

SUBJECT

2025 Groundwater Sampling Plan – Phase 1 Vapor
Intrusion Evaluation
RACER Trust – Buick City, Flint, Michigan

TO

Evin Maguire – EGLE
Jeremy Pepin – EGLE
Shaun Shields – EGLE

DATE

December 12, 2025

OUR REF

30275629

COPIES TO

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On behalf of Revitalizing Auto Communities Environmental Response (RACER) Trust, Arcadis of Michigan, LLC (Arcadis) has prepared this work plan for additional sampling activities at the RACER Buick City Site in Flint, Michigan (Site). Groundwater sampling will be completed at select existing monitoring wells and sanitary sewer vapor sampling will be completed at select manholes with both being analyzed for volatile organic compounds (VOCs). These activities represent the first phase of a vapor intrusion (VI) investigation that focuses on sampling select existing monitoring wells and sanitary sewers that will provide data with respect to VI at adjacent properties. Based on the results, additional phases of work, if needed, will be proposed to address any identified VI data gaps.

An initial overview of the Site VI assessment was presented in a meeting between RACER, Arcadis, and the Michigan Department of Environment, Great Lakes, and Energy (EGLE) on October 8, 2025 and a PDF of the presentation slides was subsequently submitted to EGLE. During this meeting, Arcadis summarized the extent of shallow groundwater and vadose zone soil impacts with respect to the 2024 updated EGLE Volatilization to Indoor Air Pathway (VIAP) screening levels. Shallow groundwater delineation was established utilizing the most recent data from appropriately screened monitoring wells. To understand the delineation of shallow groundwater and vadose zone soil impacts with respect to off-site properties, several focus areas were established where apparent off-site migration had occurred. Additionally, areas where sanitary sewer utilities intersected shallow groundwater and vadose zone soil impacts and then led off-site were evaluated for how these utilities could be acting as preferential pathways. These focus areas are depicted on **Figure 1** and **Figure 2**. Nine focus areas were identified; Focus Area 1 through 6 (principally to the east) address potential downgradient migration, while Focus Areas 7 through 9 (principally to the west) address potential sanitary sewer-related preferential pathways. Each focus area is shown in more detail on **Figure 3** through **Figure 11**. Due to current land use zoning and the presence of restrictive covenants limiting use to nonresidential, downgradient focus areas (Focus Areas 1 through 6) were evaluated using nonresidential VIAP screening levels to assess current risk, whereas upgradient focus areas (Focus Areas 7 through 9) were evaluated using residential VIAP screening levels due to proximity to residential neighborhoods and the potential sanitary sewer preferential pathways. EGLE requested that additional evaluation be conducted on the sanitary sewers east of the Site where they may encounter impacted media in downgradient focus areas. Additional desktop sewer evaluation was conducted and resulting proposed initial sewer vapor sample collection locations are proposed in this work plan.

Some of the data used to establish the estimated delineation boundaries are greater than 20 years old, and updated sampling is required to confirm the extent of groundwater delineation in several areas. In addition, the information used to initially evaluate the sanitary sewers was based on City of Flint records and has not been field verified. Since the current Site property owners may have modified the sanitary sewer system during construction activities, additional field reconnaissance is necessary to determine whether the on-site sewers currently represent a preferential pathway for VI. To address these uncertainties and complete the VI assessment with respect to off-site properties, a phased investigation approach has been proposed. The first phase, as outlined in this work plan, includes targeted sampling of select monitoring wells and the reconnaissance and sampling of sanitary sewer manholes as an initial step to address the identified data gaps.

Scope of Work

Groundwater samples will be collected from 17 existing monitoring wells, and sewer vapor samples will be collected from 8 sanitary sewer manhole locations for one time analysis. The purpose of the groundwater sampling is to provide updated data to evaluate current concentrations, trends, and identify data gaps.

Groundwater Sampling

The proposed monitoring wells and rationale for sampling are provided in **Table 1A** and their locations are shown in each focus area on **Figure 3** through **Figure 11**. Groundwater sampling will be conducted in accordance with the Arcadis technical guidance instruction (TGI): *TGI – Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells*. Equipment decontamination will be performed in accordance with *TGI – Groundwater and Soil Sampling Equipment Decontamination*, including decontamination of a water level meter and multiparameter meter. Both the low-flow groundwater sampling and equipment decontamination procedure are included in **Attachment 1**.

Sanitary Sewer Sampling

The purpose of the sanitary sewer reconnaissance and vapor sampling is to assess the current condition of the sewers where they may intersect impacted media, and to collect initial vapor data to understand if sewer vapor is a risk for preferential pathway migration. The proposed manhole sampling locations are detailed on **Table 1B** and shown on **Figure 4** and **Figure 6** through **Figure 11** and are tentative based on additional field reconnaissance. Additional sanitary sewer manholes may also be selected in downgradient focus area 1 pending additional desktop review of sanitary sewer records in this area and their depths in relation to the impacted media.

Sanitary sewer manholes will be evaluated in the field prior to sample collection for sewer manhole diameter, access to the manhole, manhole cover type (i.e., solid or grated), observation of liquid flow, measurements of the depth to liquid and depth to bottom of the pipe with a water level meter and photographs around and within the sewer manhole. If the documentation of these items requires the manhole cover to be completely removed, sampling will not occur for at least 24 hours after replacement to allow sewer vapors to re-equilibrate. For manhole covers with substantial openings, plastic sheeting will be placed under the lid at least 24 hours before sampling to minimize low-concentration bias and dilution.

Sewer vapor samples will be collected using batch-certified, one-liter whole air canisters equipped with particulate filters for instantaneous grab sample collection. Before sample collection, the canisters will be checked to ensure a starting vacuum greater than 25 inches of mercury. At the time of sewer vapor sample collection, the manhole cover may be slightly opened to allow for the insertion of sample tubing. The sample intake for sewer vapor samples will be positioned in the manhole either one to two feet above the observed liquid level or one to two feet above the bottom if no liquid is present. Teflon, Teflon-lined, or nylon tubing will be used to avoid potential sorption of contaminants. The sample tubing will be attached to the laboratory-provided particulate filter with vacuum gauge using ferrules or silicone tubing depending on the particulate filter type. No purging is required prior to sample collection. Once the starting vacuum is confirmed in the whole air canister and the particulate filter is connected with sample tubing to the proper intake depth, sample collection may begin by opening the valve on the whole air canister. Sampling will be completed when the remaining canister vacuum is between 9 and 2 inches of mercury. No sample shall be submitted to the laboratory at ambient pressure as residual vacuum verifies sample integrity during transport.

Following sewer vapor sample collection, each manhole will be screened for fixed gases (methane, carbon dioxide, and oxygen) using a multi-gas meter, such as a LANDTEC GEM™-5000 with an in-line carbon filter. These readings are required to comply with canister shipping and transport regulations. If methane concentrations in a sample exceed the lower explosive limit (5% by volume), then for shipping and transportation purposes, it will be classified as a flammable,

non-pressurized, gas sample with an identification number UN 3167 and a hazard class of 2.1 (flammable gases) under the United States Department of Transportation Hazardous Materials Regulations. Packaging, labeling, and transport of these samples will follow the requirements of 49 Code of Federal Regulations 173.

All reusable equipment from sewer vapor sampling (e.g., tubing weights and water level meters) will be decontaminated between each manhole in accordance with *TGI – Groundwater and Soil Sampling Equipment Decontamination*. Additionally, a 10% bleach rinse solution followed by a distilled water rinse will be used for biological decontamination as needed.

Data Quality

To ensure data quality objectives are met, quality control samples will be collected during this sampling event. For groundwater samples, duplicate samples will be collected at a frequency of 1 duplicate sample for every 10 samples (2 total), matrix spike/matrix spike duplicate (MS/MSD) samples will be collected at a frequency of 1 MS/MSD sample for every 20 samples (1 total), and trip blanks will be collected at a frequency of 1 per cooler shipment (4 total). For sewer vapor samples, duplicate samples will be collected at a frequency of 1 duplicate for every 10 samples (1 total).

Laboratory Analysis

Groundwater samples will be analyzed for VOCs and 1,4-dioxane by Merit laboratory by method SW 8260C and SW 8260 Selected Ion Monitoring, respectively, and sewer vapor samples will be analyzed for VOCs by Eurofins Air Toxics or Merit laboratories by method TO-15. The reported analytes will include the VOC compounds listed in **Table 2A** and **Table 2B**.

Reporting

The activities described in this work plan are anticipated to begin within 30 days of approval of this work plan. Results of the sampling will be provided to EGLE electronically in a central SharePoint folder within sixty (60) days of completion of the sampling event (R 299.9611 Environmental Monitoring, Rule 611(6)) and provided to EGLE later as a summary report. Analytical results will be managed using an EQuIS database. The summary report will present analytical tables and figures that compare results against relevant screening levels. It will also include a discussion and interpretation of the findings, highlighting any potential data gaps and if necessary, proposing resolutions to address them.

Enc.

Figures

- Figure 1 – Residential VIAP Groundwater Focus Areas
- Figure 2 – Nonresidential VIAP Groundwater Focus Areas
- Figure 3 – Nonresidential Focus Area 1
- Figure 4 – Nonresidential Focus Area 2
- Figure 5 – Nonresidential Focus Area 3
- Figure 6 – Nonresidential Focus Area 4
- Figure 7 – Nonresidential Focus Area 5

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Figure 8 – Nonresidential Focus Area 6

Figure 9 – Residential Focus Area 7

Figure 10 – Residential Focus Area 8

Figure 11 – Residential Focus Area 9

Tables

Table 1A – Proposed Monitoring Well Network and Rationale

Table 1B – Proposed Sanitary Sewer Manhole Sampling

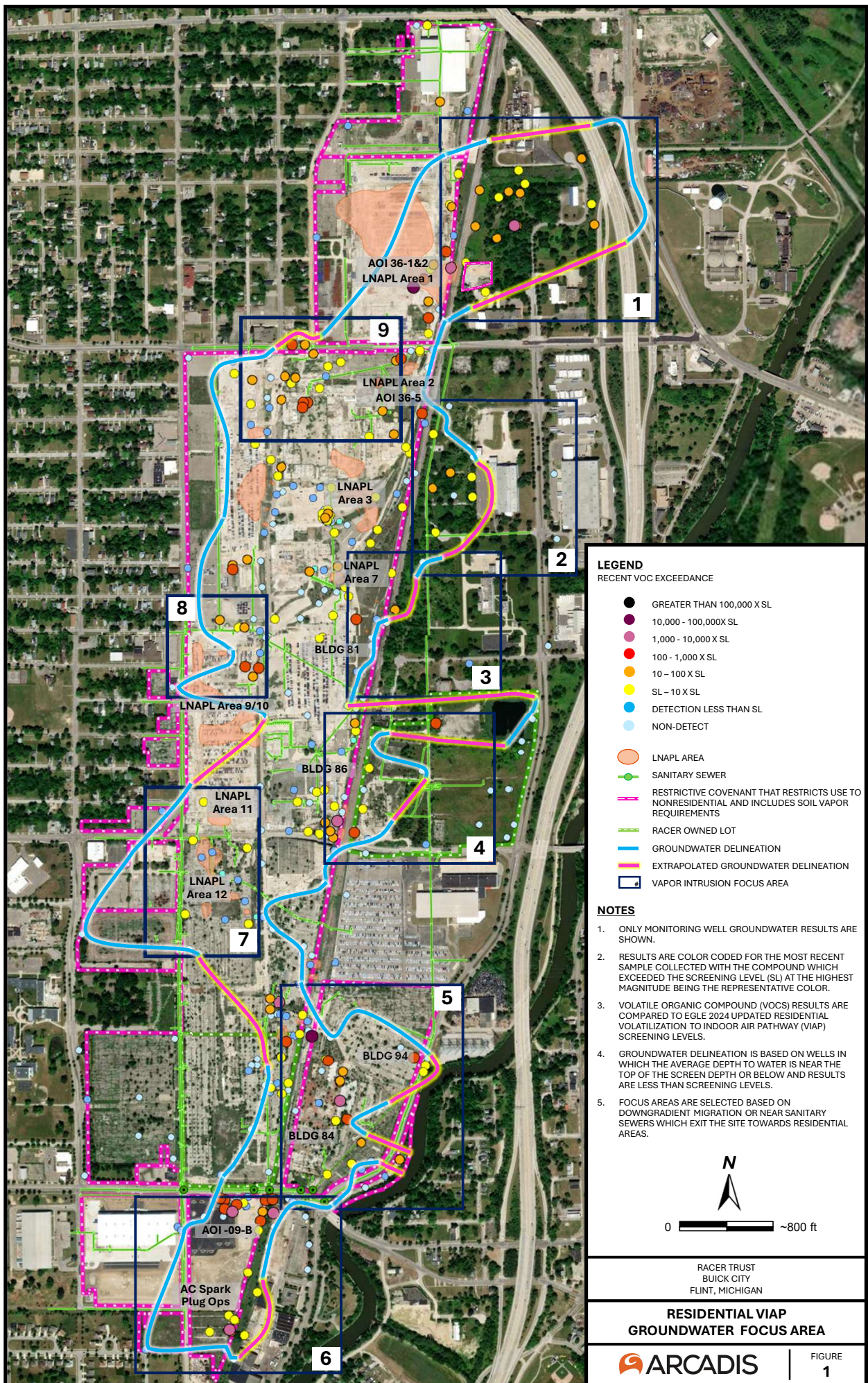
Table 2A – Groundwater Volatile Organic Compound Analyte List

Table 2B – Sewer Vapor Volatile Organic Compound Analyte List

Attachments

Attachment 1 – Technical Guidance Instructions

Figures



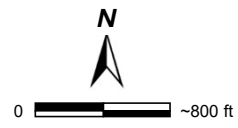
LEGEND

RECENT VOC EXCEEDANCE

- GREATER THAN 100,000 X SL
- 10,000 - 100,000 X SL
- 1,000 - 10,000 X SL
- 100 - 1,000 X SL
- 10 - 100 X SL
- SL - 10 X SL
- DETECTION LESS THAN SL
- NON-DETECT

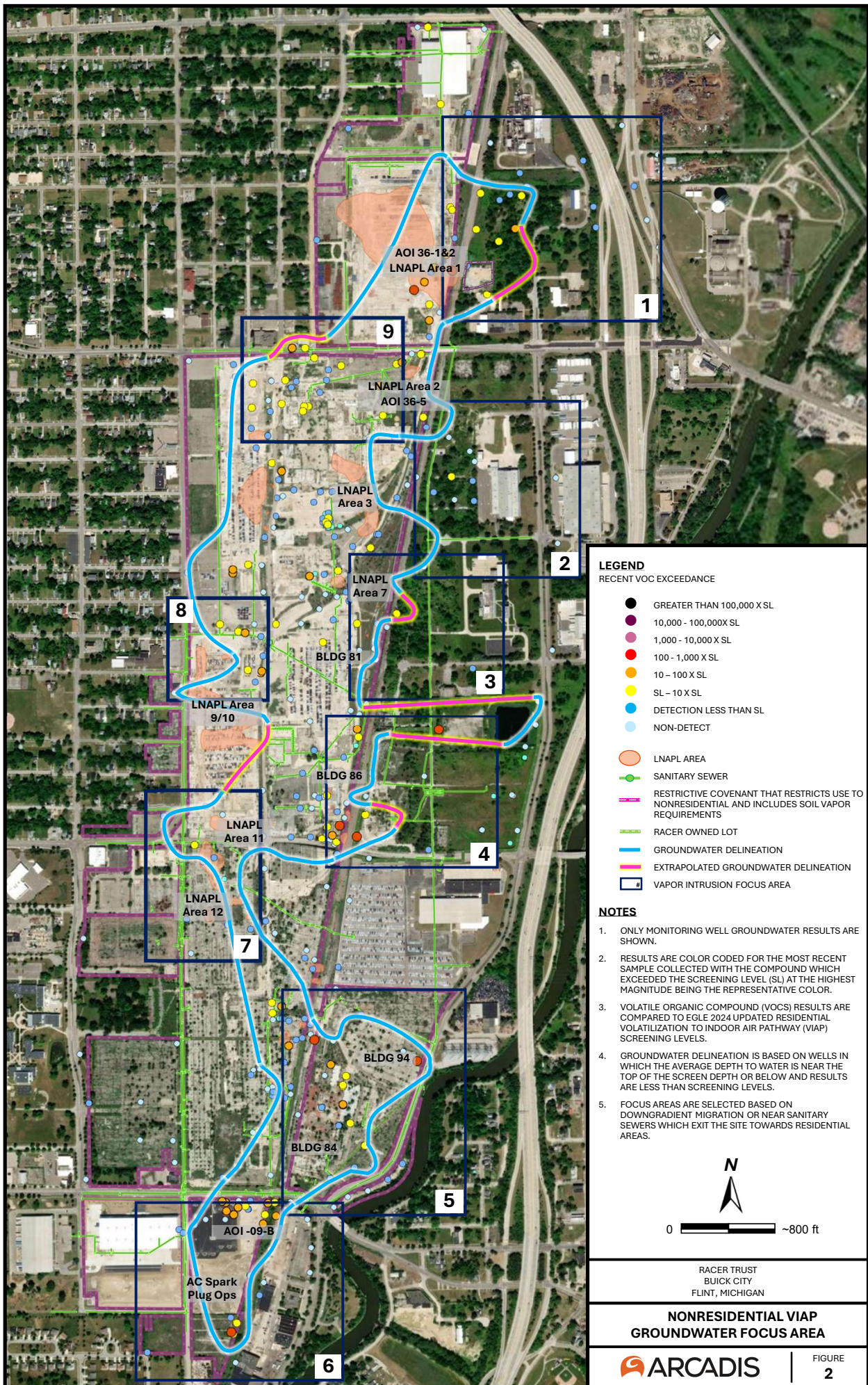
- LNAPL AREA
- SANITARY SEWER
- RESTRICTIVE COVENANT THAT RESTRICTS USE TO NONRESIDENTIAL AND INCLUDES SOIL VAPOR REQUIREMENTS
- RACER OWNED LOT
- GROUNDWATER DELINEATION
- EXTRAPOLATED GROUNDWATER DELINEATION
- VAPOR INTRUSION FOCUS AREA

- NOTES**
1. ONLY MONITORING WELL GROUNDWATER RESULTS ARE SHOWN.
 2. RESULTS ARE COLOR CODED FOR THE MOST RECENT SAMPLE COLLECTED WITH THE COMPOUND WHICH EXCEEDED THE SCREENING LEVEL (SL) AT THE HIGHEST MAGNITUDE BEING THE REPRESENTATIVE COLOR.
 3. VOLATILE ORGANIC COMPOUND (VOCs) RESULTS ARE COMPARED TO EGLE 2024 UPDATED RESIDENTIAL VOLATILIZATION TO INDOOR AIR PATHWAY (VIAP) SCREENING LEVELS.
 4. GROUNDWATER DELINEATION IS BASED ON WELLS IN WHICH THE AVERAGE DEPTH TO WATER IS NEAR THE TOP OF THE SCREEN DEPTH OR BELOW AND RESULTS ARE LESS THAN SCREENING LEVELS.
 5. FOCUS AREAS ARE SELECTED BASED ON DOWNGRAIDENT MIGRATION OR NEAR SANITARY SEWERS WHICH EXIT THE SITE TOWARDS RESIDENTIAL AREAS.



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**RESIDENTIAL VIAP
GROUNDWATER FOCUS AREA**



LEGEND

- RECENT VOC EXCEEDANCE
- GREATER THAN 100,000 X SL
 - 10,000 - 100,000 X SL
 - 1,000 - 10,000 X SL
 - 100 - 1,000 X SL
 - 10 - 100 X SL
 - SL - 10 X SL
 - DETECTION LESS THAN SL
 - NON-DETECT
- LNAPL AREA
 - SANITARY SEWER
 - RESTRICTIVE COVENANT THAT RESTRICTS USE TO NONRESIDENTIAL AND INCLUDES SOIL VAPOR REQUIREMENTS
 - RACER OWNED LOT
 - GROUNDWATER DELINEATION
 - EXTRAPOLATED GROUNDWATER DELINEATION
 - VAPOR INTRUSION FOCUS AREA

NOTES

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3. VOLATILE ORGANIC COMPOUND (VOCs) RESULTS ARE COMPARED TO EGLE 2024 UPDATED RESIDENTIAL VOLATILIZATION TO INDOOR AIR PATHWAY (VIAP) SCREENING LEVELS.
4. GROUNDWATER DELINEATION IS BASED ON WELLS IN WHICH THE AVERAGE DEPTH TO WATER IS NEAR THE TOP OF THE SCREEN DEPTH OR BELOW AND RESULTS ARE LESS THAN SCREENING LEVELS.
5. FOCUS AREAS ARE SELECTED BASED ON DOWNGRADIENT MIGRATION OR NEAR SANITARY SEWERS WHICH EXIT THE SITE TOWARDS RESIDENTIAL AREAS.



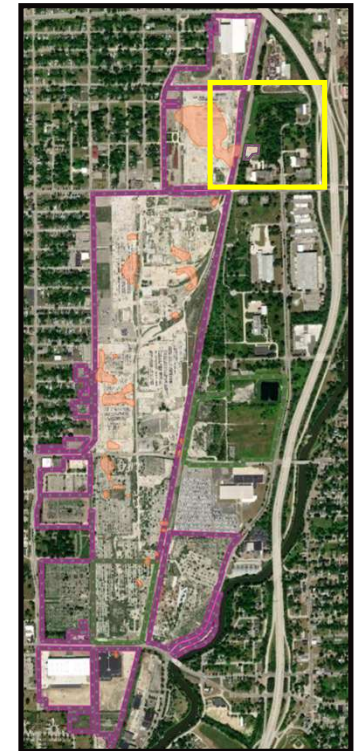
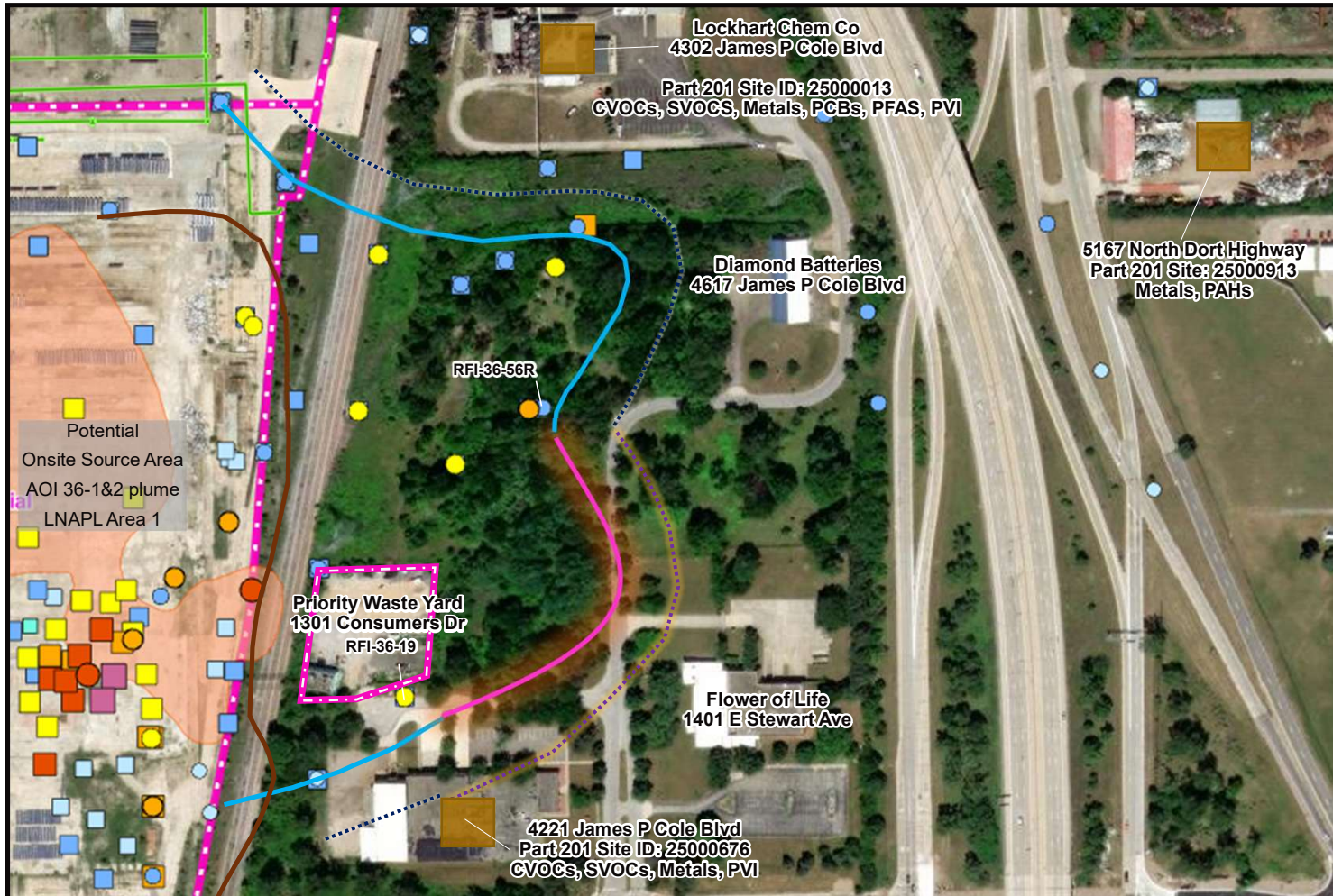
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**NONRESIDENTIAL VIAP
GROUNDWATER FOCUS AREA**



FIGURE
2



LEGEND		SOIL VOC EXCEEDANCE		LNAPL AREA	
●	GROUNDWATER VOC EXCEEDANCE GREATER THAN 100,000 X SL	■	GREATER THAN 100,000 X SL	○	LNAPL AREA
●	10,000 - 100,000 X SL	■	10,000 - 100,000 X SL	—	SANITARY SEWER
●	1,000 - 10,000 X SL	■	1,000 - 10,000 X SL	—	RESTRICTIVE COVENANT THAT RESTRICTS USE TO NONRESIDENTIAL AND INCLUDES SOIL VAPOR REQUIREMENTS
●	100 - 1,000 X SL	■	100 - 1,000 X SL	—	GROUNDWATER DELINEATION
●	10 - 100 X SL	■	10 - 100 X SL	—	100 FOOT BUFFER
●	SL - 10 X SL	■	SL - 10 X SL	—	SOIL DELINEATION
●	DETECTION LESS THAN SL	■	DETECTION LESS THAN SL	—	EXTRAPOLATED DELINEATION
●	NON-DETECT	■	NON-DETECT	—	EXTRAPOLATED 100 FOOT BUFFER
		■		■	PART 201 SITE

NOTES

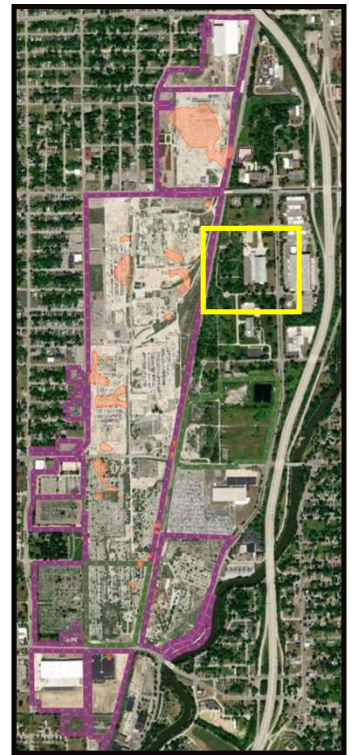
- ONLY MONITORING WELL GROUNDWATER AND HISTORICAL SOIL RESULTS ARE SHOWN.
- RESULTS ARE COLOR CODED FOR THE MOST RECENT SAMPLE COLLECTED WITH THE COMPOUND WHICH EXCEEDED THE SCREENING LEVEL (SL) AT THE HIGHEST MAGNITUDE BEING THE REPRESENTATIVE COLOR.
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- SOIL DELINEATION IS BASED ON COMPARITIVE DEPTHS FROM EXCEEDANCES ON PROPERTY BOUNDARIES TO OFFSITE RESULTS AT SIMILAR DEPTHS.

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NONRESIDENTIAL FOCUS AREA 1

ARCADIS

FIGURE
3



LEGEND

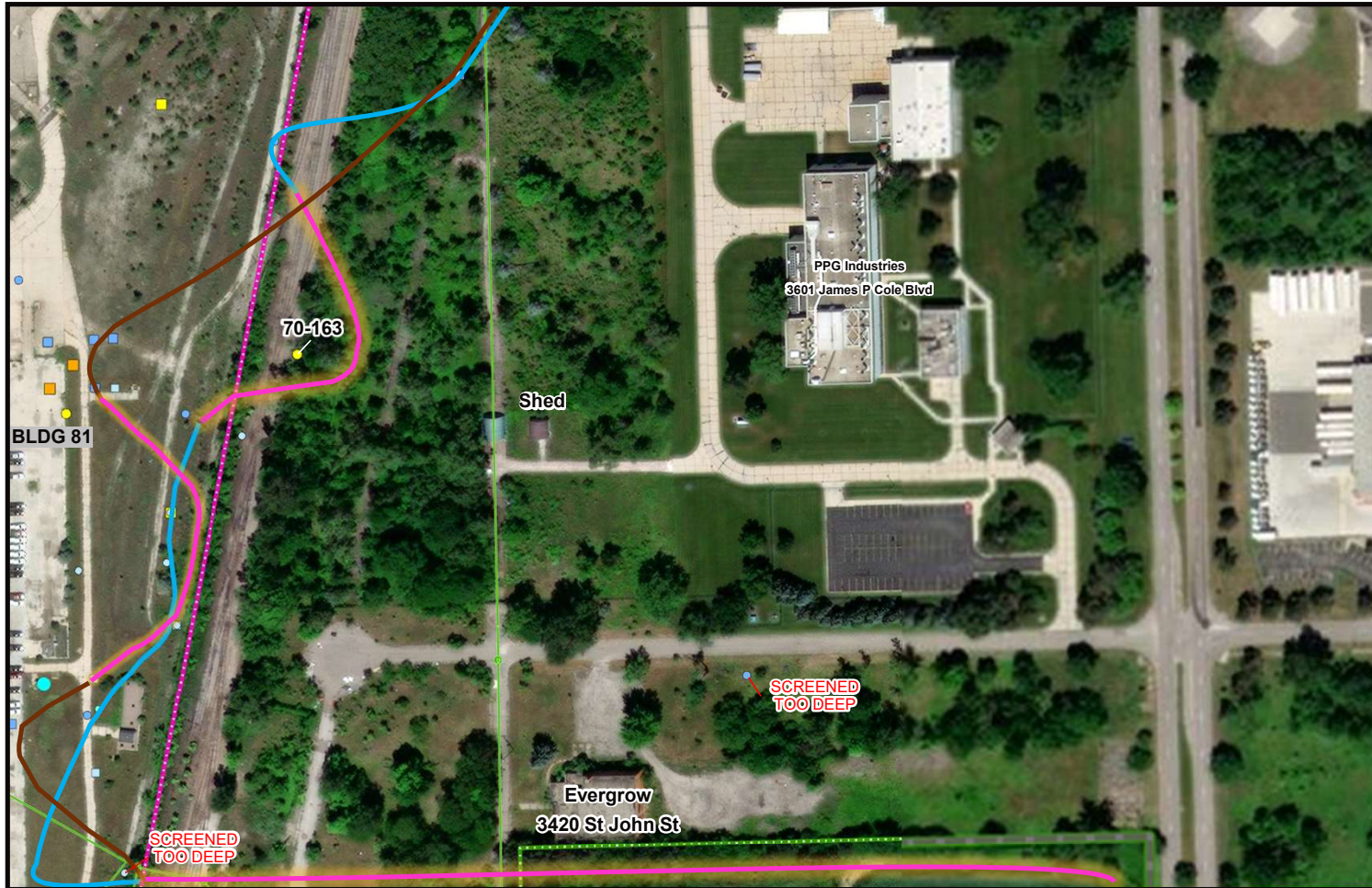
GROUNDWATER VOC EXCEEDANCE

● GREATER THAN 100,000 X SL	○ LNAPL AREA
● 10,000 - 100,000 X SL	— SANITARY SEWER
● 1,000 - 10,000 X SL	● PROPOSED SANITARY SEWER VAPOR SAMPLING LOCATION
● 100 - 1,000 X SL	○ RESTRICTIVE COVENANT THAT RESTRICTS USE TO NONRESIDENTIAL AND INCLUDES SOIL VAPOR REQUIREMENTS
● SL - 10 X SL	— NONRESIDENTIAL RESTRICTIVE COVENANT
● 10 - 100 X SL	— GROUNDWATER DELINEATION
● DETECTION LESS THAN SL	— EXTRAPOLATED DELINEATION
● NON-DETECT	■ PART 201 SITE

- NOTES**
1. ONLY MONITORING WELL GROUNDWATER RESULTS ARE SHOWN.
 2. RESULTS ARE COLOR CODED FOR THE MOST RECENT SAMPLE COLLECTED WITH THE COMPOUND WHICH EXCEEDED THE SCREENING LEVEL (SL) AT THE HIGHEST MAGNITUDE BEING THE REPRESENTATIVE COLOR.
 3. VOLATILE ORGANIC COMPOUND (VOCs) RESULTS ARE COMPARED TO EGLE 2024 UPDATED NONRESIDENTIAL VOLATILIZATION TO INDOOR AIR PATHWAY (VIAP) SCREENING LEVELS.
 4. GROUNDWATER DELINEATION IS BASED ON WELLS IN WHICH THE AVERAGE DEPTH TO WATER IS NEAR THE TOP OF THE SCREEN DEPTH OR BELOW AND RESULTS ARE LESS THAN SCREENING LEVELS.
 5. THE FOLLOWING LOCATIONS ARE NOT MONITORING WELLS BUT ARE SHOWN FOR RESULT REFERENCE: OST 2-8, OST 4-8, AND OST 4-5.

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NONRESIDENTIAL FOCUS AREA 2



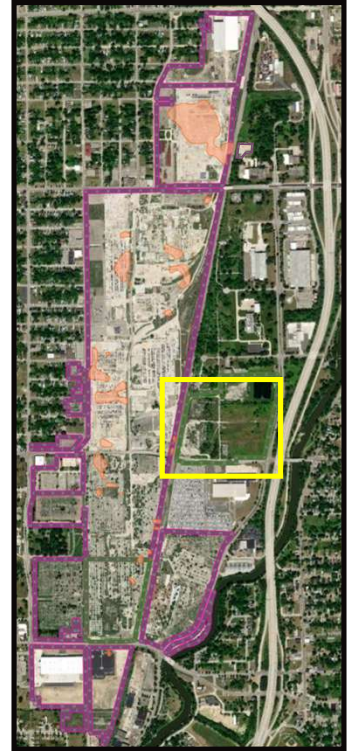
LEGEND

GROUNDWATER VOC EXCEEDANCE	SOIL VOC EXCEEDANCE	SANITARY SEWER
● GREATER THAN 100,000 X SL	■ GREATER THAN 100,000 X SL	RESTRICTIVE COVENANT THAT RESTRICTS USE TO NONRESIDENTIAL AND INCLUDES SOIL VAPOR REQUIREMENTS
● 10,000 - 100,000X SL	■ 10,000 - 100,000X SL	RACER OWNED LOT WITH VI RESTRICTION
● 1,000 - 10,000 X SL	■ 1,000 - 10,000 X SL	GROUNDWATER DELINEATION
● 100 - 1,000 X SL	■ 100 - 1,000 X SL	SOIL DELINEATION
● 10 - 100 X SL	■ 10 - 100 X SL	EXTRAPOLATED DELINEATION
● SL - 10 X SL	■ SL - 10 X SL	
● DETECTION LESS THAN SL	■ DETECTION LESS THAN SL	
● NON-DETECT	■ NON-DETECT	

NOTES

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5. SOIL DELINEATION IS BASED ON COMPARITIVE DEPTHS FROM EXCEEDANCES ON PROPERTY BOUNDARIES TO OFFSITE RESULTS AT SIMILAR DEPTHS.

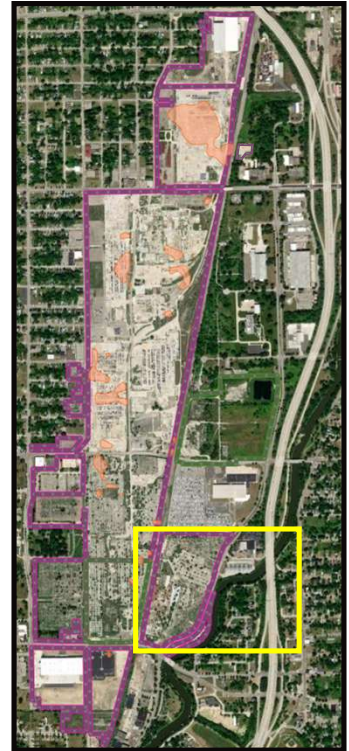
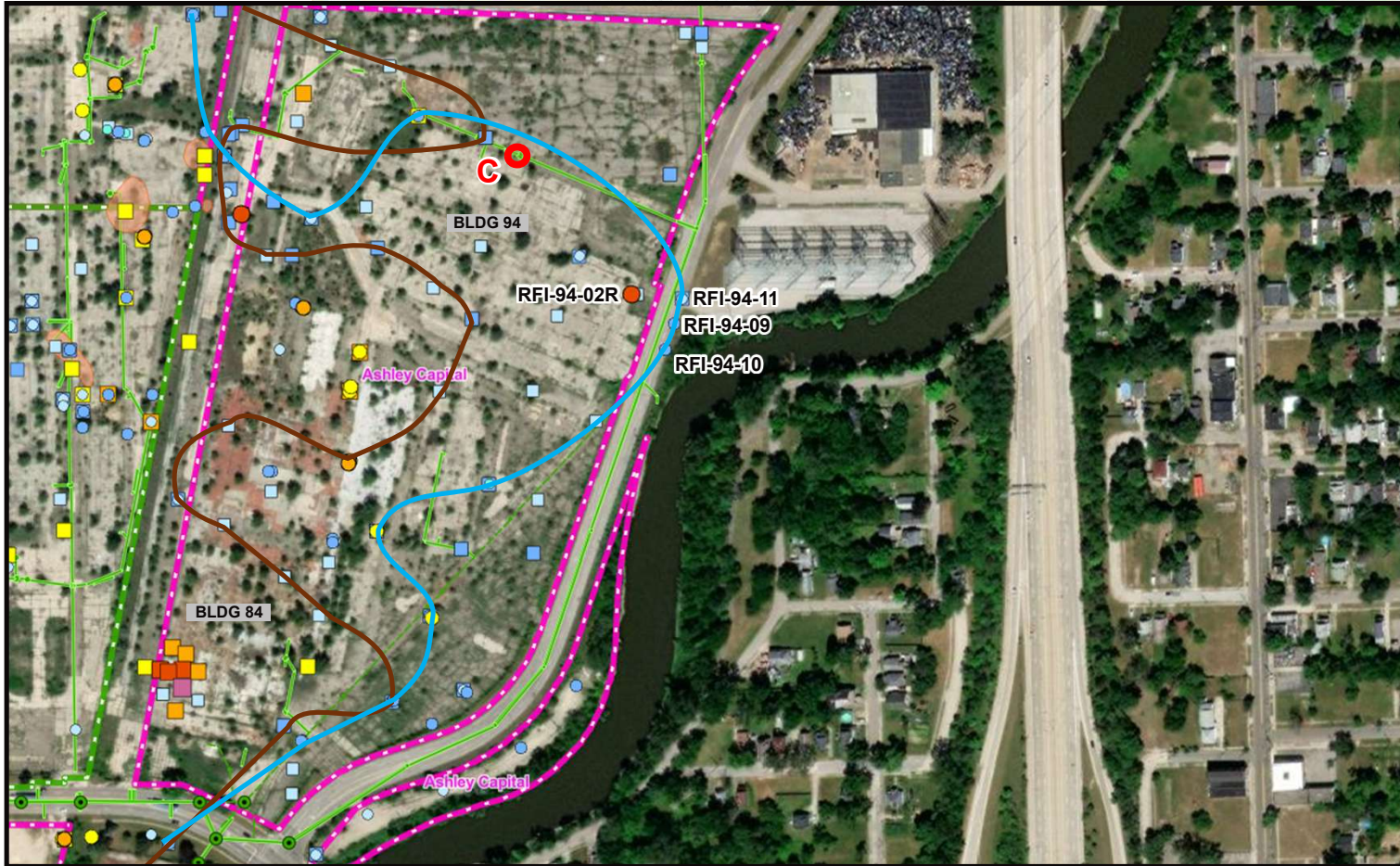
RACER TRUST BUICK CITY FLINT, MICHIGAN	
NONRESIDENTIAL FOCUS AREA 3	
	FIGURE 5



LEGEND	
GROUNDWATER VOC EXCEEDANCE	SOIL VOC EXCEEDANCE
● GREATER THAN 100,000 X SL	■ GREATER THAN 100,000 X SL
● 10,000 - 100,000X SL	■ 10,000 - 100,000X SL
● 1,000 - 10,000 X SL	■ 1,000 - 10,000 X SL
● 100 - 1,000 X SL	■ 100 - 1,000 X SL
● 10 - 100 X SL	■ 10 - 100 X SL
● SL - 10 X SL	■ SL - 10 X SL
● DETECTION LESS THAN SL	■ DETECTION LESS THAN SL
● NON-DETECT	■ NON-DETECT
○ LNAPL AREA	○ SANITARY SEWER
○ PROPOSED SANITARY SEWER VAPOR SAMPLING LOCATION	○ RESTRICTIVE COVENANT THAT RESTRICTS USE TO NONRESIDENTIAL AND INCLUDES SOIL VAPOR REQUIREMENTS
○ RACER OWNED PARCEL VI REQUIREMENT	○ GROUNDWATER DELINEATION
○ SOIL DELINEATION	○ EXTRAPOLATED DELINEATION

- NOTES**
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 5. SOIL DELINEATION IS BASED ON COMPARITIVE DEPTHS FROM EXCEEDANCES ON PROPERTY BOUNDARIES TO OFFSITE RESULTS AT SIMILAR DEPTHS.

RACER TRUST BUICK CITY FLINT, MICHIGAN	
NONRESIDENTIAL FOCUS AREA 4	
	FIGURE 6



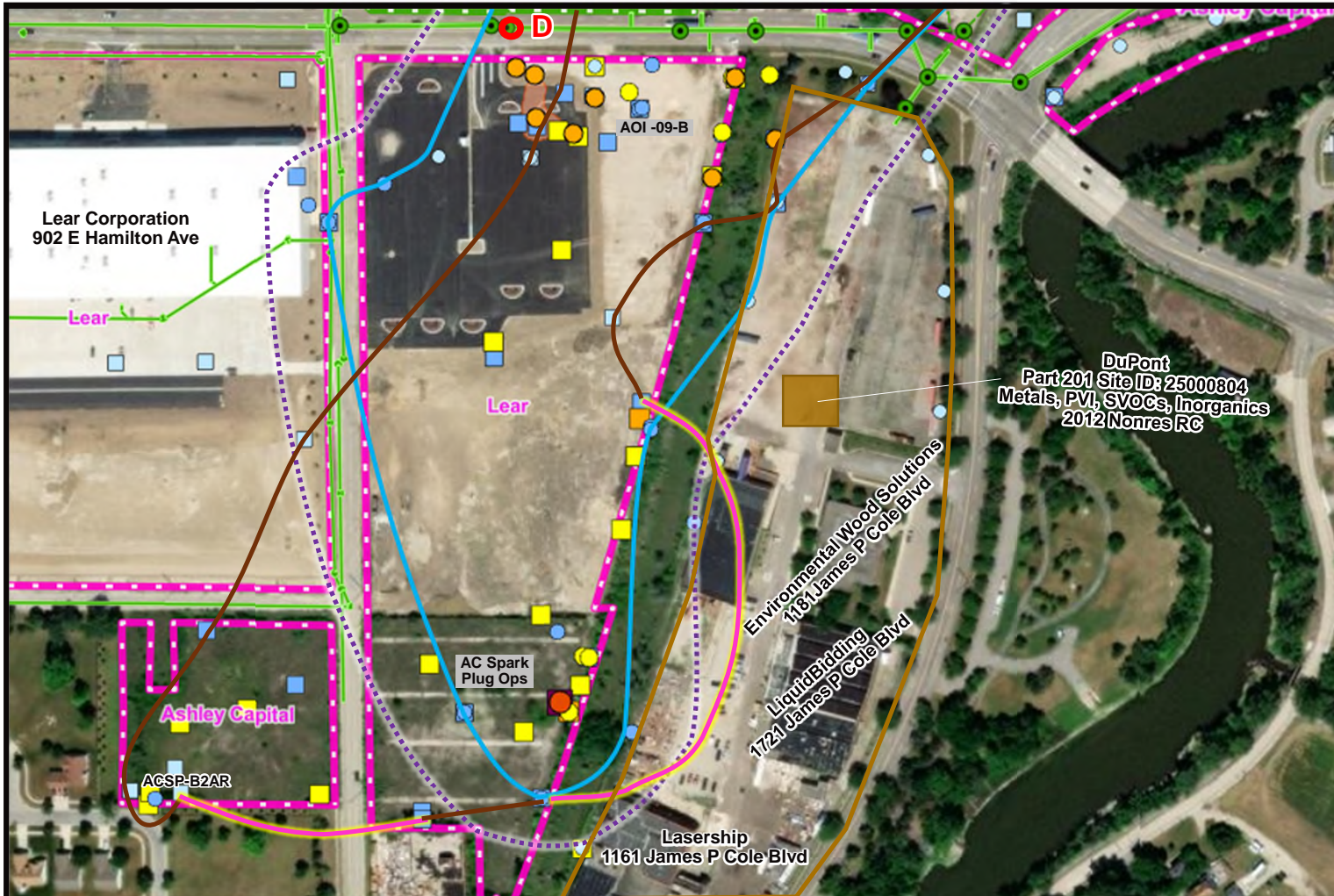
LEGEND

GROUNDWATER VOC EXCEEDANCE		SOIL VOC EXCEEDANCE		LNAPL AREA
GREATER THAN 100,000 X SL	GREATER THAN 100,000 X SL	SANITARY SEWER	PROPOSED SANITARY SEWER VAPOR SAMPLING LOCATION	RESTRICTIVE COVENANT THAT RESTRICTS USE TO NONRESIDENTIAL AND INCLUDES SOIL VAPOR REQUIREMENTS
10,000 - 100,000X SL	10,000 - 100,000X SL	RACER PARCEL LOT VI REQUIREMENT	GROUNDWATER DELINEATION	SOIL DELINEATION
1,000 - 10,000 X SL	1,000 - 10,000 X SL	GROUNDWATER DELINEATION	SOIL DELINEATION	EXTRAPOLATED DELINEATION
100 - 1,000 X SL	100 - 1,000 X SL	GROUNDWATER DELINEATION	SOIL DELINEATION	
10 - 100 X SL	10 - 100 X SL	GROUNDWATER DELINEATION	SOIL DELINEATION	
SL - 10 X SL	SL - 10 X SL	GROUNDWATER DELINEATION	SOIL DELINEATION	
DETECTION LESS THAN SL	DETECTION LESS THAN SL	GROUNDWATER DELINEATION	SOIL DELINEATION	
NON-DETECT	NON-DETECT	GROUNDWATER DELINEATION	SOIL DELINEATION	

NOTES

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RACER TRUST BUICK CITY FLINT, MICHIGAN	
NONRESIDENTIAL FOCUS AREA 5	
	FIGURE 7



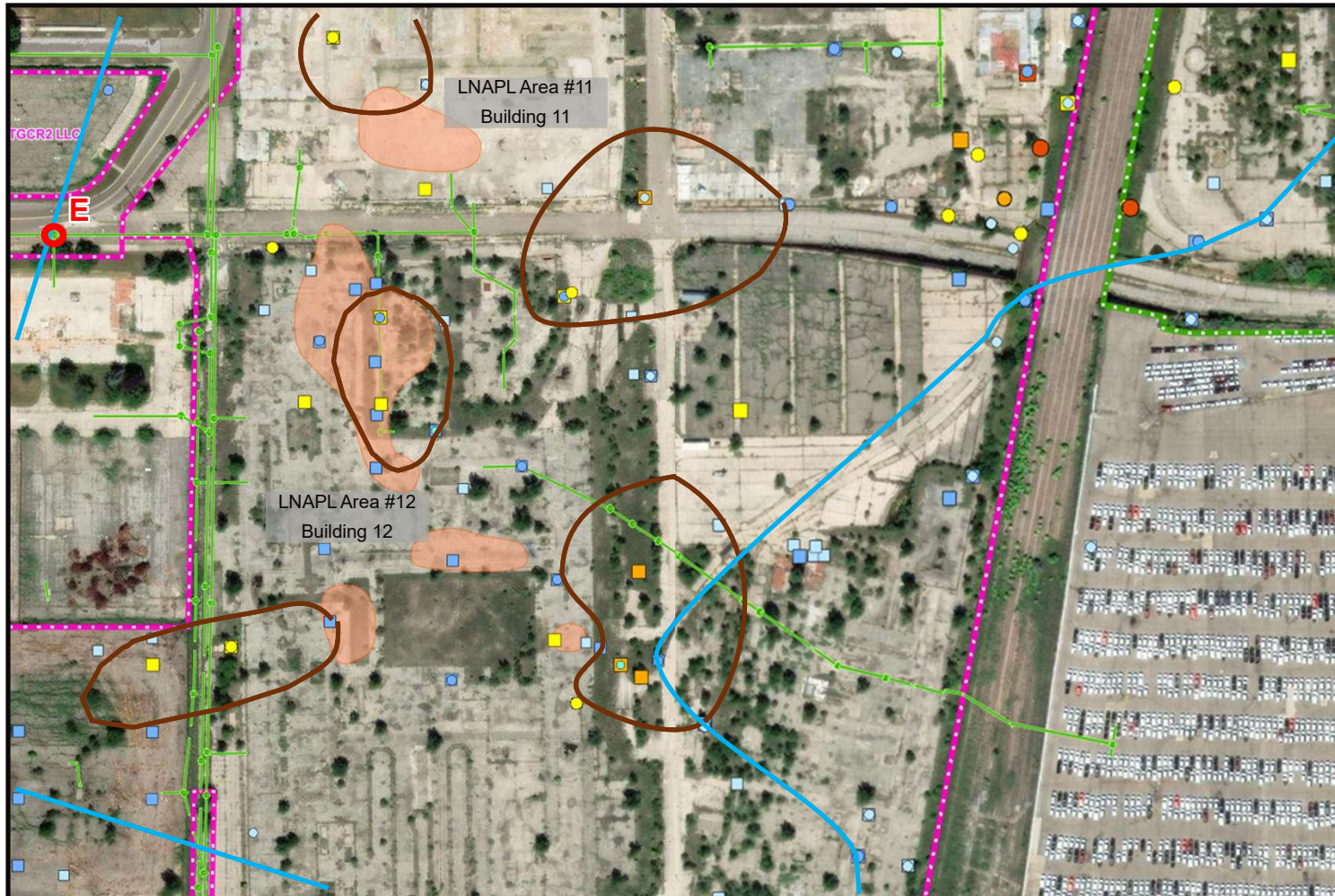
LEGEND		NOTES	
GROUNDWATER VOC EXCEEDANCE	SOIL VOC EXCEEDANCE	LNAPL AREA	1. ONLY MONITORING WELL GROUNDWATER AND HISTORICAL SOIL RESULTS ARE SHOWN.
GREATER THAN 100,000 X SL	GREATER THAN 100,000 X SL	SANITARY SEWER	2. RESULTS ARE COLOR CODED FOR THE MOST RECENT SAMPLE COLLECTED WITH THE COMPOUND WHICH EXCEEDED THE SCREENING LEVEL (SL) AT THE HIGHEST MAGNITUDE BEING THE REPRESENTATIVE COLOR.
10,000 - 100,000X SL	10,000 - 100,000X SL	RESTRICTIVE COVENANT THAT RESTRICTS USE TO NONRESIDENTIAL AND INCLUDES SOIL VAPOR REQUIREMENTS	3. VOLATILE ORGANIC COMPOUND (VOCs) RESULTS ARE COMPARED TO EGLE 2024 UPDATED NONRESIDENTIAL VOLATILIZATION TO INDOOR AIR PATHWAY (VIAP) SCREENING LEVELS.
1,000 - 10,000 X SL	1,000 - 10,000 X SL	NONRESIDENTIAL RESTRICTIVE COVENANT	4. GROUNDWATER DELINEATION IS BASED ON WELLS IN WHICH THE AVERAGE DEPTH TO WATER IS NEAR THE TOP OF THE SCREEN DEPTH OR BELOW AND RESULTS ARE LESS THAN SCREENING LEVELS.
100 - 1,000 X SL	100 - 1,000 X SL	GROUNDWATER DELINEATION	5. SOIL DELINEATION IS BASED ON COMPARITIVE DEPTHS FROM EXCEEDANCES ON PROPERTY BOUNDARIES TO OFFSITE RESULTS AT SIMILAR DEPTHS.
10 - 100 X SL	10 - 100 X SL	100 FOOT BUFFER	
SL - 10 X SL	SL - 10 X SL	SOIL DELINEATION	
DETECTION LESS THAN SL	DETECTION LESS THAN SL	EXTRAPOLATED DELINEATION	
NON-DETECT	NON-DETECT	PART 201 SITE	



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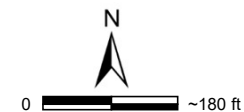
NONRESIDENTIAL FOCUS AREA 6

ARCADIS | FIGURE
8

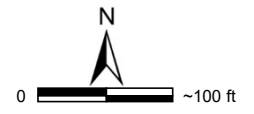
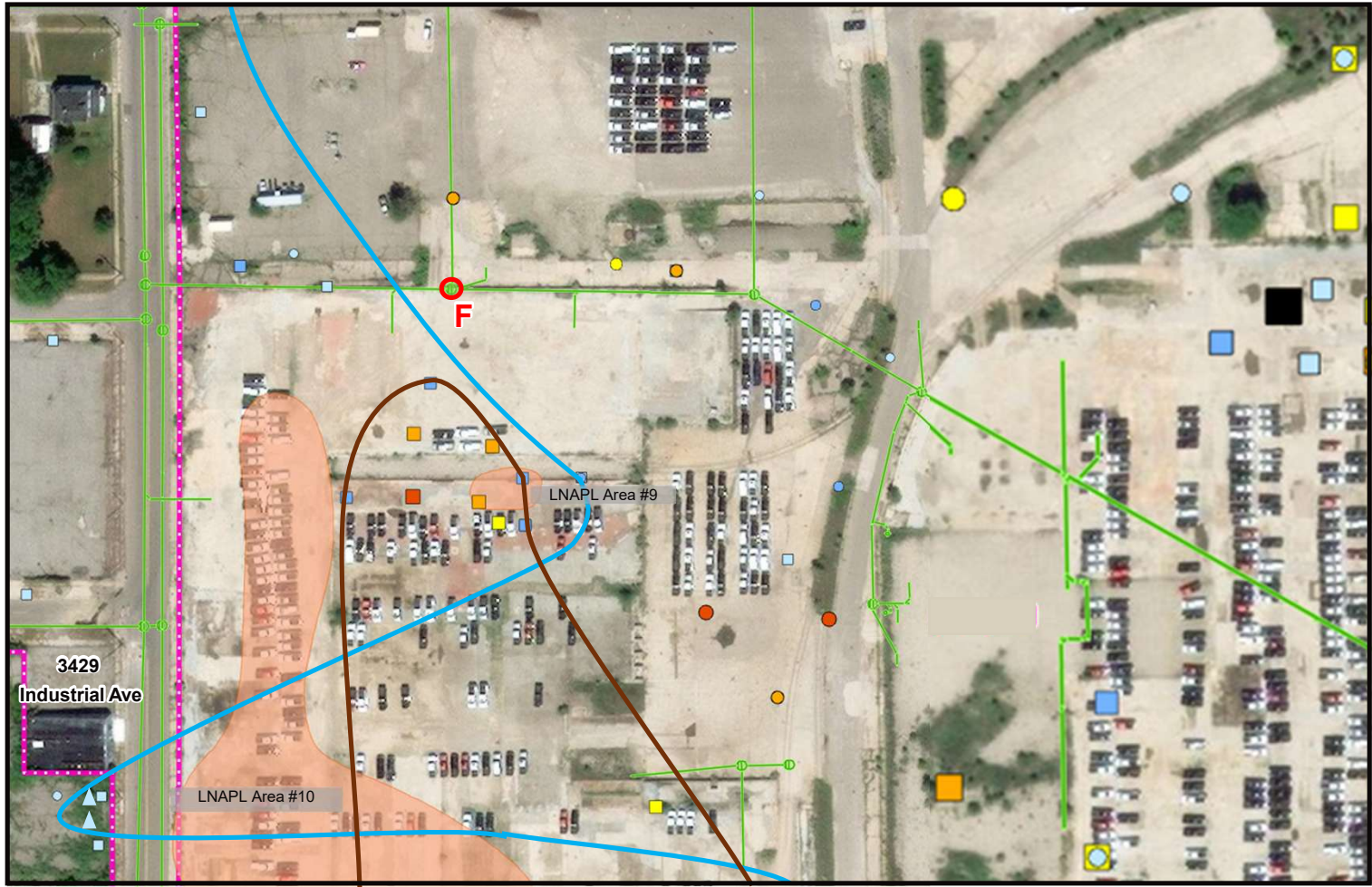


LEGEND	
GROUNDWATER VOC EXCEEDANCE	SOIL VOC EXCEEDANCE
● GREATER THAN 100,000 X SL	■ GREATER THAN 100,000 X SL
● 10,000 - 100,000X SL	■ 10,000 - 100,000X SL
● 1,000 - 10,000 X SL	■ 1,000 - 10,000 X SL
● 100 - 1,000 X SL	■ 100 - 1,000 X SL
● 10 - 100 X SL	■ 10 - 100 X SL
● SL - 10 X SL	■ SL - 10 X SL
● DETECTION LESS THAN SL	■ DETECTION LESS THAN SL
● NON-DETECT	■ NON-DETECT
○ LNAPL AREA	○ SANITARY SEWER
○ RESTRICTIVE COVENANT THAT RESTRICTS USE TO NONRESIDENTIAL AND INCLUDES SOIL VAPOR REQUIREMENTS	○ GROUNDWATER DELINEATION
○ SOIL DELINEATION	○ EXTRAPOLATED DELINEATION
○ PROPOSED SANITARY SEWER VAPOR SAMPLING LOCATION	

- NOTES**
1. ONLY MONITORING WELL GROUNDWATER AND HISTORICAL SOIL RESULTS ARE SHOWN.
 2. RESULTS ARE COLOR CODED FOR THE MOST RECENT SAMPLE COLLECTED WITH THE COMPOUND WHICH EXCEEDED THE SCREENING LEVEL (SL) AT THE HIGHEST MAGNITUDE BEING THE REPRESENTATIVE COLOR.
 3. VOLATILE ORGANIC COMPOUND (VOCs) RESULTS ARE COMPARED TO EGLE 2024 UPDATED RESIDENTIAL VOLATILIZATION TO INDOOR AIR PATHWAY (VIAP) SCREENING LEVELS.
 4. GROUNDWATER DELINEATION IS BASED ON WELLS IN WHICH THE AVERAGE DEPTH TO WATER IS NEAR THE TOP OF THE SCREEN DEPTH OR BELOW AND RESULTS ARE LESS THAN SCREENING LEVELS.
 5. SOIL DELINEATION IS BASED ON COMPARITIVE DEPTHS FROM EXCEEDANCES ON PROPERTY BOUNDARIES TO OFFSITE RESULTS AT SIMILAR DEPTHS.



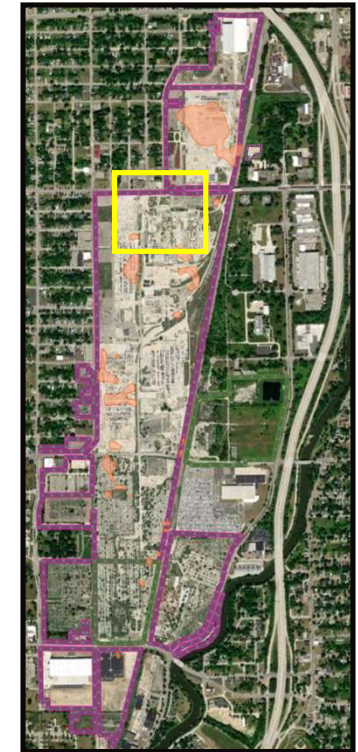
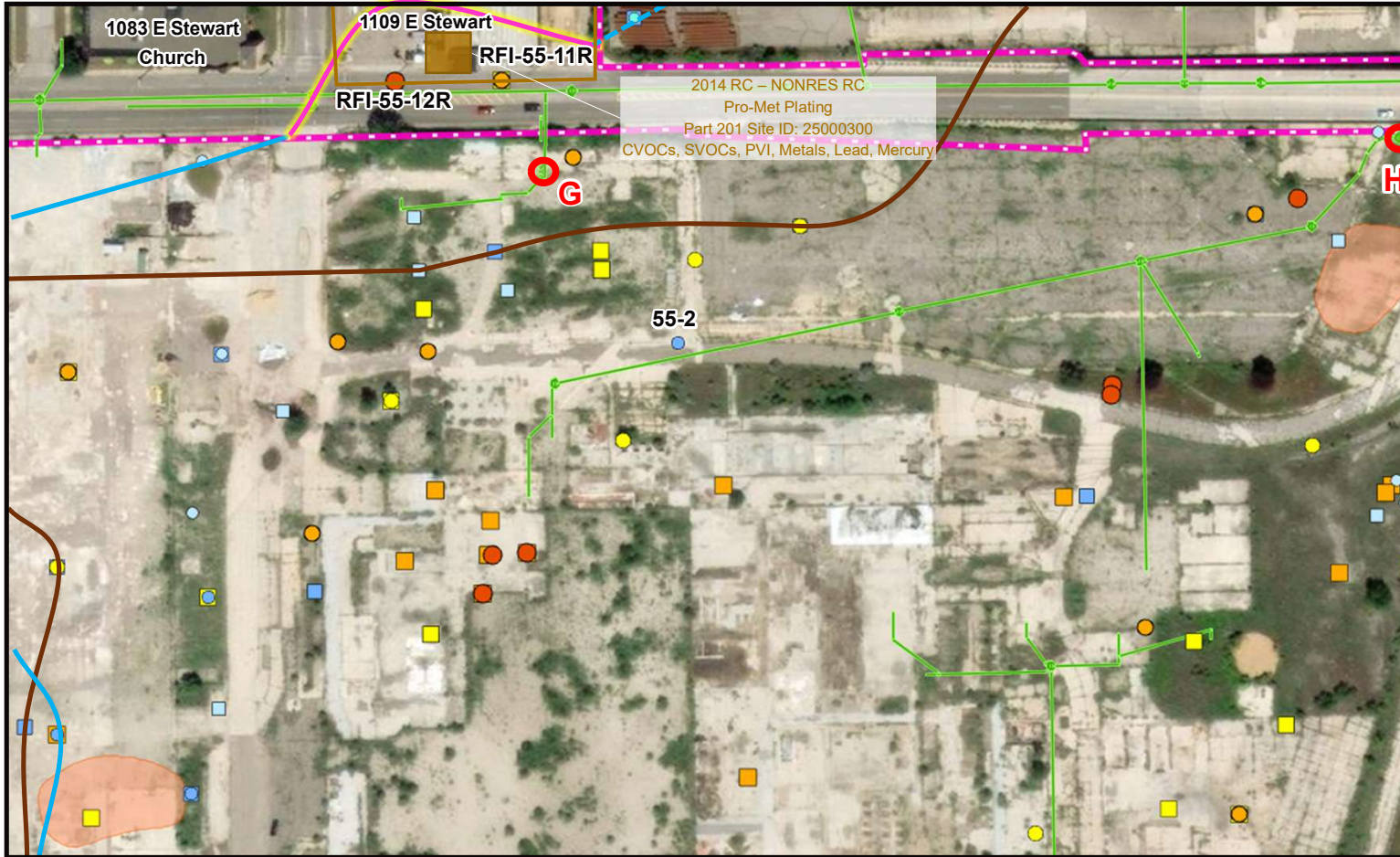
RACER TRUST BUICK CITY FLINT, MICHIGAN	
RESIDENTIAL FOCUS AREA 7	
	FIGURE 9



LEGEND		
GROUNDWATER VOC EXCEEDANCE	SOIL VOC EXCEEDANCE	LNAPL AREA
● GREATER THAN 100,000 X SL	■ GREATER THAN 100,000 X SL	○ LNAPL AREA
● 10,000 - 100,000X SL	■ 10,000 - 100,000X SL	— SANITARY SEWER
● 1,000 - 10,000 X SL	■ 1,000 - 10,000 X SL	— RESTRICTIVE COVENANT THAT RESTRICTS USE TO NONRESIDENTIAL AND INCLUDES SOIL VAPOR REQUIREMENTS
● 100 - 1,000 X SL	■ 100 - 1,000 X SL	— GROUNDWATER DELINEATION
● 10 - 100 X SL	■ 10 - 100 X SL	— SOIL DELINEATION
● SL - 10 X SL	■ SL - 10 X SL	▲ SOIL VAPOR MONITORING PORT
● DETECTION LESS THAN SL	■ DETECTION LESS THAN SL	○ PROPOSED SANITARY SEWER VAPOR SAMPLING LOCATION
● NON-DETECT	■ NON-DETECT	

- NOTES**
1. ONLY MONITORING WELL GROUNDWATER AND HISTORICAL SOIL RESULTS ARE SHOWN.
 2. RESULTS ARE COLOR CODED FOR THE MOST RECENT SAMPLE COLLECTED WITH THE COMPOUND WHICH EXCEEDED THE SCREENING LEVEL (SL) AT THE HIGHEST MAGNITUDE BEING THE REPRESENTATIVE COLOR.
 3. VOLATILE ORGANIC COMPOUND (VOCs) RESULTS ARE COMPARED TO EGLE 2024 UPDATED RESIDENTIAL VOLATILIZATION TO INDOOR AIR PATHWAY (VIAP) SCREENING LEVELS.
 4. GROUNDWATER DELINEATION IS BASED ON WELLS IN WHICH THE AVERAGE DEPTH TO WATER IS NEAR THE TOP OF THE SCREEN DEPTH OR BELOW AND RESULTS ARE LESS THAN SCREENING LEVELS.
 5. SOIL DELINEATION IS BASED ON COMPARITIVE DEPTHS FROM EXCEEDANCES ON PROPERTY BOUNDARIES TO OFFSITE RESULTS AT SIMILAR DEPTHS.

RACER TRUST BUICK CITY FLINT, MICHIGAN	
RESIDENTIAL FOCUS AREA 8	
	FIGURE 10



LEGEND

GROUNDWATER VOC EXCEEDANCE	SOIL VOC EXCEEDANCE	LNAPL AREA
● GREATER THAN 100,000 X SL	■ GREATER THAN 100,000 X SL	○ SANITARY SEWER
● 10,000 - 100,000 X SL	■ 10,000 - 100,000 X SL	— RESTRICTIVE COVENANT THAT RESTRICTS USE TO NONRESIDENTIAL AND INCLUDES SOIL VAPOR REQUIREMENTS
● 1,000 - 10,000 X SL	■ 1,000 - 10,000 X SL	— GROUNDWATER DELINEATION
● 100 - 1,000 X SL	■ 100 - 1,000 X SL	— SOIL DELINEATION
● 10 - 100 X SL	■ 10 - 100 X SL	— EXTRAPOLATED DELINEATION
● SL - 10 X SL	■ SL - 10 X SL	○ PROPOSED SANITARY SEWER VAPOR SAMPLING LOCATION
● DETECTION LESS THAN SL	■ DETECTION LESS THAN SL	■ PART 201 SITE / NONRESIDENTIAL RESTRICTIVE COVENANT
● NON-DETECT	■ NON-DETECT	

NOTES

- ONLY MONITORING WELL GROUNDWATER AND HISTORICAL SOIL RESULTS ARE SHOWN.
- RESULTS ARE COLOR CODED FOR THE MOST RECENT SAMPLE COLLECTED WITH THE COMPOUND WHICH EXCEEDED THE SCREENING LEVEL (SL) AT THE HIGHEST MAGNITUDE BEING THE REPRESENTATIVE COLOR.
- VOLATILE ORGANIC COMPOUND (VOCs) RESULTS ARE COMPARED TO EGLE 2024 UPDATED RESIDENTIAL VOLATILIZATION TO INDOOR AIR PATHWAY (VIAP) SCREENING LEVELS.
- GROUNDWATER DELINEATION IS BASED ON WELLS IN WHICH THE AVERAGE DEPTH TO WATER IS NEAR THE TOP OF THE SCREEN DEPTH OR BELOW AND RESULTS ARE LESS THAN SCREENING LEVELS.
- SOIL DELINEATION IS BASED ON COMPARITIVE DEPTHS FROM EXCEEDANCES ON PROPERTY BOUNDARIES TO OFFSITE RESULTS AT SIMILAR DEPTHS.

RACER TRUST BUICK CITY FLINT, MICHIGAN	
RESIDENTIAL FOCUS AREA 9	
	FIGURE 11

Tables

Table 1A
Phase 1 VI - Proposed Monitoring Well Sampling Network and Rationale
RACER Trust Buick City
Flint, Michigan

Well ID	Screen Depth (ft bgs)	Focus Area	Date of Most Recent Sample	Rationale
RFI-36-56R	8 - 18	1	7/18/2023	Delineation location - confirm trend. Only sampled twice as a replacement for RFI-36-56 which has a trend above nonresidential screening levels.
RFI-36-19	11.5 - 21.5	1	10/20/2020	Delineation location - confirm trend. Only exceeded screening levels in most recent sample for chloroform.
RFI-10-32	9 - 19	2	10/20/2017	Isolated exceedance confirm if trend has changed since 2017.
70-163	3 - 10	3	10/18/2017	Delineation location - confirm trend. Trichloroethene started increasing after 2016 above nonresidential screening levels. <i>Note - well on railroad property and needs access to be negotiated</i>
OW-3S	6 - 16	4	10/9/2017	Delineation location - confirm trend. Historically high concentrations.
RFI-86-16R	10 - 20	4	11/8/2012	Delineation location - confirm if still below nonresidential screening levels.
RFI-86-14	9 - 17	4	6/17/2002	Delineation location - confirm if still below nonresidential screening levels.
RFI-86-15	10 - 20	4	4/3/2003	Delineation location - confirm if still below nonresidential screening levels.
RFI-07-08	10 - 20	4	10/6/2004	Delineation location - confirm if still below nonresidential screening levels.
RFI-94-02R	10 - 15	5	10/18/2017	Site Boundary location - confirm trichloroethene and cis-1,2-dichloroethene trend.
RFI-94-09	7 - 17	5	9/25/2015	Delineation location - confirm if still below nonresidential screening levels.
RFI-94-10	7 - 17	5	10/18/2017	Delineation location - confirm if still below nonresidential screening levels.
RFI-94-11	8 - 18	5	9/25/2015	Delineation location - confirm if still below nonresidential screening levels. <i>Note - well will need to be rehabilitated to sample as previously noted as filled with soils</i>
ACSP-B2AR	22 - 33	6	12/13/2002	Delineation location - confirm if still below residential screening levels.
RFI-55-11R	5 - 15	9	3/15/2019	Delineation replacement location - original location was above nonresidential screening levels and replacement location was not analyzed for volatile organic compounds.
RFI-55-12R	5 - 15	9	3/15/2019	Delineation replacement location - original location was above nonresidential screening levels and replacement location was not analyzed for volatile organic compounds.
55-2	9 - 16	9	3/20/2003	Location downgradient of RFI-55-11R and FRI-55-12R. Sample to evaluate potential for migration from Part 201 facility located at 1109 E Stewart.

Notes:

ft bgs = feet below ground surface

Table 1B
Phase 1 VI - Proposed Sanitary Sewer Manhole Sampling
RACER Trust Buick City
Flint, Michigan

Manhole Reference	City Record Invert Depth (ft bgs)	Nearby Historical High Groundwater Depth (ft bgs)	Focus Area	Rationale
A	17	2	2	The sanitary sewer is likely in contact with impacted groundwater. The 20" diameter sewer main flows south.
B	8	7	4	The sanitary sewer is likely in contact with impacted groundwater. The 20" diameter sewer main flows south.
C	1	5	5	Due to high fluctuations in groundwater the sanitary sewer main likely comes into contact with impacted groundwater. Sewer lateral is 8" and leads into 24" east main which then flows south.
D	10	5	6	The sanitary sewer is likely in contact with impacted groundwater. The 10-15" diameter sewer main flows west.
E	1	5	7	Sewer main likely deeper than city record provided and likely comes in contact with impacted groundwater. The 15" diameter sewer flows west into offsite main.
F	8	5	8	The sanitary sewer is likely in contact with impacted groundwater. The 18" diameter sewer main flows east but connects to offsite western main.
G	2	6	9	Sewer main likely deeper than city record provided and likely comes in contact with impacted groundwater. The 12" diameter sewer lateral flows north offsite into the sewer main.
H	9	6	9	The sanitary sewer is likely in contact with impacted groundwater. The 14" diameter sewer lateral flows north offsite into the sewer main.

Notes:

All invert depths are estimate based on city records and estimate manhole elevations. No manhole depths, diameters, or flow directions have been field confirmed at the time of this work plan.

ft bgs = feet below ground surface

Table 2A
Groundwater Volatile Organic Compound Analyte List
RACER Trust Buick City
Flint, Michigan



CAS Number	Analyte	Laboratory Detection Limit (µg/L)
60297	Diethyl ether	10
67641	Acetone	50
74884	Methyl iodide	1
75150	Carbon disulfide	5
1634044	tert-Methyl butyl ether (MTBE)	5
197131	Acrylonitrile	2
78933	2-Butanone (MEK)	25
75718	Dichlorodifluoromethane	5
74873	Chloromethane	5
75014	Vinyl chloride	1
74839	Bromomethane	5
75003	Chloroethane	5
75694	Trichlorofluoromethane	1
75354	1,1-Dichloroethene	1
75092	Methylene chloride	5
156605	trans-1,2-Dichloroethene	1
75343	1,1-Dichloroethane	1
156592	cis-1,2-Dichloroethene	1
109999	Tetrahydrofuran	90
67663	Chloroform	1
74975	Bromochloromethane	1
71556	1,1,1-Trichloroethane	1
108101	4-Methyl-2-pentanone (MIBK)	50
591786	2-Hexanone	50
56235	Carbon tetrachloride	1
71432	Benzene	1
107062	1,2-Dichloroethane	1
79016	Trichloroethene	1
78875	1,2-Dichloropropane	1
75274	Bromodichloromethane	1
74953	Dibromomethane	5
10061015	cis-1,3-Dichloropropene	1
108883	Toluene	1
10061026	trans-1,3-Dichloropropene	1
79005	1,1,2-Trichloroethane	1
127184	Tetrachloroethene	1
110576	trans-1,4-Dichloro-2-butene	1
124481	Dibromochloromethane	5
106934	1,2-Dibromoethane	1

CAS Number	Analyte	Laboratory Detection Limit (µg/L)
108907	Chlorobenzene	1
630206	1,1,1,2-Tetrachloroethane	1
100414	Ethylbenzene	1
	p,m-Xylene	2
95476	o-Xylene	1
100425	Styrene	1
98828	Isopropylbenzene	5
75252	Bromoform	1
79345	1,1,2,2-Tetrachloroethane	1
96184	1,2,3-Trichloropropane	1
103651	n-Propylbenzene	1
108861	Bromobenzene	1
108678	1,3,5-Trimethylbenzene	1
98066	tert-Butylbenzene	1
95636	1,2,4-Trimethylbenzene	1
135988	sec-Butylbenzene	1
99876	p-Isopropyltoluene	5
541731	1,3-Dichlorobenzene	1
106467	1,4-Dichlorobenzene	1
95501	1,2-Dichlorobenzene	1
526738	1,2,3-Trimethylbenzene	1
104518	n-Butylbenzene	1
67721	Hexachloroethane	5
96128	1,2-Dibromo-3-chloropropane	5
120821	1,2,4-Trichlorobenzene	5
87616	1,2,3-Trichlorobenzene	5
91203	Naphthalene	5
91576	2-Methylnaphthalene	5
123911	1,4-Dioxane	1

Acronyms and Abbreviations:
µg/L micrograms per liter

Table 2B
Sewer Vapor Volatile Organic Compound Analyte List
RACER Trust Buick City
Flint, Michigan



CAS Number	Analyte	Laboratory Detection Limit (µg/m ³)
75718	Freon 12	2.47
76142	Freon 114	3.5
74873	Chloromethane	10.33
75014	Vinyl Chloride	1.28
106990	1,3-Butadiene	1.1
74839	Bromomethane	19.4
75003	Chloroethane	5.28
75694	Freon 11	2.81
64175	Ethanol	9.4
76131	Freon 113	3.83
75354	1,1-Dichloroethene	1.99
67641	Acetone	11.9
67630	2-Propanol	4.92
75150	Carbon Disulfide	6.22
107051	3-Chloropropene	6.26
75092	Methylene Chloride	17.4
1634044	Methyl tert-butyl ether	7.22
156605	trans-1,2-Dichloroethene	1.99
110543	Hexane	1.77
75343	1,1-Dichloroethane	2.02
78933	2-Butanone (Methyl Ethyl Ketone)	5.9
156592	cis-1,2-Dichloroethene	1.99
109999	Tetrahydrofuran	1.48
67663	Chloroform	2.44
71556	1,1,1-Trichloroethane	2.73
110827	Cyclohexane	1.72
56235	Carbon Tetrachloride	3.15
540841	2,2,4-Trimethylpentane	2.35
71432	Benzene	1.6
107062	1,2-Dichloroethane	2.02
142825	Heptane	2.05
79016	Trichloroethene	2.69
78875	1,2-Dichloropropane	2.31
123911	1,4-Dioxane	7.22
75274	Bromodichloromethane	3.35
10061015	cis-1,3-Dichloropropene	2.27

CAS Number	Analyte	Laboratory Detection Limit (µg/m ³)
108101	4-Methyl-2-pentanone	2.05
108883	Toluene	3.77
10061026	trans-1,3-Dichloropropene	2.27
79005	1,1,2-Trichloroethane	2.73
127184	Tetrachloroethene	3.39
591786	2-Hexanone	8.2
124481	Dibromochloromethane	4.26
106934	1,2-Dibromoethane (EDB)	3.84
108907	Chlorobenzene	2.3
100414	Ethyl Benzene	2.17
108383	m,p-Xylene	4.34
95476	o-Xylene	2.17
100425	Styrene	2.13
75252	Bromoform	5.17
98828	Cumene	2.46
79345	1,1,1,2-Tetrachloroethane	3.43
103651	Propylbenzene	2.46
622968	4-Ethyltoluene	2.46
108678	1,3,5-Trimethylbenzene	2.46
95636	1,2,4-Trimethylbenzene	2.46
541731	1,3-Dichlorobenzene	3
106467	1,4-Dichlorobenzene	3
100447	alpha-Chlorotoluene	2.59
95501	1,2-Dichlorobenzene	3
120821	1,2,4-Trichlorobenzene	14.86
87683	Hexachlorobutadiene	21.34

Acronyms and Abbreviations:
 µg/m³ micrograms per cubic meter

Attachment 1

Technical Guidance Instructions

TGI – Low-Flow Groundwater Purging and Sampling Procedures for Monitoring Wells

Rev: 3

Rev Date: April 5, 2023

Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	October 12, 2018	All	Updated and re-written as TGI with new branding and content	Marc Killingstad
	1	May 8, 2020	Pages 5, 10-11	Added clarification/details for equipment requirements and procedure steps based on USEPA guidance	Marc Killingstad
	2	April 5, 2022	All	Updated to new branding template and minor edits	Marc Killingstad
	3	April 5, 2023	All	Annual review completed by SME. Document version number and document date updated.	Marc Killingstad

Approval Signatures

Prepared by:

4/5/2023



Xuan Xu (Preparer)

Date

Reviewed by:

4/5/2023



Marc Killingstad (Subject Matter Expert)

Date

1 Introduction

Groundwater samples are collected from monitoring wells to evaluate groundwater quality. The protocol presented in this Technical Guidance Instruction (TGI) describes the procedures to purge monitoring wells and collect groundwater samples using the low flow purging/sampling methodology. This protocol has been developed in accordance with the United States Environmental Protection Agency (USEPA) Region I *Low Stress (Low Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells* (EQASOP-GW4; September 19, 2017).

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

Both filtered and unfiltered groundwater samples may be collected using this low-flow sampling method. Filtered samples will be obtained using a 0.45-micron disposable filter. Project teams will evaluate the last time the monitoring wells were developed and determine if additional development might be necessary. Water samples will not be taken immediately following well development. Sufficient time will be allowed for the groundwater flow regime in the vicinity of the monitoring well to stabilize and to approach chemical equilibrium with the well

construction materials. This lag time will depend on site conditions and methods of installation but often exceeds one week.

4 Personnel Qualifications

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour HAZWOPER training and/or OSHA HAZWOPER site supervisor training. Arcadis personnel will also have current training as identified in the site-specific Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. The HASP will also identify any access control requirements.

Prior to mobilizing to the field, the groundwater sampling team will review and be thoroughly familiar with relevant site-specific documents including but not limited to the task-specific work plan or field implementation plan (FIP)/field sampling plan, Quality Assurance Project Plan (QAPP), HASP, historical information, and other relevant site documents.

Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and TGIs and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. Additionally, the groundwater sampling team will review and be thoroughly familiar with documentation provided by equipment manufacturers and become familiar with the operation of (i.e., hands-on experience) all equipment that will be used in the field prior to mobilization.

5 Equipment List

Specific to this activity, the following materials (or equivalent) will be used:

- Site-specific HASP and health and safety documents identified in the HASP
- Field Implementation Plan (FIP) that includes site map, well construction records, sampling plan (sample analyses, sample volume required, and sample holding time), and prior groundwater sampling records (if available)
- Field notebook and/or smart device (phone or tablet)
- Low-flow sampling field forms (**Attachment A**)
- Appropriate personal protective equipment (PPE) (e.g., latex or nitrile gloves, safety glasses, etc.) as specified in the HASP
- Well keys and other tools to remove manhole covers (manual torque wrench with 9/16" socket and flat head screwdriver typical)
- Photoionization detector (PID) or Flame ionization detector (FID) (as appropriate, depending on site-specific constituents of concern)
- Electronic water-level indicator (e.g., Solinst Model 101) or oil/water interface probe with 0.01-foot accuracy (oil/water as appropriate, note that sampling will not be performed when sheen or light non-aqueous phase liquid [LNAPL] is present)
- Down-hole multi-parameter water-quality sonde (temperature/pH/specific conductivity/oxidation reduction [ORP]/turbidity/dissolved oxygen) meter coupled with flow-through-cell for measurements, for example:

- YSI 6-Series Multi-Parameter Instrument
- Horiba U-22 Multi-Parameter Instrument.
- Hydrolab Series 3 or Series 4a Multiprobe and Display.

NOTE: *Transparent, small volume flow-through-cells (e.g., 250 milliliters or less) are preferred as they allow for easy detection of air bubbles and sediment buildup in the cell, which can interfere with the monitoring instrument probes. A small volume cell also allows for quick turnover of water in the cell between measurements of the indicator field parameters. It is recommended to use a flow-through-cell and monitoring probes from the same manufacturer and model to avoid incompatibility between the probes and flow-through-cell.*

- Plastic sheeting (e.g., Weatherall Visqueen) to protect all down-hole sampling equipment from contact with potential sources of contamination.
- Decontamination equipment
 - Non-phosphate laboratory soap (Alconox or equivalent), brushes, and clean buckets, and/or clean wash tubs—new buckets or tubs will be purchased if it cannot be determined if the present items are clean
 - Distilled or de-ionized water for equipment decontamination
- Indelible ink pen
- 150-foot measuring tape (or sufficient length for the maximum site depth requirement)
- Sampling pump, which may consist of one or more of the following:
 - Submersible pump (e.g., Grundfos Redi-Flo 2)
 - Peristaltic pump (e.g., ISCO Model 150)
 - Bladder pump (e.g., Marschalk System 1, QED Micropurge, Geotech)
- Appropriate controller and power source for pump:
 - Submersible and peristaltic pumps require electric power from either a generator or a deep cell battery
 - Submersible pumps such as Grundfos require a pump controller to run the pump
 - Bladder pumps require a pump controller and a gas source (e.g., air compressor or compressed N₂ or CO₂ gas cylinders)
- Teflon® tubing or Teflon®-lined polyethylene tubing of an appropriate size for the pump being used
 - For peristaltic pumps, dedicated Tygon® tubing (or other type as specified by the manufacturer) will be used through the pump apparatus
 - Teflon® will not be used when sampling for per- and polyfluoroalkyl substances (PFAS)
- Graduated cylinder and stopwatch or other device to measure time to determine pumping rate
- Appropriate water sample containers (supplied by the laboratory)
- Appropriate blanks (trip blank supplied by the laboratory)
- Sample labels and Chain-of-Custody forms (COC)
- 0.45-micron disposable filters (if field filtering is required)

- A supplemental turbidity meter (e.g., Horiba U-10, Hach 2100P, LaMotte 2020) may be required for specific projects and will be specified in the project FIP/ work plan and the kick-off notes.
 - If used, in-line 'T' and valve allows for collection of water for turbidity measurements before the pump discharge enters the flow-through cell

NOTE: *The maintenance requirements for the above equipment generally involve decontamination or periodic cleaning, battery charging, and proper storage, as specified by the manufacturer. For operational difficulties, the equipment will be serviced by a qualified technician.*

6 Cautions

Different USEPA regions and/or state regulatory agencies may stipulate deviations from this document. It is the responsibility of the Project Team (Project Manager and Technical Lead) to be fully aware of the requirements from the applicable regulatory framework.

Weather

- If heavy precipitation occurs, and no cover over the sampling area and monitoring well can be erected, sampling may be discontinued until adequate cover is provided. Rainwater could compromise groundwater samples.
- Avoid extreme weather situations. Be aware that thermal currents and vertical mixing of cold and warm water inside the well casing could create a convection cell within the well and compromise data collection (e.g., biological mechanisms).
 - Direct sunlight and hot ambient temperatures may cause the groundwater in the tubing or flow-through-cell to heat up and de-gas. This may result in the loss of volatile organic compounds (VOCs) and dissolved gases. Shade the equipment from direct sunlight, keep the tubing as short as possible and avoid the hottest times of the day.
 - Sampling during freezing conditions may adversely impact the data quality objectives. USEPA recommends low-flow sampling be conducted at air temperatures above 32°F (0°C) or taking special precautions to prevent groundwater from freezing in the equipment.

Cross-Contamination

- To mitigate potential cross-contamination, groundwater samples are to be collected in a pre-determined order from least impacted to impacted based on previous analytical data. If no analytical data are available, collect samples in order of up-gradient, then furthest down-gradient to source area locations.
- Note that permanent markers could introduce volatile constituents into the samples; *therefore, indelible ink is recommended* to be used for labels on sample containers or sample coolers.
- When using a gasoline generator, this power source will be set-up at least 30 feet downwind from the well to avoid exhaust fumes to contaminate samples.

Pumps

- Preferred methods of extracting groundwater are adjustable rate, submersible pumps - such as centrifugal pumps or bladder pumps – constructed of stainless steel or polytetrafluoroethylene (PTFE, i.e., Teflon®). However, *PTFE will not be used when sampling for per- and polyfluoroalkyl substances (PFAS). PTFE could contain PFAS.*

- When using a bladder pump for collecting VOCs and dissolved gases, “best practice” is to set-up the pump to deliver sufficient water to fill a 40 mL VOC vial.
- The use of peristaltic pumps will be based on the type of data to be collected. *Because the use a peristaltic pump can result in de-gassing of VOC and / or dissolved gases from groundwater, a different type of pump will be considered if these compounds are of concern.*
- *Manual or motor driven inertial pumping devices are not recommended because they cause greater disturbance during purging and pumping than regular pumps and are less easily controlled. This could cause a higher degree of data variability.*

Tubing

- When sampling for VOCs, SVOCs, pesticides, PCBs and inorganics, use of PTFE (Teflon®) or PTFE-lined tubing is preferred. However, PTFE tubing will not be used when sampling for PFAS.
- PVC, polypropylene or polyethelene tubing may be used when sampling for metals or other inorganics.
- Tubing with inside diameters of 1/4 or 3/8 inch is recommended because this will help ensure tubing remains water filled when operating at very low pumping rates.

General Precautions

- Store and/or stage empty and full sample containers and coolers out of direct sunlight.
- It may be necessary to field filter the groundwater for some parameters (e.g., metals) during collection, depending on preservation, analytical method, and project quality objectives. The task-kick-off notes and the FIP/work plan will list the samples that require field filtering.
- Be careful not to overtighten lids with Teflon® liners or septa (e.g., 40 mL vials). Over-tightening can cause the glass to shatter or impair the integrity of the Teflon® seal.

7 Health and Safety Considerations

The HASP will be followed, as appropriate, to ensure the safety of field personnel.

Appropriate personal protective equipment (PPE) will be always worn in line with the task and the site-specific HASP.

Review all site-specific and procedural hazards as they are provided in the HASP, and review Job Safety Analysis (JSA) documents in the field each day prior to beginning work.

Access to wells may expose field personnel to hazardous materials such as contaminated groundwater or non-aqueous phase liquid (NAPL) (e.g., oil). Other potential hazards include pressurized wells, stinging insects that may inhabit well heads, other biologic hazards (e.g. ticks in long grass/weeds around well head), and potentially the use of sharp cutting tools (scissors, knife)—open well caps slowly and keep face and body away to allow to vent any built-up pressure; only use non-toxic peppermint oil spray for stinging insect nests; review client-specific health and safety requirements, which may preclude the use of fixed/folding-blade knives, and use appropriate hand protection.

Generators and cord and plug equipment will employ an overcurrent protection device such as an integrated ground fault circuit interrupter (GFCI) cord. Grundfos pump controllers will not run properly with a GFCI, so the power source will be equipped with other overcurrent protection means.

Overtightening of lids with Teflon® liners can cause the glass to shatter and create a risk for hand injuries.

8 Procedure

Field personnel will set up and perform low-flow sampling in accordance with the following procedures.

1. Review FIP and groundwater sampling records from previous sampling events (if available) prior to mobilization to estimate the optimum pumping rate and anticipated drawdown for each well to perform sampling as efficiently as possible (i.e., reach a stabilized pumping condition).
2. Calibrate field instruments according to manufacturer procedures for calibration and record calibration procedure and results in field log.
3. All equipment will either be new or decontaminated in accordance with appropriate guidance document (*TGI – Groundwater and Soil Sampling Equipment Decontamination*) prior to use.
4. Visually inspect the well to ensure that it is undamaged, properly labeled and secured
 - a. Damage or other conditions that may affect the integrity of the well will be recorded in the Field Activity Daily Log and brought to the attention of the designated Field Manager and/or Project Manager
 - b. Record well construction and conditions on the Low-Flow Sampling Field Form (**Attachment A**).
5. Place clean plastic sheeting on the ground near the well to keep monitoring and sampling equipment off the surface unless the equipment is elevated above the ground (e.g., on a table).
6. Open the well cover while standing upwind of the well. Remove the well cap and place it on the plastic sheeting. If appropriate or required for site-specific conditions, insert the photoionization detector (PID) probe approximately 4 to 6 inches into the casing or the well headspace and cover it with a gloved hand. Record the PID reading in the field log. Perform air monitoring in the breathing zone according to the HASP and/or JSA.
7. Measure and record the initial depth to groundwater prior to placing the pumps.
8. Prepare and install the pump in the well.

NOTE: Groundwater will be purged from the wells using an appropriate pump. If the depth to water is below the sampling range of a peristaltic pump (approximately 25 feet below ground surface), a submersible or bladder pump will be used, provided that the well is constructed with a casing diameter of at least two (2) inches (the minimum well diameter capable of accommodating such pumps). For smaller diameter wells, where the depth to water is below the sampling range of a peristaltic pump, alternative sampling methods (i.e., bailing or small diameter bladder pumps) will be used to purge and sample the groundwater. Bladder pumps are preferred over peristaltic and submersible pumps to prevent volatilization if sampling of VOCs and/or dissolved gasses is required. Purge water will be collected and containerized according to the direction of the project team.

- a. For submersible and non-dedicated bladder pumps, decontaminate the pump according to site decontamination procedures. Non-dedicated bladder pumps will require a new bladder and attachment of an air-line, sample discharge line, and safety cable prior to placement in the well. Attach the air-line tubing to the air-port on the top of the bladder pump. Attach the sample discharge tubing to the water port on the top of the bladder pump. Take care not to reverse the air and discharge tubing lines during bladder pump setup, as this could result in bladder failure or rupture. Attach and secure a safety cable to the eyebolt on the top of pump (if present, depending on pump model used). Slowly lower the pump, safety cable, tubing, and electrical lines into the well to a depth corresponding to the approximate center of the saturated screen section of the well. Avoid twisting

and tangling of safety cable, tubing, and electrical lines while lowering the pump into the well; twisted and tangled lines could result in the pump becoming stuck in the well casing. Also, make sure to keep tubing and lines from touching the ground or other surfaces while introducing them into the well, as this could lead to unintended contamination.

- b. If using a bladder pump, connect the air-line to the pump controller output port. The pump controller will be connected to a supply line from an air compressor or compressed gas cylinder using an appropriate regulator and air hose. Tighten the regulator connector onto the gas cylinder (if used) to prevent leaks. Teflon® tape may be used on the threads of the cylinder to provide a tighter seal. Once the air compressor or gas cylinder is connected to the pump controller, turn on the compressor or open the valve on the cylinder to begin the gas flow. Turn on the pump controller power (if an on/off switch is present) and verify that all batteries are charged and fully functioning before starting the pump.
 - c. If a peristaltic pump is being used, slowly lower the sampling tubing into the well to a depth corresponding to the approximate center of the saturated screen section of the well. The pump intake or sampling tube must be kept at least two (2) feet above the bottom of the well to prevent mobilization of any sediment present in the bottom of the well.
 - d. If using an in-line 'T' and valve, install between pump discharge water line and the bottom inlet port of the flow-through cell. Attach a short piece of tubing to the outlet. This set-up will be used to collect samples for turbidity readings.
9. Connect the pump discharge water line to the bottom inlet port on the flow-through cell connected to the multi-parameter water-quality sonde and make sure to record equipment/instrument identification (manufacturer and model number).
 10. Before starting the pump, ensure that the water level inside the well has stabilized (i.e., measure the water level multiple times after deploying the pump in the well).
 11. Start pumping the well at 200 to 500 milliliters (mL) per minute (or at lower site-specific rate if specified) and adjust the pumping rate to cause little or no water level drawdown in the well (less than 0.3 feet below the initial static depth to water measurement): the water level should stabilize, however, this is not always possible.
 12. If the well diameter is of sufficient size, measure the water level every 3 to 5 minutes (or as appropriate, lower flow rates may require longer time between readings) during pumping.
 13. Maintain a steady flow rate to the extent practicable and do not break pump suction or cause entrainment of air in the sample.
 14. Record pumping rate adjustments and depths to water.

If necessary, reduce pumping rates to the minimum capabilities of the pump to avoid pumping the well dry and/or to stabilize indicator parameters; if the recharge rate of the well is very low, use alternative purging techniques, which will vary based on the well construction and screen position.

For wells screened across the water table, the well may be pumped dry, and sampling can commence as soon as the volume in the well has recovered sufficiently to permit collection of samples.

For wells screened entirely below the water table, the well can be pumped until a stabilized level (which may be greater than the maximum displacement goal of 0.3 feet) is maintained and monitoring for stabilization of field indicator parameters can commence; if a lower stabilization level cannot be

maintained, the well may be pumped until the drawdown is at a level slightly higher than top of the well screen.

15. After water levels have stabilized and a sufficient volume has been purged (see note below), continue pumping and begin monitoring field indicator parameters using a multi-parameter water-quality sonde coupled with a flow-through-cell.

NOTE: The final purge volume must be greater than the stabilized drawdown volume plus the pump's tubing volume. If the drawdown has exceeded 0.3 feet and stabilizes, calculate the volume of water between the initial water level and the stabilized water level. Add the volume of the water which occupies the pump's tubing to this calculation. This combined volume of water needs to be purged from the well after the water level has stabilized before samples are collected.

16. Use the flow to measure all indicator field parameters, except for turbidity, every 3 to 5 minutes (or after each volume of the flow-through cell has been purged or other appropriate interval); turbidity samples will be collected before the flow-through-cell using the T-valve and a clean container such as a glass beaker.
17. Record field indicator parameters on the groundwater sampling log.
18. The well is considered stabilized and ready for sample collection when three consecutive readings are within the following limits:

- **Turbidity** within $\pm 10\%$ for values greater than 5 nephelometric turbidity units [NTUs] or if three turbidity values are less than 5 NTUs, consider the values stabilized
- **Dissolved Oxygen (DO)** within $\pm 10\%$ for values greater than 0.5 mg/L or if three DO values are less than 0.5 mg/L, consider the values stabilized
- **Specific Conductance** within $\pm 3\%$
- **Temperature** within $\pm 3\%$
- **pH** within ± 0.1 unit
- **Oxidation/Reduction Potential (ORP)** within ± 10 millivolts (mV)

NOTE: Alternate stabilization goals may exist in different geographic regions, consult the site-specific FIP/work plan for stabilization criteria).

NOTE: While achieving turbidity levels less than 5 NTU and a stable drawdown of less than 0.3 feet is desirable, sample collection may still take place provided the indicator field parameter criteria in this procedure are met.

19. If the parameters have stabilized but turbidity remains relatively high (e.g., greater than 50 NTUs), the pump flow rate may be decreased to a minimum rate of 100 mL/min to reduce turbidity levels as low as possible. If groundwater turbidity has been minimized (i.e., consecutive readings within $\pm 10\%$) and the values for all other parameters have stabilized, the well may be sampled; however, consult specifications in the FIP/work plan and/or the project technical lead prior to sampling.
20. If after one (1) hour of purging indicator field parameters have not stabilized, consult specifications in the FIP/work plan and/or the project technical lead prior to sampling.

In general, three potential options are available if stabilization criteria are not met:

- a. Continue purging until stabilization is achieved.
- b. Discontinue purging, do not collect any samples, and record in field logbook/on the sampling form that stabilization could not be achieved (documentation must describe attempts to achieve stabilization).

- c. Discontinue purging, collect samples, and provide full explanation of attempts to achieve stabilization. There is a risk that the analytical data obtained under these conditions, particularly metals and hydrophobic organic analytes, may reflect a sampling bias and, as a result, the data may not meet the data quality objectives of the sampling event.

NOTE: DO is extremely susceptible to various external influences (including temperature or the presence of bubbles on the DO meter); therefore, great care will be taken to minimize the agitation or other disturbance of water within the flow-through cell while collecting these measurements. If air bubbles are present on the DO probe or in the discharge tubing, remove them before taking a measurement. If DO values are not within acceptable range for the temperature of groundwater, again check for and remove air bubbles on the probe before re-measuring. The table below may be used as a general guide for DO values under various temperatures; however, understand that the table corresponds to freshwater solubility and groundwater contaminants may affect oxygen solubility. If DO value is 0.00 or less, then the meter will be serviced and re-calibrated. If DO values are above possible results, then the meter will be serviced and re-calibrated.

NOTE: During extreme weather conditions, stabilization of field indicator parameters may be difficult to attain. Modifications to the sampling procedures to alleviate these conditions (e.g., measuring the water temperature in the well adjacent to the pump intake) will be documented in the field logbook/on the sampling form.

NOTE: If other field conditions are suspected of preventing stabilization of certain parameters, detailed observations will be documented in the field logbook/on the sampling form.

Oxygen Solubility in Fresh Water

Temperature (degrees C)	Dissolved Oxygen (mg/L)
0	14.6
1	14.19
2	13.81
3	13.44
4	13.09
5	12.75
6	12.43
7	12.12
8	11.83
9	11.55
10	11.27
11	11.01
12	10.76
13	10.52
14	10.29
15	10.07
16	9.85
17	9.65
18	9.45
19	9.26
20	9.07
21	8.9
22	8.72
23	8.56
24	8.4
25	8.24
26	8.09
27	7.95
28	7.81
29	7.67
30	7.54
31	7.41
32	7.28
33	7.16
34	7.05
35	6.93

Reference: Vesilind, P.A., Introduction to Environmental Engineering, PWS Publishing Company, Boston, 468 pages (1996)

21. Complete the sample label(s) and cover the label(s) with clear packing tape to secure the label onto the container.
22. After the indicator parameters have stabilized, collect groundwater samples by diverting flow out of the unfiltered discharge tubing into the appropriate labeled sample container.
 - a. If a flow-through analytical cell is being used to measure field parameters, the flow-through cell will be disconnected after stabilization of the field indicator parameters and prior to groundwater sample collection.
 - b. Under no circumstances will analytical samples be collected from the discharge of the flow-through cell.
 - c. If an in-line 'T' and valve are used, the valve needs to be removed as well.

- d. Samples will be collected in the following order: VOCs, total organic carbon (TOC), semi-volatile organic compounds (SVOCs), metals and cyanide, and others (or other order as defined in the site-specific FIP/work plan).
 - e. When the container is full, tightly screw on the cap.
23. If sampling for total and filtered metals and/or polychlorinated biphenyls (PCBs), a filtered and unfiltered sample will be collected.
- a. Install an in-line, disposable 0.45-micron particle filter on the discharge tubing after the appropriate unfiltered groundwater sample has been collected.
 - b. Continue to run the pump until an initial volume of “flush” water has been run through the filter in accordance with the manufacturer’s directions (generally 100 to 300 mL).
 - c. Collect the filtered groundwater sample by diverting flow out of the filter into the appropriately labeled sample container.
 - d. When the container is full, tightly screw on the cap.
24. Secure with packing material and store the samples on ice in an insulated transport container provided by the laboratory and include a temperature blank in each container to be shipped.
25. Record on the Low-Flow Sampling Field Form (and bound field logbook) the time at which sampling procedures were completed, any pertinent observations of the sample (e.g., physical appearance and the presence or lack of odors or sheens), and the values of the stabilized field indicator parameters as measured during the final reading during purging (**see Attachment A**).
26. Turn off the pump and air compressor or close the gas cylinder valve if using a bladder pump setup.
27. Slowly remove the pump, tubing, lines, and safety cable from the well.
- a. If using dedicated tubing, do not allow the tubing or lines to touch the ground or any other surfaces which could contaminate them.
 - b. If using dedicated tubing, it will be folded - without pinching it - to a length that will allow the well to be capped and also facilitate retrieval of the tubing during later sampling events.
 - c. Use a length of rope or string to tie the tubing to the well cap.
 - d. Alternatively, if tubing and safety line are to be saved and reused for sampling the well at a later date, coil the tubing neatly and placed in a clean plastic bag that is clearly labeled with the well ID ensuring the bag is tightly sealed before placing it in storage.
28. Secure the well and properly dispose of personal protective equipment (PPE) and disposable equipment.
29. Complete the procedures for packaging, shipping, and handling with the associated Chain-of-Custody.
30. Complete decontamination for flow-through analytical cell and submersible or bladder pump, as appropriate (*TGI – Groundwater and Soil Sampling Equipment Decontamination*).
31. At the end of each day of the sampling event, perform calibration check of field instruments and record procedure and results in field log.

9 Waste Management

Materials generated during groundwater sampling activities, including disposable equipment and excess purge water, will be stored on site in appropriately labeled containers and disposed of properly. Waste will be managed in accordance with the *TGI – Investigation-Derived Waste Handling and Storage*, the procedures identified in the

FIP or QAPP as well as state-, federal- or client-specific requirements. Be certain that waste containers are properly labeled and documented in the field logbook.

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

Management of the original documents from the field will be completed in accordance with the site- specific QAPP.

In general, forms (e.g., Low-Flow Sampling Field Forms), logs/notes (including daily field and calibration logs), digital records, and Chain-of-Custody records will be maintained by the field team lead.

Field logs and Chain-of-Custody records will be transmitted to the Arcadis Project Manager and/or Task Manager, as appropriate, at the end of each day unless otherwise directed. Electronic data files will be sent to the project team and uploaded to the electronic project folder daily.

Records generated as a result of this TGI will be controlled and maintained in the project record files in accordance with project requirements.

11 Quality Assurance

Quality assurance procedures shall be conducted in accordance with the Arcadis Quality Management System or the site-specific QAPP.

Unless described otherwise in the project-specific FIP/work plan, QAPP, or Sampling and Analysis Plan, quality assurance/quality control samples will be collected as follows:

- One duplicate for every 10 samples
- One laboratory matrix/matrix spike sample for every 20 samples
- In addition to the quality control samples to be collected in accordance with this TGI, the following quality control procedures will be observed in the field:
 - Collect samples from monitoring wells, in order of increasing concentration, to the extent known based on review of historical site information if available
 - Equipment blanks will include the pump and tubing (if using disposable tubing) or the pump only (if using tubing dedicated to each well)
 - Collect equipment blanks after wells with higher concentrations (if known) have been sampled

- Operate all monitoring instrumentation in accordance with manufacturer's instructions and calibration procedures—calibrate instruments at the beginning of each day, verify the calibration at the end of each day, and record all calibration activities in the field notebook
- Clean all groundwater sampling equipment prior to use in the first well and after each subsequent well following the procedure for equipment decontamination

12 References

USEPA. 1986. *RCRA Groundwater Monitoring Technical Enforcement Guidance Document* (September 1986).

USEPA. 1991. *Handbook Groundwater, Volume II Methodology*, Office of Research and Development, Washington, DC. USEPN62S, /6-90/016b (July 1991).

USEPA Region I. 2017. *Low Stress (Low Flow) Purging and Sampling Procedures for the Collection of Groundwater Samples from Monitoring Wells* (EQASOP-GW4; September 19, 2017).

U.S. Geological Survey (USGS). 1977. *National Handbook of Recommended Methods for Water-Data Acquisition: USGS Office of Water Data Coordination*. Reston, Virginia.

13 Attachments

Attachment A – Low Flow Sampling Field Form

Attachment A

Low-Flow Sampling Field Form

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TGI – Groundwater and Soil Sampling Equipment Decontamination

Rev: 3

Rev Date: August 30, 2023

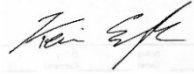
Version Control

Issue	Revision No.	Date Issued	Page No.	Description	Reviewed By
	0	February 23, 2017	All	Conversion from SOP to TGI	Cassandra McCloud / Pete Frederick
	1	May 8, 2020	4, 5	Added note regarding use of Liquinox and 1,4-Dioxane	Marc Killingstad
	2	June 14, 2022	All	Conversion to new TGI format and minor edits.	Kevin Engle / Marc Killingstad
	3	August 30, 2023	All	Annual review completed by SME. Updated Rev 1.	Marc Killingstad

Approval Signatures

Prepared by:

8/30/2023



Name (Preparer)

Date

Reviewed by:

8/30/2023



Marc Killingstad (Subject Matter Expert)

Date

1 Introduction

This document is intended to provide guidance to staff performing decontamination procedures at project sites. The content in this document describes the intended use, scope and application, personnel qualifications, equipment, cautions, health and safety considerations, procedures, waste management, data recording and management, and quality assurance of decontamination procedures.

2 Intended Use and Responsibilities

This document describes general and/or specific procedures, methods, actions, steps, and considerations to be used and observed by Arcadis staff when performing work, tasks, or actions under the scope and relevancy of this document. This document may describe expectations, requirements, guidance, recommendations, and/or instructions pertinent to the service, work task, or activity it covers.

It is the responsibility of the Arcadis Certified Project Manager (CPM) to provide this document to the persons conducting services that fall under the scope and purpose of this procedure, instruction, and/or guidance. The Arcadis CPM will also ensure that the persons conducting the work falling under this document are appropriately trained and familiar with its content. The persons conducting the work under this document are required to meet the minimum competency requirements outlined herein, and inquire to the CPM regarding any questions, misunderstanding, or discrepancy related to the work under this document.

This document is not considered to be all inclusive nor does it apply to all projects. It is the CPM's responsibility to determine the proper scope and personnel required for each project. There may be project- and/or client- and/or state-specific requirements that may be more or less stringent than what is described herein. The CPM is responsible for informing Arcadis and/or Subcontractor personnel of omissions and/or deviations from this document that may be required for the project. In turn, project staff are required to inform the CPM if or when there is a deviation or omission from work performed as compared to what is described herein.

In following this document to execute the scope of work for a project, it may be necessary for staff to make professional judgment decisions to meet the project's scope of work based upon site conditions, staffing expertise, regulation-specific requirements, health and safety concerns, etc. Staff are required to consult with the CPM when or if a deviation or omission from this document is required that has not already been previously approved by the CPM. Upon approval by the CPM, the staff can perform the deviation or omission as confirmed by the CPM.

3 Scope and Application

Decontamination is performed on sampling equipment prior to sample collection to ensure that the sampling equipment that contacts a sample, or monitoring equipment that is brought into contact with environmental media to be sampled, is free from analytes of interest and/or constituents that could interfere with laboratory analysis for analytes of interest. Sampling equipment must be appropriately cleaned prior to use for sampling or coming into contact with environmental media to be sampled and following completion of the sampling event prior to shipment or storage. The effectiveness of the decontamination procedure should be verified by collecting and analyzing equipment blank samples.

The sampling equipment cleaning procedures described herein includes pre-field, in the field, and post-field cleaning of sampling equipment which may be conducted at an established equipment decontamination area (EDA) on site, as appropriate and necessary. Sampling equipment that may require decontamination at a given site include soil sampling tools; groundwater, sediment, and surface-water sampling devices; water testing instruments; down-hole instruments; and other activity-specific sampling equipment. Non-disposable equipment will be cleaned before collecting each sample, between each sample collected, and prior to placing sampling equipment in protective cases, or containers for transport. Cleaning procedures for sampling equipment should be monitored by collecting equipment blank samples as required in project work plans, field sampling plans, quality assurance project plans (QAPP), or other pertinent project documents. Dedicated and/or single-use (i.e., not to be re-used) sampling equipment will not require decontamination.

4 Personnel Qualifications

Arcadis field sampling personnel will have completed or are in the process of completing site-specific training as well as having current health and safety training as required by Arcadis, client, or regulations, such as 40-hour hazardous waste operations and emergency response (HAZWOPER) training and/or Occupational Safety and Health Administration (OSHA) HAZWOPER site supervisor training. Arcadis personnel will also have current training as specified in the Health and Safety Plan (HASP) which may include first aid, cardiopulmonary resuscitation (CPR), Blood Borne Pathogens (BBP) as needed. In addition, Arcadis field sampling personnel will be knowledgeable in the relevant processes, procedures, and Technical Guidance Instructions (TGIs) and possess the demonstrated required skills and experience necessary to successfully complete the desired field work. The project HASP and other documents will identify other training requirements or access control requirements.

5 Equipment List

The equipment required for equipment decontamination is presented below. Note that certain contaminants may require specific materials be used that are not captured in this list. Always review project and contaminant specific TGIs or work plans to ensure proper equipment is utilized. Note for per- and polyfluoroalkyl substances (PFAS) see *TGI – Per- and Polyfluoroalkyl Substances (PFAS) Field Sampling Guide*.

- Health and safety equipment, including appropriate personal protective equipment (PPE), as required in the site HASP
- Deionized water that meets the analytical criteria for deionized water with no detectable constituents above the reporting limits for the methods to be used and analytes being analyzed for. Deionized water is used for inorganics, and organic-free water for volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), pesticides, etc.
- Non-phosphate detergent such as Alconox® or, if sampling for phosphorus or phosphorus-containing compounds, Liquinox (or equivalent). NOTE: Liquinox has shown to provide false positives for 1,4-Dioxane and should not be used at sites where that may be a constituent of concern (COC).
- Tap water
- Rinsate collection plastic containers

- Department of Transportation (DOT)-approved waste shipping container(s), as specified in the work plan, field sampling plan, or regulatory requirements if decontamination waste is to be shipped for disposal
- Brushes
- Large heavy-duty garbage bags
- Spray bottles
- (Optional) – Isopropyl alcohol (free of ketones) or methanol. These can be wipes or diluted with water (usually 1part isopropyl/methanol to 10 parts water) if a spray is needed.
- Airtight, sealable plastic baggies, such as Ziploc®-type
- Plastic sheeting

6 Cautions

Rinse equipment thoroughly and allow the equipment to dry before re-use or storage to prevent introducing solvent into sample medium. If manual drying of equipment is required, use clean lint-free material to wipe the equipment dry. Ensure all rinse materials do not adversely affect sample collection efficiency or analytical results.

Store decontaminated equipment in a clean, dry environment. Do not store near combustion engine exhausts. Properly containerize equipment to ensure cross-contamination doesn't happen from other uncontaminated surfaces or equipment.

If equipment is damaged to the extent that decontamination is uncertain due to cracks, gouges, crevices, or dents, the equipment should not be used and should be discarded or submitted for repair prior to use for sample collection.

A proper shipping determination regarding hazardous materials will be performed by a DOT-trained individual for cleaning materials shipped by Arcadis.

Caution should be exercised to avoid contact with the pump casing and water in the container while the pump is running (do not use metal drums or garbage cans) to avoid electric shock.

7 Health and Safety Considerations

Review the safety data sheets (SDS) for the cleaning agents and materials used in decontamination. If solvent is used during decontamination, use appropriate PPE and work in a well-ventilated area and stand upwind while applying solvent to equipment. Apply solvent in a manner that minimizes potential for exposure to workers and bystanders. Follow health and safety procedures outlined in the HASP.

8 Procedure

A designated area will be established to clean sampling equipment in the field prior to and following sample collection. Equipment cleaning areas will be set up within or adjacent to the specific work area, but not at a location that expose equipment to contamination (i.e., exposed to combustion engine exhaust). Detergent solutions will be prepared in clean containers for use in equipment decontamination. Decontaminated equipment

will be handled by workers wearing clean gloves, properly changed to prevent cross-contamination. The procedures detailed in this section provide an overview of common decontamination techniques. Additional steps may be required based on the type of contaminant present or client/site requirements.

Cleaning Sampling Equipment

1. Wash the equipment/pump with potable water.
2. Wash with detergent solution (Alconox®, Liquinox® or equivalent) to remove all visible particulate matter and any residual oils or grease. NOTE: Liquinox® has shown to provide false positives for 1,4-Dioxane and will not be used at sites where that may be a COC.
3. If equipment is very dirty, precleaning gross debris with a brush and tap water may be necessary.
4. If non-aqueous phase liquids are present, the use of isopropyl alcohol (free of ketones) or methanol is recommended. Cloth wipes or diluted solution can be used to remove the non-aqueous phase liquids that are hard to remove with detergent solution in step 2. Consult with project manager if non-aqueous phase liquids are present onsite and design an appropriate decontamination procedure that includes step 4.
5. Rinse with deionized water.

Decontaminating Submersible Pumps

Submersible pumps may be used during well development, groundwater sampling, or other investigative activities. The pumps must be cleaned and flushed before and between uses. This cleaning process will consist of an external detergent solution wash and tap water rinse, a flush of detergent solution through the pump, followed by a flush of potable water through the pump. Flushing will be accomplished by using an appropriate container filled with detergent solution and another container filled with potable water. The pump will be flushed with deionized water as the last step prior to use. The pump will run long enough to effectively flush the pump housing and hose (unless new, disposable hose is used). Disconnect the pump from the power source before handling. The pump and hose will be placed on or in clean polyethylene sheeting to avoid contact with the ground surface.

9 Waste Management

Equipment decontamination rinsate will be managed in conjunction with all other waste produced during the field sampling effort. Waste management procedures are outlined in the work plan or Waste Management Plan (WMP).

10 Data Recording and Management

Digital data collection is the Arcadis standard using available FieldNow® applications that enable real-time, paperless data collection, entry, and automated reporting. Paper forms should only be used as backup to FieldNow® digital data collection and/or as necessary to collect data not captured by available FieldNow® applications. The Field Now® digital form applications follow a standardized approach, correlate to most TGIs and are available to all projects accessible with a PC or capable mobile device. Once the digital forms are saved within FieldNow®, the data is instantly available for review on a web interface. This facilitates review by project management team members and SMEs enabling error or anomalous data detection for correction while the staff

are still in the field. Continual improvements of FieldNow® applications are ongoing, and revisions are made as necessary in response to feedback from users and subject matter experts.

Equipment cleaning and decontamination will be noted during project documentation. Information will include the type of equipment cleaned, the decontamination location, specific procedures utilized, solvents and/or cleaning agents used, source of water, and deviations or omissions from this TGI.

Unusual field conditions should be noted if there is potential to impact the efficacy of the decontamination or subsequent sample collection.

An inventory of the solvents brought on site and used and removed from the site will be maintained in the project documentation. Records will be maintained for solvents used in decontamination, including lot number and expiration date.

Containers with decontamination fluids will be labeled.

11 Quality Assurance

Equipment blanks should be collected to verify that the decontamination procedures are effective in minimizing potential for cross contamination. The equipment blank is prepared by pouring deionized water (or organic-free water, for organic analyses) over the clean and dry tools and collecting the water into appropriate sample containers. Equipment blanks should be analyzed for the same set of parameters that are performed on the field samples collected with the equipment that was cleaned as specified in the sampling and analysis plan. Equipment blanks are collected per equipment set, which represents all the tools needed to collect a specific sample.

12 References

USEPA Region 9 - Field Sampling Guidance #1230, Sampling Equipment Decontamination.

USEPA Region 1 - Low Stress (low flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells.

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