID	Analytes/Methods							
		Water Quality Parameters	CSIA	VOCs (SW8260D)	TOC (SM5310B)	Alkalinity (SM2320B)	Anions (SW905 6A) <sup>1</sup>	Dissolved Gases (RSK-175)	Dissolved <sup>2</sup> Fe & Mn (6010D)
<i>New Monitoring Wells</i>									
MW-CM-01S	FSND-MW-CM-01S-YYYYMMDD	X	X	X	X	X	X	X	X
MW-CM-01D	FSND-MW-CM-01D-YYYYMMDD	X	X	X	X	X	X	X	X
MW-CM-02S	FSND-MW-CM-02S-YYYYMMDD	X	X	X	X	X	X	X	X
MW-CM-02D	FSND-MW-CM-02D-YYYYMMDD	X	X	X	X	X	X	X	X
MW-CM-03S	FSND-MW-CM-03S-YYYYMMDD	X	X	X	X	X	X	X	X
MW-CM-03D	FSND-MW-CM-03D-YYYYMMDD	X	X	X	X	X	X	X	X
MW-CM-04S	FSND-MW-CM-04S-YYYYMMDD	X	X	X	X	X	X	X	X
MW-CM-04D	FSND-MW-CM-04D-YYYYMMDD	X	X	X	X	X	X	X	X
<i>Existing Monitoring Wells</i>									
B-1R	FSND-B-1R-YYYYMMDD	X	--	X	--	--	--	--	--
MW-B-3	FSND-MW-B-3-YYYYMMDD	X	--	X	--	--	--	--	--
MW-4		--	--	--	--	--	--	--	--
MW-5	FSND-MW-5-YYYYMMDD	X	--	X	--	--	--	--	--
MW-6	FSND-MW-6-YYYYMMDD	X	X	X	X	X	X	X	X
MW-7	FSND-MW-7-YYYYMMDD	X	--	X	--	--	--	--	--
MW-8	FSND-MW-8-YYYYMMDD	X	--	X	--	--	--	--	--
MW-9	FSND-MW-9-YYYYMMDD	X	--	X	--	--	--	--	--
MW-11R	FSND-MW-11R-YYYYMMDD	X	--	X	--	--	--	--	--
MW-12R	FSND-MW-12R-YYYYMMDD	X	--	X	--	--	--	--	--
MW-13	FSND-MW-13-YYYYMMDD	X	X	X	X	X	X	X	X
MW-14	FSND-MW-14-YYYYMMDD	X	--	X	--	--	--	--	--
MW-15	FSND-MW-15-YYYYMMDD	X	X	X	X	X	X	X	X
MW-16 <sup>3</sup>	N/A	--	--	--	--	--	--	--	--
MW-17	FSND-MW-17-YYYYMMDD	X	--	X	--	--	--	--	--
MW-18	FSND-MW-18-YYYYMMDD	X	X	X	X	X	X	X	X

Well ID	Sample ID	Analytes/Methods							
		Water Quality Parameters	CSIA	VOCs (SW8260D)	TOC (SM5310B)	Alkalinity (SM2320B)	Anions (SW905 6A) <sup>1</sup>	Dissolved Gases (RSK-175)	Dissolved <sup>2</sup> Fe & Mn (6010D)
MW-19	FSND-MW-19-YYYYMMDD	X	--	X	--	--	--	--	--
MW-20	FSND-MW-20-YYYYMMDD	X	--	X	--	--	--	--	--
MW-21	FSND-MW-21-YYYYMMDD	X	--	X	--	--	--	--	--
MW-22R	FSND-MW-22R-YYYYMMDD	X	X	X	X	X	X	X	X
MW-23	FSND-MW-23-YYYYMMDD	X	--	X	--	--	--	--	--
MW-24	FSND-MW-24-YYYYMMDD	X	X	X	X	X	X	X	X
MW-25	FSND-MW-25-YYYYMMDD	X	X	X	--	--	--	--	--
MW-26	FSND-MW-26-YYYYMMDD	X	X	X	X	X	X	X	X
MW-27	FSND-MW-27-YYYYMMDD	X	X	X	X	X	X	X	X
MW-28	FSND-MW-28-YYYYMMDD	X	--	X	--	--	--	--	--
MW-29	FSND-MW-29-YYYYMMDD	X	--	X	--	--	--	--	--
MW-30	FSND-MW-30-YYYYMMDD	X	--	X	--	--	--	--	--
MW-31	FSND-MW-31-YYYYMMDD	X	--	X	--	--	--	--	--
MW-32	FSND-MW-32-YYYYMMDD	X	X	X	X	X	X	X	X
MW-33	FSND-MW-33-YYYYMMDD	X	X	X	X	X	X	X	X
MW-34	FSND-MW-34-YYYYMMDD	X	--	X	--	--	--	--	--
MW-35	FSND-MW-35-YYYYMMDD	X	--	X	--	--	--	--	--
MW-36	FSND-MW-36-YYYYMMDD	X	--	X	--	--	--	--	--
GEP-1	FSND-GEP-1-YYYYMMDD	X	X	X	X	X	X	X	X
GEP-2	FSND-GEP-2-YYYYMMDD	X	X	X	X	X	X	X	X
GEP-3	FSND-GEP-3-YYYYMMDD	X	X	X	X	X	X	X	X
GEP-4	FSND-GEP-4-YYYYMMDD	X	X	X	X	X	X	X	X
MW-EVAL-01S	FSND-MW-EVAL-01S-YYYYMMDD	X	X	X	X	X	X	X	X
MW-EVAL-01D	FSND-MW-EVAL-01D-YYYYMMDD	X	X	X	X	X	X	X	X
MW-EVAL-02S	FSND-MW-EVAL-02S-YYYYMMDD	X	X	X	X	X	X	X	X
MW-EVAL-02D	FSND-MW-EVAL-02D-YYYYMMDD	X	X	X	X	X	X	X	X
MW-EVAL-03S	FSND-MW-EVAL-03S-YYYYMMDD	X	X	X	X	X	X	X	X
MW-EVAL-03D	FSND-MW-EVAL-03D-YYYYMMDD	X	X	X	X	X	X	X	X

Well ID	Sample ID	Analytes/Methods							
		Water Quality Parameters	CSIA	VOCs (SW8260D)	TOC (SM5310B)	Alkalinity (SM2320B)	Anions (SW905 6A) <sup>1</sup>	Dissolved Gases (RSK-175)	Dissolved <sup>2</sup> Fe & Mn (6010D)
MW-EVAL-04S	FSND-MW-EVAL-04S-YYYYMMDD	X	X	X	X	X	X	X	X
MW-EVAL-04D	FSND-MW-EVAL-04D-YYYYMMDD	X	X	X	X	X	X	X	X

Notes:

Fe = iron

Mn = manganese

1) Anion (nitrate) by M9056A has a 48-hour holding time.

2) Dissolved metals (iron) must be collected with a field filter into a separate preserved high-density polyethylene (HDPE) bottle.

3) MW-16 was observed to be damaged in November 2024 and cannot be sampled in its existing condition. MW-16 will be replaced with the shallow/deep monitoring well pair installed at location PRO-12.

**Table 18-3. Microcosm Sampling Locations**

Well ID	Sample ID	Location WRT PRB	Rationale	Unamended Microcosm (Control) MI-SOP-QuantArray	Amended Microcosm MI-SOP-QuantArray
MW-24	FSND-MW-24-YYYYMMDD	Downgradient	High CVOCs Low DO, Neg. ORP	X	X
MW-EVAL-03D	FSND-MW-EVAL-03D-YYYYMMDD	Downgradient	High CVOCs, Low DO, Neg. ORP	X	X
MW-27	FSND-MW-27-YYYYMMDD	Downgradient	High CVOCs, Mid-range DO	X	X
MW-33	FSND-MW-33-YYYYMMDD	Upgradient	High CVOCs, Mid-range DO	X	X
MW-15	FSND-MW-15-YYYYMMDD	Upgradient	High CVOCs, High DO	X	X
GEP-3	FSND-GEP-3-YYYYMMDD	Upgradient	High CVOCs, High DO	X	X

**Worksheet #19 and #30 Sample Containers, Preservation, and Hold Times**

19/30.1 Field teams will coordinate with the laboratory prior to mobilization to obtain sample containers and preservatives. It is possible that sample volume for certain analytical methods may be efficiently combined into single sample containers than what is listed in this worksheet.

Laboratory Name: University of Waterloo – Environmental Isotope Laboratory  
 Laboratory Sample Receipt Address: 263 Phillip Street, Waterloo, ON N2L 3W8  
 Laboratory POC: Rhys Gwynne  
 Laboratory POC Email: [rgwynne@uwaterloo.ca](mailto:rgwynne@uwaterloo.ca)  
 Laboratory POC Phone Number: 519-888-4567, ext. 35838

Matrix: Aqueous  
 Sample Delivery Method: Overnight shipping (Expedited courier, i.e., Federal Express)

Analyte/ Analyte Group	Analytical/ Preparation Method SOP Reference <sup>1</sup>	Accreditation Expiration Date	Container(s) (number, size, and type per sample)	Preservation	Maximum Holding Time <sup>1</sup> (preparation / analysis)	Data Package Turnaround (business days)
CSIA	EIL-TP38.0 EIL-TP42.0	On file at laboratory	Four 40-milliliter VOA vials with Teflon™-faced silicone septum (zero headspace)	Cool < 6°C; pH ≤ 2; HCl	6 months if preserved and refrigerated	40

## Notes:

1) Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.

± plus or minus

°C = degrees Celsius

HCl = hydrochloric acid

L = liter(s)

mL = milliliter(s)

VOA = volatile organic analyte

Laboratory Name: Microbial Insights  
 Laboratory Sample Receipt Address: 10515 Research Drive, Knoxville, TN 37932  
 Laboratory POC: Christian Polanco  
 Laboratory POC Email: [CPolanco@microbe.com](mailto:CPolanco@microbe.com)  
 Laboratory POC Phone Number: 1-865-573-8188 ext. 116

Matrix: Groundwater  
 Sample Delivery Method: Overnight shipping (Expedited courier, i.e., Federal Express)

Analyte/ Analyte Group	Analytical/ Preparation Method SOP Reference <sup>1</sup>	Accreditation Expiration Date	Container(s) (number, size, and type per sample)	Preservation	Maximum Holding Time <sup>1</sup> (preparation / analysis)	Data Package Turnaround (business days)
QuantArray- Chlor	MI SOP QuantArray	On file at laboratory	BioFlo Filter	Cool ≤ 6°C	24-48 hours	Standard (14 Calendar Days)

Notes:

1) Maximum holding time is calculated from the time the sample is collected to the time the sample is prepared/extracted.

### Worksheet #20 Field Quality Control

20.1 This worksheet summarizes the number of field QC samples that will be collected and submitted to the laboratory for each matrix and analytical group.

**Table 20-1. Field Quality Control Sample Summary for Proposed Vertical Aquifer Groundwater Grab Sample Profiling Borehole Samples, Groundwater Monitoring Well Samples, and In Situ Microcosm Samples**

Matrix	Analyte/ Analytical Method	Number of Field Samples <sup>1</sup>	Field Duplicates <sup>2</sup>	MS/MSD <sup>3</sup>	Trip Blanks <sup>4</sup>	Equipment Blanks <sup>5,6</sup>	Instrument Verification Checks <sup>7</sup>	Total Number of Analyses
<b>Vertical Aquifer Groundwater Grab Sample Profiling Samples</b>								
Aqueous	VOCs (SW8260D)	33	4	2	5	4	0	48
Aqueous	FROG-5000™	33	0	0	0	33	33	99
<b>Groundwater Monitoring Well Samples</b>								
Aqueous	VOCs (SW8260D)	53	6	3	6	6	0	74
Aqueous	TOC (SW9060A)	31	0	0	0	0	0	31
Aqueous	Alkalinity (SM2320B)	31	0	0	0	0	0	31
Aqueous	Anions (SW9056A)	31	0	0	0	0	0	31
Aqueous	Dissolved Gases (RSK-175)	31	0	0	0	0	0	31
Aqueous	Dissolved Metals (SW6010D)	31	0	0	0	0	0	31
Aqueous	TOC (SW9060A)	31	0	0	0	0	0	31
Aqueous	CSIA	31	0	0	0	0	0	31
<b>In Situ Microcosm Study</b>								
Solid	In Situ Microcosm Samplers (6 locations, 1 amended and 1 unamended bio filter per location)	12	0	0	0	0	0	12

Notes:

- 1) Standard, non-QC samples.
- 2) Duplicates for vertical aquifer groundwater grab sample profiling samples will be collected and analyzed at a rate of 10 percent (%) of samples with detectable concentrations (1 per 10 of samples with detectable concentrations). Duplicates for groundwater monitoring well samples are collected at a minimum rate of 10% (1 per 10 standard samples), with a minimum of 1 per event. The number of duplicates may increase if additional standard samples are collected.
- 3) MS/MSDs are collected at a minimum rate of 5% (1 set per 20 standard samples), with a minimum of 1 per event. MS/MSD pairs require extra volume. These will be collected in separate containers; however, because they are not separate samples, they are not included in the total number of samples. The number of MS/MSD pairs may increase if additional standard samples are collected.
- 4) Trip blanks will be shipped at a rate of 1 per cooler (1 in each cooler) that contains aqueous VOC and/or dissolved gas samples.

- 5) During vertical aquifer groundwater grab sample profiling, a clean baseline sample using a blank will be analyzed before each field sample to confirm that the instrument is clean.
- 6) Groundwater monitoring well sample equipment blanks will be collected at a minimum rate of 5% (1 per 20 standard samples), or at a minimum of one per day when non-dedicated field equipment is used.
- 7) Instrument verification checks will be completed once per day throughout vertical aquifer groundwater grab Sample profiling and sampling when field screening samples are analyzed. Instrument verification checks will consist of re-analyzing the first sample of the day with detectable concentrations of VOCs at the end of the day following completion of field screening and comparing results of the initial and re-analyzed sample to determine if concentrations are comparable (relative percent difference [RPD] <50%).

### Worksheet #23 Analytical Standard Operating Procedures

23.1 Subcontracted commercial laboratories will perform the fixed laboratory analyses under the UFP-QAPP (EA 2022a). The SOPs listed in the following table may be used for the fixed laboratory analyses for the UFP-QAPP. SOPs are found in **Appendix A**.

SOP No.	Title and Revision Number	Organization Performing Analysis	Definitive or Screening Data	Matrix	Analytical Group	Instrument	Modified for Project Work
EIL-TP38.0	TP38.0 $\delta^{13}\text{C}$ CSIA by GC-C-IRMS Rev date 1/1/2023	University of Waterloo – Environmental Isotope Laboratory	Definitive	Groundwater, adsorbent resins (Thermal Desorption tubes)	Chlorinated solvents and daughter products	Purge and Trap, GC-IRMS	N
EIL-TP42.0	TP42.0 $\delta^{37}\text{Cl}$ CSIA by GC-IRMS Rev date 1/1/2023	University of Waterloo – Environmental Isotope Laboratory	Definitive	Groundwater, adsorbent resins (TD tubes)	Chlorinated solvents and daughter products	Purge and Trap, GC-IRMS	N
MI SOP QuantArray	MI SOP - QuantArray 1.3, revision date 06/08/2024	Microbial Insights	Definitive	Groundwater	Cells	QuantStudio™ 12K Flex PCR System	No

Notes:

GC = gas chromatograph

IRMS = isotope ratio mass spectrometer

PCR = polymerase chain reaction

### Worksheet #24 Analytical Instrument Calibration

24.1 Laboratories will be required to follow their own policies and documented procedures in accordance with their certification requirements of the methods, SOPs, and support of the project objectives.

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action	Person Responsible for Corrective Action	Laboratory SOP Reference
Purge and Trap, GC-IRMS	Initial	Primary	Precision for primary and secondary standards with 0.3‰ (2σ)	Rerun assay / Check reagents	Laboratory Manager	EIL-TP38.0 EIL-TP42.0
	Calibration Verification	Secondary – run with every sample batch	$\delta^{13}\text{C}$ values are within $\pm 0.3\%$ of true value			
QuantStudio™ 12K Flex PCR System	Initial	Prior to analysis	Standard curve $r^2 > 0.95$	Rerun assay / check reagents	Lab area supervisor	MI SOP QuantArray
	Calibration Verification	Secondary – daily	Concentrations within 20% of certified values	Rerun assay / check reagents	Lab area supervisor	MI SOP QuantArray
	Dye Calibration	Annual-per manufacturer's recommendation	Manufacturer's specifications	Manufacturer reruns	Manufacturer	MI SOP-QuantArray

### Worksheet #25 Analytical Instrument and Equipment Maintenance, Testing, and Inspection

25.1 Laboratories will be required to follow their own policies and documented procedures in accordance with their certification requirements of the methods, SOPs, and support of the project objectives.

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	Lab SOP No.
GC-IRMS	Change column	Run standards	Instrument performance and sensitivity	As needed, monitoring analytical standards, blanks and background signal	Consistent standard peak height and width, peak symmetry	Change column	Analyst	EIL-TP38.0 EIL-TP42.0
	Isotope ratio Mass Spectrometer source maintenance	NA	Instrument performance and sensitivity	Annually/ as needed	Stable signal	Remove source, perform cleaning, and replace filament and pars as needed	Analyst	
	Change rough pump oil	NA	Visual color determination	Annually/ as needed	See manufacturer's manual	Replace or refill as necessary	Analyst	
	Change turbo pump oil	NA	Visual color determination	Annually	See manufacturer's manual	Replace or refill as necessary	Analyst	
QuantStudio™ 12K Flex PCR System	Dye calibration	Dye plate	Run dye plate	Annual	Spectra follows normal pattern	Contact manufacturer	Analyst	MI SOP QuantArray
	Background	Water plate	Run water plate	Monthly	No spectra detected	Clean instrument and rerun	Analyst	

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**Worksheet #26 and #27 Sample Handling, Custody, and Disposal**

26/27.1 To ensure sample authenticity and data defensibility, the sample handling system presented in the UFP-QAPP (EA 2022a) will be followed from the time of sample collection to final sample disposal.

**Sampling Organization:** Contractor  
**Laboratory:** University of Waterloo  
Environmental Isotope Laboratory (EIT 5025)  
263 Phillip Street  
Waterloo, ON N2L 3W8  
**Point-of-Contact:** Rhys Gwynne  
**Email:** rgwynne@uwaterloo.ca  
**Telephone:** 519-888-4567, ext. 35838  
**Sample Delivery Method:** TBD

**Sampling Organization:** Contractor  
**Laboratory:** Microbial Insights  
10515 Research Drive, Knoxville, TN 37932  
**Point-of-Contact:** Christian Polanco  
**Email:** CPolanco@microbe.com  
**Telephone:** 1-865-573-8188 ext. 116  
**Sample Delivery Method:** TBD

26/27.2 Samples will be handled and delivered in accordance with the UFP-QAPP (EA 2022a).

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### Worksheet #28 Analytical Quality Control and Corrective Action

28.1 Laboratories will be required to follow their own documented procedures (Tables 28-1 and 28-2) in accordance with their QA/QC requirements, SOPs, and quality manual.

**Table 28-1. Summary of QC Procedures for Carbon CSIA Using GC-IRMS (EIL-TP38.0 and EIL-TP42.0)**

QC Sample	Number/ Frequency	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Initial Calibration	Primary - Initial	Precision for primary and secondary standards with 0.3‰ (2σ)	Rerun standards; remake standards; perform maintenance	Lab area supervisor	Accuracy/bias	$r^2 \geq 0.95$
Calibration Verification	Secondary – run with every sample batch	$\delta^{13}\text{C}$ values are within $\pm 0.3\%$ of true value	Rerun assay / check reagents; recalibrate if necessary	Lab area supervisor	Accuracy/bias	$\delta^{13}\text{C}$ values within $\pm$ 0.3‰ of true value
Method Blank	Sample run bracketed	< lower quantitation limit	Flag data, determine cause, and reanalyze if possible	Lab area supervisor	Contamination /bias	< lower quantitation limit
Laboratory Sample Replicate	20% of samples in batch ( $\delta^{13}\text{C}$ )	Standard deviation of $\delta^{13}\text{C}$ values is less than 0.3‰	Rerun sample and if still unacceptable, flag data	Lab area supervisor	Contamination /bias	Serves as a positive control to evaluate precision
LCS	Sample run bracketed	Average $\delta^{13}\text{C}$ value of LCS within +/- 0.3‰ of true $\delta^{13}\text{C}$ ; Standard Deviation of $\delta^{13}\text{C} \leq 0.3\%$	Flag data, determine cause, and reanalyze if possible	Lab area supervisor	Accuracy/ Precision	Average $\delta^{13}\text{C}$ value of LCS within +/- 0.3‰ of true $\delta^{13}\text{C}$ ; Standard Deviation of $\delta^{13}\text{C} \leq 0.3\%$
Field Duplicate	1 per 10 samples	RPD $\leq 30\%$	Flag data	Lab area supervisor	Precision	RPD $\leq 30\%$

**Table 28-2. Summary of QC Procedures for QuantArray (MI-SOP-QuantArray)**

QC Sample	Number/ Frequency	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator	Project-Specific Measurement Performance Criteria
Continuing Calibration Verification	Primary – initial	Standard Curve $r^2 \geq 0.95$	Rerun assay / check reagents	Lab area supervisor	Accuracy/bias	Standard Curve $r^2 \geq 0.95$
Continuing Calibration Verification	Secondary – every plate (assay)	Cycle Threshold value within +/- 20% of known value	Rerun assay / check reagents	Lab area supervisor	Accuracy/bias	Cycle Threshold value within +/- 20% of known value
Assay Negative Control (Blank)	One per analytical assay plate	Values for positive samples are set above any fluorescence for the negative control	Rerun assay; may have to re- optimize assay	Lab area supervisor	Contamination /bias	Values for positive samples are set above any fluorescence for the negative control
DNA Extraction – Negative Control	One per analytical batch	Cycle Threshold $\leq$ Assay negative control	Rerun assay or re-extract samples if problem persists	Lab area supervisor	Contamination / bias	Cycle Threshold $\leq$ Assay negative control
Positive Control	One per analytical assay plate	Calculated concentration within +/-20% of same concentration on standard curve	Rerun assay/ check reagents	Lab area supervisor	Contamination / bias	Calculated concentration within +/- 20% of same concentration on standard curve
Field Duplicate	At client's request and with sample submission	Not applicable	Not applicable	Lab area supervisor	Contamination / bias	Not applicable

**Worksheet #36 Data Validation Procedures**

36.1 This worksheet documents procedures that will be used to validate project data. Data validation is an analyte and sample-specific process for evaluating compliance with contract requirements, methods/SOPs, and method performance criteria. The validation will be performed in accordance with the UFP-QAPP (EA 2022a) and previous UFP-QAPP Addendum (EA 2023). Data validation will be performed by a third-party validator, Environmental Data Services, Inc.

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## REFERENCES

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- U.S. Environmental Protection Agency. 2006. *Guidance on Systematic Planning Using the Data Quality Objectives Process EPA QA/G-4*. February.

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## **Appendix A**

### **Laboratory Standard Operating Procedures**

MI-SOP-QuantStudio QuantArray 1.3 Cover Page

UW-EIL TP 38.0  $\delta^{13}\text{C}$  CSIA by GC-C-IRMS Cover Page

UW-EIL TP 42.0  $\delta^{37}\text{Cl}$  CSIA by GC-IRMS Cover Page

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## STANDARD OPERATING PROCEDURE

### QuantStudio QuantArray

<b>SOP Number:</b>	QuantArray
<b>Revision Number:</b>	1.3
<b>Effective Date:</b>	04/01/2013
<b>Revision Date:</b>	06/08/2024

MI Controlled Document

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ENVIRONMENTAL ISOTOPE LABORATORY  
DEPARTMENT OF EARTH & ENVIRONMENTAL SCIENCES  
UNIVERSITY OF WATERLOO

Technical Procedure 38.0

**$\delta^{13}\text{C}$  CSIA by GC-C-IRMS**

AUTHOR(S):

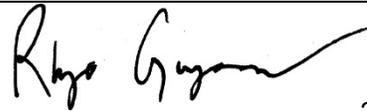


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Rhys Gwynne

APPROVAL:



Laboratory Manager

2025-01-01

Date

Issue Date: 2025-01-01  
Supersedes: Original Issuance

Revision: 07

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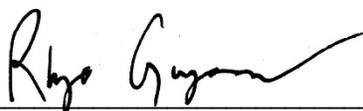
Technical Procedure 42.0

**$\delta^{37}\text{Cl}$  CSIA by GC-IRMS**

AUTHOR(S):

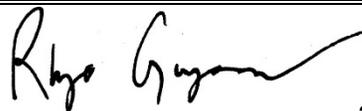


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