State of Wisconsin
Department of Natural Resources
PO Box 7921, Madison WI 53707-7921
dnr.wi.gov

Technical Assistance, Environmental Liability Clarification or Post-Closure Modification Request

Notice: Use this form to request **a written response (on agency letterhead)** from the Department of Natural Resources (DNR) regarding technical assistance, a post-closure change to a site, a specialized agreement or liability clarification for Property with known or suspected environmental contamination. A fee will be required as is authorized by s. 292.55, Wis. Stats., and NR 749, Wis. Adm. Code., unless noted in the instructions below. Personal information collected will be used for administrative purposes and may be provided to requesters to the extent required by Wisconsin's Open Records law [ss. 19.31 - 19.39, Wis. Stats.].

Definitions

"Property" refers to the subject Property that is perceived to have been or has been impacted by the discharge of hazardous substances.

"Liability Clarification" refers to a written determination by the Department provided in response to a request made on this form. The response clarifies whether a person is or may become liable for the environmental contamination of a Property, as provided in s. 292.55, Wis. Stats.

"Technical Assistance" refers to the Department's assistance or comments on the planning and implementation of an environmental investigation or environmental cleanup on a Property in response to a request made on this form as provided in s. 292.55, Wis. Stats.

"Post-closure modification" refers to changes to Property boundaries and/or continuing obligations for Properties or sites that received closure letters for which continuing obligations have been applied or where contamination remains. Many, but not all, of these sites are included on the GIS Registry layer of RR Sites Map to provide public notice of residual contamination and continuing obligations.

Select the Correct Form

This from should be used to request the following from the DNR:

- Technical Assistance
- Liability Clarification
- Post-Closure Modifications
- Specialized Agreements (tax cancellation, negotiated agreements, etc.)

Do not use this form if one of the following applies:

- Request for an **off-site liability exemption or clarification** for Property that has been or is perceived to be contaminated by one or more hazardous substances that originated on another Property containing the source of the contamination. Use DNR's Off-Site Liability Exemption and Liability Clarification Application Form 4400-201.
- Submittal of an Environmental Assessment for the **Lender Liability Exemption**, s 292.21, Wis. Stats., **if no response or review by DNR is requested**. Use the Lender Liability Exemption Environmental Assessment Tracking Form 4400-196.
- Request for an **exemption to develop on a historic fill site** or licensed landfill. Use DNR's Form 4400-226 or 4400-226A.
- **Request for closure** for Property where the investigation and cleanup actions are completed. Use DNR's Case Closure - GIS Registry Form 4400-202.

All forms, publications and additional information are available on the internet at: dnr.wi.gov/topic/Brownfields/Pubs.html.

Instructions

1. Complete sections 1, 2, 6 and 7 for all requests. Be sure to provide adequate and complete information.
2. Select the type of assistance requested: Section 3 for technical assistance or post-closure modifications, Section 4 for a written determination or clarification of environmental liabilities; or Section 5 for a specialized agreement.
3. Include the fee payment that is listed in Section 3, 4, or 5, unless you are a "Voluntary Party" enrolled in the Voluntary Party Liability Exemption Program **and** the questions in Section 2 direct otherwise. Information on to whom and where to send the fee is found in Section 8 of this form.
4. Send the completed request, supporting materials and the fee to the appropriate DNR regional office where the Property is located.

   See the map on the last page of this form. A paper copy of the signed form and all reports and supporting materials shall be sent with an electronic copy of the form and supporting materials on a compact disk. For electronic document submittal requirements see: http://dnr.wi.gov/files/PDF/pubs/rr/RR690.pdf"

The time required for DNR's determination varies depending on the complexity of the site, and the clarity and completeness of the request and supporting documentation.

Section 1. Contact and Recipient Information

Requester Information

This is the person requesting technical assistance or a post-closure modification review, that his or her liability be clarified or a specialized agreement and is identified as the requester in Section 7. DNR will address its response letter to this person.

Last Name	First	MI	Organization/ Business Name		
Wahl	Scott		Tyco Fire Products LP		
Mailing Address			City	State	ZIP Code
2700 Industrial Parkway South			Marinette	WI	54143
Phone # (include area code)	Fax # (include area code)		Email		

The requester listed above: (select all that apply)

- [x] Is currently the owner
- [ ] Is considering selling the Property
- [ ] Is renting or leasing the Property
- [ ] Is considering acquiring the Property
- [ ] Is a lender with a mortgagee interest in the Property
- [ ] Other. Explain the status of the Property with respect to the applicant:

Contact Information (to be contacted with questions about this request)

☐ Select if same as requester

Contact Last Name	First	MI	Organization/ Business Name		
Milionis	Peter		Arcadis		
Mailing Address			City	State	ZIP Code
126 N Jefferson Street, Suite 400			Milwaukee	WI	53202
Phone # (include area code)	Fax # (include area code)		Email		
(267) 285-1815			peter.milionis@arcadis.com		

Environmental Consultant (if applicable)

Contact Last Name	First	MI	Organization/ Business Name		
Milionis	Peter		Arcadis		
Mailing Address			City	State	ZIP Code
126 N Jefferson Street, Suite 400			Milwaukee	WI	53202
Phone # (include area code)	Fax # (include area code)		Email		
(267) 285-1815			peter.milionis@arcadis.com		

Section 2. Property Information

Property Name			FID No. (if known)		
Tyco Fire Technology Center - PFCs			438005590		
BRRTS No. (if known)			Parcel Identification Number		
0238580694					
Street Address			City	State	ZIP Code
2700 Industrial Parkway South			Marinette	WI	54143
County	Municipality where the Property is located		Property is composed of:		Property Size Acres
Marinette	◉ City ◯ Town ◯ Village of Marinette		◯ Single tax parcel ◯ Multiple tax parcels		380

1. Is a response needed by a specific date? (e.g., Property closing date) Note: Most requests are completed within 60 days. Please plan accordingly.

◉ No ○ Yes

Date requested by: _____

Reason:

_____

2. Is the "Requester" enrolled as a Voluntary Party in the Voluntary Party Liability Exemption (VPLE) program?

◉ No. **Include the fee that is required for your request in Section 3, 4 or 5.**

○ Yes. **Do not include a separate fee.** This request will be billed separately through the VPLE Program.

Fill out the information in Section 3, 4 or 5 which corresponds with the type of request:
Section 3. Technical Assistance or Post-Closure Modifications;
Section 4. Liability Clarification; or Section 5. Specialized Agreement.

Section 3. Request for Technical Assistance or Post-Closure Modification

Select the type of technical assistance requested: [**Numbers in brackets are for WI DNR Use]**

☐ No Further Action Letter (NFA) (Immediate Actions) - NR 708.09, [183] - **Include a fee of $350.** Use for a written response to an immediate action after a discharge of a hazardous substance occurs. Generally, these are for a one-time spill event.

☐ Review of Site Investigation Work Plan - NR 716.09, [135] - **Include a fee of $700.**

☐ Review of Site Investigation Report - NR 716.15, [137] - **Include a fee of $1050.**

☐ Approval of a Site-Specific Soil Cleanup Standard - NR 720.10 or 12, [67] - **Include a fee of $1050.**

☐ Review of a Remedial Action Options Report - NR 722.13, [143] - **Include a fee of $1050.**

☐ Review of a Remedial Action Design Report - NR 724.09, [148] - **Include a fee of $1050.**

☐ Review of a Remedial Action Documentation Report - NR 724.15, [152] - **Include a fee of $350**

☒ Review of a Long-term Monitoring Plan - NR 724.17, [25] - **Include a fee of $425.**

☐ Review of an Operation and Maintenance Plan - NR 724.13, [192] - **Include a fee of $425.**

Other Technical Assistance - s. 292.55, Wis. Stats. [97] (For request to build on an abandoned landfill use Form 4400-226)

☐ Schedule a Technical Assistance Meeting - **Include a fee of $700.**

☐ Hazardous Waste Determination - **Include a fee of $700.**

☐ Other Technical Assistance - **Include a fee of $700.** Explain your request in an attachment.

Post-Closure Modifications - NR 727, [181]

☐ Post-Closure Modifications: Modification to Property boundaries and/or continuing obligations of a closed site or Property; sites may be on the GIS Registry. This also includes removal of a site or Property from the GIS Registry. **Include a fee of $1050, and:**

☐ Include a fee of $300 for sites with residual soil contamination; and

☐ Include a fee of $350 for sites with residual groundwater contamination, monitoring wells or for vapor intrusion continuing obligations.

Attach a description of the changes you are proposing, and documentation as to why the changes are needed (if the change to a Property, site or continuing obligation will result in revised maps, maintenance plans or photographs, those documents may be submitted later in the approval process, on a case-by-case basis).

Skip Sections 4 and 5 if the technical assistance you are requesting is listed above and complete Sections 6 and 7 of this fo

Section 6. Other Information Submitted

Identify all materials that are included with this request.

Send both a paper copy of the signed form and all reports and supporting materials, and an electronic copy of the form and all reports, including Environmental Site Assessment Reports, and supporting materials on a compact disk.

Include one copy of any document from any state agency files that you want the Department to review as part of this request. The person submitting this request is responsible for contacting other state agencies to obtain appropriate reports or information.

☐ Phase I Environmental Site Assessment Report - Date: _____

☐ Phase II Environmental Site Assessment Report - Date: _____

☐ Legal Description of Property (required for all liability requests and specialized agreements)
☐ Map of the Property (required for all liability requests and specialized agreements)
Analytical results of the following sampled media: Select all that apply and include date of collection.
☐ Groundwater ☐ Soil ☐ Sediment ☐ Other medium - Describe: _____
Date of Collection: _____
☐ A copy of the closure letter and submittal materials
☐ Draft tax cancellation agreement
☐ Draft agreement for assignment of tax foreclosure judgment WDNR Fee Check #: 318719
☒ Other report(s) or information - Describe: LTMP for the GETS: Pre-Startup through Initial Years of Operation

For Property with newly identified discharges of hazardous substances only: Has a notification of a discharge of a hazardous substance been sent to the DNR as required by s. NR 706.05(1)(b), Wis. Adm. Code?

◯ Yes - Date (if known): _____
◯ No

Note: The Notification for Hazardous Substance Discharge (non-emergency) form is available at: dnr.wi.gov/files/PDF/forms/4400/4400-225.pdf.

Section 7. Certification by the Person who completed this form

☐ I am the person submitting this request (requester)
☒ I prepared this request for: Scott Wahl
Requester Name

I certify that I am familiar with the information submitted on this request, and that the information on and included with this request is true, accurate and complete to the best of my knowledge. I also certify I have the legal authority and the applicant's permission to make this request.

Signature

7/8/2021
Date Signed

Project Environmental Specialist
Title

(312) 575-3732
Telephone Number (include area code)

Section 8. DNR Contacts and Addresses for Request Submittals

Send or deliver one paper copy and one electronic copy on a compact disk of the completed request, supporting materials, and fee to the region where the property is located to the address below. Contact a DNR regional brownfields specialist with any questions about this form or a specific situation involving a contaminated property. For electronic document submittal requirements see: http://dnr.wi.gov/files/PDF/pubs/rr/RR690.pdf.

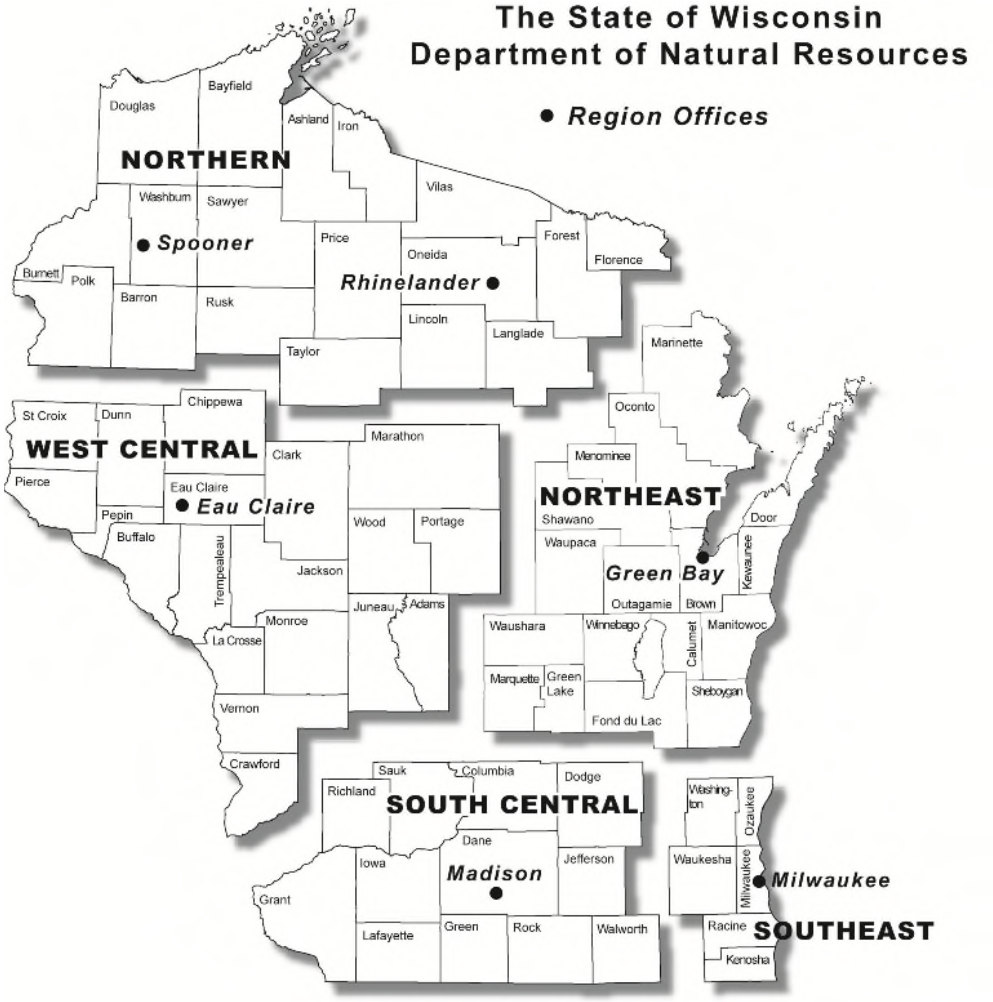
DNR NORTHERN REGION
Attn: RR Program Assistant
Department of Natural Resources
223 E Steinfest Rd Antigo, WI 54409

DNR NORTHEAST REGION
Attn: RR Program Assistant
Department of Natural Resources
2984 Shawano Avenue
Green Bay WI 54313

DNR SOUTH CENTRAL REGION
Attn: RR Program Assistant
Department of Natural Resources
3911 Fish Hatchery Road
Fitchburg WI 53711

DNR SOUTHEAST REGION
Attn: RR Program Assistant
Department of Natural Resources
2300 North Martin Luther King Drive
Milwaukee WI 53212

DNR WEST CENTRAL REGION
Attn: RR Program Assistant
Department of Natural Resources
1300 Clairemont Ave.
Eau Claire WI 54702



Note: These are the Remediation and Redevelopment Program's designated regions. Other DNR program regional boundaries may be different.

DNR Use Only			
Date Received	Date Assigned	BRRTS Activity Code	BRRTS No. (if used)
DNR Reviewer	Comments		
Fee Enclosed? ◯ Yes ◯ No	Fee Amount $	Date Additional Information Requested	Date Requested for DNR Response Letter
Date Approved	Final Determination		

Tyco Fire Products LP

Long-Term Monitoring Plan for the Groundwater Extraction and Treatment System

Tyco Fire Technology Center – Marinette, Wisconsin
BRRTS No. 02-38-580694

July 2021

Long-Term Monitoring Plan for the Groundwater Extraction and Treatment System

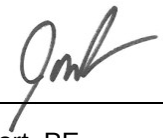
Tyco Fire Technology Center – Marinette, Wisconsin
BRRTS No. 02-38-580694

July 16, 2021

Prepared By:
Arcadis U.S., Inc.
126 North Jefferson Street
Suite 400
Milwaukee
Wisconsin 53202
Phone: 414 276 7742
Fax: 414 276 7603

Prepared for:
Tyco Fire Products LP
2700 Industrial Parkway South
Marinette
Wisconsin 54143

Christopher S. Peters, PG
Principal Geologist



Jon Forbort, PE
Principal Engineer

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Acronyms and Abbreviations

Arcadis	Arcadis U.S., Inc.
BRRTS	Bureau for Remediation and Redevelopment Tracking System
Ditch B SWTS	Ditch B interim remedial action surface water treatment system
FTC	Fire Technology Center
GETS	groundwater extraction and treatment system
LTM	long-term monitoring
ng/L	nanograms per liter
NR	Natural Resources
OMM	operation, maintenance, and monitoring
PFAS	per- and poly-fluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PVC	polyvinyl chloride
PZ	piezometer
QAPP	Quality Assurance Project Plan
RADR	Remedial Action Design Report
Site	Fire Technology Center located at 2700 Industrial Parkway South, Marinette, Wisconsin
SWTS	surface water treatment system
Tyco	Tyco Fire Products LP
WDNR	Wisconsin Department of Natural Resources

1 Introduction

This document describes the Long-Term Monitoring (LTM) Plan for the groundwater extraction and treatment system (GETS) associated with the Tyco Fire Products LP (Tyco) Fire Technology Center (FTC) located at 2700 Industrial Parkway South in Marinette, Wisconsin (the Site; **Figure 1**). This document is applicable from approximately 6 months prior to startup of the GETS through the first 2 years of operation at which time a subsequent revision will be evaluated. The area of the GETS addressed by this LTM Plan is shown on **Figure 2**. The proposed GETS system components will be constructed on portions of the Site and off-site areas within the City of Marinette.

As described in the Remedial Action Design Report (RADR; Arcadis 2021), the primary objectives of the proposed GETS interim remedy are to reduce the per- and poly-fluoroalkyl substances (PFAS) groundwater plume upwelling into Ditch B, treat PFAS mass existing in the recovered groundwater, and significantly reduce PFAS mass flux throughout the groundwater plume.

The LTM Plan is designed to evaluate and document performance of the GETS interim remedy, specifically its effect on PFAS concentrations in groundwater and surface water within the Site and off-site areas proposed for GETS implementation. The LTM Plan will also assess whether operation of the GETS has potential secondary effects, including changed flow in Ditch B or changed conditions of wetlands within the project areas. This LTM Plan is not intended to address the full site-wide extent of PFAS impacts associated with the FTC. Tyco anticipates that the GETS LTM Plan will form a component of a future site-wide monitoring program, to be developed after site characterization is complete.

Construction of the GETS is planned to begin in the fourth quarter of 2021, with startup expected in 2022. A Commissioning Plan is included as **Appendix A**. The Commissioning Plan describes the sequencing of the startup of extraction wells and treatment system, the monitoring and decision framework for selecting the extraction well pumping rates and treatment parameters, and stop conditions or contingency plans based on monitoring results.

The monitoring program presented in this LTM Plan will commence in the pre-startup period and will continue for the lifespan of the GETS. The LTM Plan is organized into the following four phases:

- **Pre-Startup Phase** (GETS permitting and construction period), in which the data collected will be used to establish baseline conditions and further the understanding of seasonal effects on the interaction between groundwater and surface water within Ditch B.
- **Startup Phase** (first 6 months of operation), in which the data will be used to evaluate initial system performance, troubleshoot and optimize system operation, and develop an understanding of the sensitivity of system operations to changing seasonal conditions.
- **Short-Term Monitoring Phase** (2-year period after startup phase), in which the data collected will be used to track performance of the system toward meetings the remedial goals and provide information to optimize operations.
- **Long-Term Monitoring Phase,** in which data will be collected at a reduced frequency to demonstrate continued effectiveness of the system, and provide data for further system optimization, as needed.

The remainder of this LTM Plan describes the proposed monitoring tasks, monitoring data objectives, schedule, and methods to be employed. The RADR describes the GETS system design, including installation of new

extraction and monitoring wells proposed to be monitored as part of the LTM Plan. Sampling protocols, analytical methods, and quality assurance/quality control measures applicable to this plan are documented in the Draft Quality Assurance Project Plan (QAPP; Arcadis 2020).

2 Long-Term Monitoring Plan Components

The LTM Plan includes six major components. This section describes each data type, the purpose of collecting the data, data collection locations, and the performance objectives against which the data will be compared, if applicable. The sampling schedule for each data type is described in Section 3. Sampling methods are described in Section 4.

2.1 Surface Water Sampling

Data Type	Ditch B surface water PFAS concentrations
Purpose	• Monitor baseline seasonal variability (pre-startup period) • Evaluate GETS effectiveness at reducing PFAS concentrations in Ditch B
Monitoring Locations	• Seasonal (when the ditch surface water is not frozen) samples from seven locations in Ditch B between Industrial Parkway South and Shore Drive as shown on **Figure 3** and listed in **Table 1** • Year-round influent sampling at the existing Ditch B interim remedial action surface water treatment system (Ditch B surface water treatment system [SWTS])
Performance Objective	• Eventual compliance with current Wisconsin Department of Natural Resources (WDNR) surface water criteria of 11 nanograms per liter (ng/L) for perfluorooctanesulfonic acid (PFOS) and 420 ng/L for perfluorooctanoic acid (PFOA)

The surface water sampling program is designed to monitor only the areas of Ditch B within the influence of the GETS. Surface water quality of water flowing into this area from upstream will be monitored at location SG-U10 at Industrial Parkway South. The water quality of Ditch B exiting the area influenced by the GETS will be monitored at the Ditch B SWTS.

2.2 Streambed Groundwater Sampling

Data Type	Ditch B streambed groundwater PFAS concentrations
Purpose	• Monitor baseline seasonal variability (pre-startup period) • Evaluate influence of GETS on PFAS concentrations in groundwater just beneath Ditch B
Monitoring Locations	• Seasonal (when the ditch surface water is not frozen) samples from five mini-piezometer locations in Ditch B between Industrial Parkway South and Edwin Street as shown on **Figure 3** and listed in **Table 1**
Performance Objective	• No specific analytical target concentration • Data to be reviewed collectively with hydraulic data and surface water sampling results to assess the extent of GETS plume capture

The groundwater sampling program at the mini-piezometers will be completed concurrently with water level gauging and surface water sampling at the same locations in Ditch B.

2.3 Groundwater Sampling at Extraction Wells

Data Type	PFAS concentrations and groundwater pumping rates for extraction well network
Purpose	• Determine baseline groundwater quality (pre-startup period) • Evaluate individual well PFAS removal rates to support system optimization
Monitoring Locations	• Nine extraction wells (EX-1 to EX-9), shown on **Figure 2** and listed in **Table 2**
Performance Objectives	• No specific analytical target concentration • Data to be reviewed collectively with hydraulic data and surface water sampling results to adjust targeted pumping rates

2.4 Groundwater Sampling at Monitoring Wells

Data Type	Concentrations of PFAS and supplemental water quality parameters in groundwater
Purpose	• Determine baseline groundwater quality (pre-startup period) • Evaluate influence of GETS on PFAS concentrations in groundwater in the vicinity of Ditch B • Track changes in supplemental (non-PFAS) water quality that may affect GETS operations
Monitoring Locations	• 28[1] new and existing monitoring well and piezometer locations, as shown on **Figure 4** and listed in **Table 2**
Performance Objectives	• No specific analytical target concentration • Data to be reviewed collectively with hydraulic data and surface water sampling results to assess the extent of GETS plume capture • Evaluation of non-PFAS data for treatment system optimization

The proposed groundwater sampling network includes five new piezometers planned for installation during the pre-design period as part of system construction. Construction of the proposed additional wells is described in the RADR (Arcadis 2021).

The wells proposed for the groundwater sampling network fall into several groups:

- Wells located upgradient of the extraction network (e.g., location PZ-22 and proposed new piezometer location A)
- Wells located downgradient of the network (e.g., locations PZ-29 and PZ-30, on the far side of Ditch B)

[1] During the baseline sampling event, two additional monitoring wells will be sampled (i.e., total of 30 wells to be sampled). The results of the baseline monitoring event will be used to make the final selection of which of three similarly constructed deep sand unit monitoring wells on the eastern site-boundary (PZ-22D, PZ-18D and PZ-3) will be sampled for the remainder of the LTM program. If PFAS concentrations from all three wells are similar, PZ-22D will be used going forward in the LTM plan to provide continuity with existing historical results from that well. If the PFAS concentrations from either of the other wells are significantly higher (e.g., more than 15%), the well with the highest concentration will be substituted for PZ-22D for the remainder of the LTM program.

- Wells at locations peripheral to the area of GETS capture (e.g., location PZ-25 to the north and location PZ-24 to the south)
- Wells completed in shallow bedrock (both upgradient and downgradient of Ditch B).

As shown in **Table 2**, wells are grouped into three sampling lists. All 28 sampling locations are proposed for PFAS sampling in a baseline event and then semi-annually after startup. A focused list of 13 locations is proposed for quarterly PFAS sampling for the first 2 years of system operation. A "supplemental-analytes" list denotes locations where samples from the baseline and one semi-annual event per year will include the 24 additional analyses listed in **Table 3**. The focused list consists of wells screened in the depth zone with highest concentrations, which are expected to be most important for evaluating early time system performance. The baseline and semi-annual list includes additional wells screened at other depths within the sand aquifer where concentrations are lower and where changes in groundwater quality are expected to be most apparent on a longer time scale. The baseline and semi-annual list also includes three bedrock wells that fall within the GETS LTM Plan network. The supplemental-analyte sampling is intended to assess any potential changes in groundwater chemistry that may affect long-term operation of the treatment system.

The effects of the GETS operation will differ for each group of wells. While the design and placement of the GETS will allow it to intercept a high percentage of the estimated total mass in the plume, the system is not designed as a total plume remedy and is not designed to have a direct influence on bedrock groundwater. By monitoring areas peripheral to the influence of the GETS, Tyco will obtain data useful to identify potential future remedial options that may be appropriate for areas not addressed by the GETS.

2.5 Ditch B Flow Gauging

Data Type	Continuous Ditch B flow rate
Purpose	• Track seasonal and short-term changes in flow to assess whether changes affect GETS performance • Assess the effects of GETS operation on total flow in the ditch
Monitoring Location	• Existing flow gauging station at Ditch B SWTS
Performance Objectives	• No specific performance objectives • Data to be reviewed collectively with surface water sample results, Ditch B stage levels, and streambed groundwater levels to assess reductions in total PFAS load resulting from GETS operation

Continuous flow gauging is proposed at the existing gauging station located near the Ditch B SWTS, downstream of the area influenced by the GETS. As described in Section 2.6, the LTM Plan includes two continuous upstream stream-level gauges, as a proxy for flow, to help in assessing whether operation of the GETS affects hydrodynamic conditions in the ditch.

2.6 Ditch B Stage and Streambed Groundwater Levels

Data Type	Ditch B surface water levels and relative groundwater levels
Purpose	• Evaluate the relative difference between surface water and groundwater levels to assess the influence of the GETS on vertical gradients between groundwater and surface water • Monitor surface water elevations to incorporate in potentiometric surface mapping
Monitoring Locations	• Seasonal (when the ditch surface water is not frozen) measurements at five mini-piezometer locations on Ditch B between Industrial Parkway South and Edwin Street, as shown on **Figure 5** and listed in **Table 1** • Seasonal (when the ditch surface water is not frozen) surface water elevation gauging measurements at four surveyed benchmarks at four Ditch B road crossings at Industrial Parkway South, Pierce Avenue, Edwin Street, and Shore Drive • Continuous water-level gauging via transducers in stilling wells to be installed where Ditch B crosses Industrial Parkway South and Pierce Avenue (note that gauging may be discontinued in winter months if locations freeze)
Performance Objectives	• Water level measurements in mini-piezometers will be assessed to document reductions in the upwelling of PFAS in Ditch B between Industrial Parkway South and Edwin Street where discharging groundwater affects surface water criteria • Assessment of stage measurements to verify that GETS operation is not having unexpected adverse effects on ditch conditions (e.g., flooding or running dry) • Data to be reviewed collectively with surface water sample results to assess reductions in total PFAS load resulting from GETS operation

2.7 Groundwater Level Measurement

Data Type	Water levels at piezometers and monitoring wells
Purpose	• Evaluate hydraulic influence of GETS operation to demonstrate performance and make system adjustments to optimize operation • Assess condition of individual extraction wells to determine need for maintenance
Monitoring Locations	• Approximately 46[2] new and existing monitoring well and piezometer locations, as shown on **Figure 5** and listed in **Table 2**
Performance Objective	• Observable drawdown in vicinity of extraction wells that demonstrates hydraulic capture of the PFAS plume currently upwelling to Ditch B between Industrial Parkway South and Edwin Street

The proposed water-level gauging network includes wells located within the area expected to be directly influenced by pumping, and downgradient or sidegradient locations where pumping is unlikely to affect water levels. The breadth of the monitoring network will show the influence of GETS pumping within the context of a larger-scale potentiometric surface.

[2] See footnote 1. During the baseline sampling event, two additional monitoring wells will be gauged (i.e., total of 48 wells to be gauged).

As described in the RADR (Arcadis 2021), water levels in each extraction well will also be monitored continuously as a component of treatment system operation. Water levels from extraction wells will not be used directly for interpretation of capture or potentiometric surfaces, and therefore are not considered a component of this LTM Plan.

3 Monitoring Schedule

This section describes the anticipated schedule for data collection in each monitoring phase, including continuous flow monitoring that will span multiple phases. Specific monitoring locations and activities to be performed during each phase are indicated in **Table 1** (surface water) and **Table 2** (groundwater). The surface water and streambed groundwater sampling locations (i.e., mini-piezometers) are shown on **Figure 3**, and the monitoring well sampling locations are shown on **Figure 4**. The groundwater and surface water gauging locations are shown on **Figure 5**.

3.1 Continuous Monitoring

Continuous monitoring will be performed at three locations:

- Flow and stage measurements will be collected continuously at the existing Ditch B SWTS station.
- Stage measurements will be collected at a stilling well to be installed where Ditch B crosses Industrial Parkway South.
- Stage measurements will be collected at a stilling well to be installed where Ditch B crosses Pierce Road.

Continuous year-round flow and stage monitoring may not be feasible if freezing conditions affect instrument performance. If weather conditions may potentially result in damage to the gauging equipment, or the data they collect would be inaccurate (e.g., due to ice-jams), systems may be pulled and redeployed when open-water conditions return in the spring.

The existing flow meter at the Ditch B SWTS is currently in operation and is expected to continue for the lifespan of the Ditch B SWTS. Measurements are recorded every 5 minutes. Stage measurements at stilling wells will be recorded by transducers at a frequency of every 30 minutes. Data will be downloaded during each LTM event.

Continuous flow gauging as a component of the GETS LTM Plan may be discontinued after the short-term monitoring period. Tyco intends to provide a recommendation to continue or discontinue continuous gauging based on an assessment of the data's usefulness in maintaining effective system operation or demonstrating compliance with remedial goals.

Additional continuous monitoring will be completed as a component of the GETS operations. These data will include continuous water-level and pumping rate measurements at each extraction well, and the flow rate of treated water discharged from the system into Ditch B. Collection of these data is described in the RADR (Arcadis 2021).

3.2 Pre-Startup Phase

The pre-startup monitoring phase coincides with the period of permitting and construction of the GETS. The pre-startup monitoring phase is expected to begin in April 2021 and end when the GETS goes online (end of year 2021). The schedule of monitoring activities in the pre-startup phase is summarized below.

Pre-Startup Activities and Frequency

Media	Activity	Approximate Frequency (Duration: approximately 6 months)
Groundwater	Water-level gauging at monitoring wells	Two events
	Groundwater sampling (baseline event)	One baseline event, after the complete well network is in place
Surface Water	Water-level gauging at surveyed gauging locations	Every 2 months (total of three events)
	Water-level gauging at mini-piezometers	
	Surface water and mini-piezometer groundwater sampling	
	Ditch B SWTS influent sampling	Monthly

3.3 Startup Phase

The startup monitoring phase will begin after the GETS goes online and continue for the first 6 months of the GETS operation. The schedule of monitoring activities in the startup phase is summarized below.

Startup Activities and Frequency

Media	Activity	Approximate Frequency (Duration: 6 months)
Groundwater	Water-level gauging at monitoring wells	Monthly
	Groundwater sampling at monitoring wells	Two events at quarterly intervals
	Groundwater sampling at extraction wells	Monthly after pumping initiated at well
Surface Water	Water-level gauging at surveyed gauging locations	Monthly when the ditch surface water is not frozen
	Water-level gauging at mini-piezometers	
	Surface water and mini-piezometer groundwater sampling	
	Ditch B SWTS influent sampling	Monthly

3.4 Short-Term Monitoring Phase

The short-term monitoring phase will start after the GETS startup monitoring phase is completed and continue for 2 years. The schedule of monitoring activities in the short-term phase is summarized below.

Short-Term Monitoring Activities and Frequency

Media	Activity	Approximate Frequency (Duration: 2 years)
Groundwater	Water-level gauging at monitoring wells	Quarterly for 6 events, then semi-annually
	Groundwater sampling	
Surface Water	Water-level gauging at surveyed gauging locations	Three events per year on a quarterly interval when the ditch surface water is not frozen
	Water-level gauging at mini-piezometers	
	Surface water and mini-piezometer groundwater sampling	
	Ditch B SWTS influent sampling	Monthly

Quarterly groundwater monitoring is proposed for a total of eight consecutive quarters for the startup and short-term monitoring phases (two and six events, respectively). After the eighth event, the sampling frequency will be reduced to semi-annually. During the period of quarterly groundwater monitoring, samples will be collected from a focused group of monitoring wells (approximately 13 wells) for two of the four quarters each year; 2 quarters of each year will be a larger semi-annual event comprising an additional 15 sampling locations. During one of the two semi-annual events, the annual sampling for supplemental analytes listed in **Table 3** will also be completed at six locations. **Table 2** identifies the wells in each sampling group.

3.5 Long-Term Monitoring Phase

The long-term monitoring phase is expected to continue for the lifespan the GETS. The anticipated schedule of monitoring activities in the long-term phase is summarized below. A revised scope of the long-term monitoring phase will be provided in a work plan to be prepared at the conclusion of the short-term monitoring phase.

Long-Term Monitoring Activities and Frequency

Media	Activity	Approximate Frequency
Groundwater	Water-level gauging at monitoring wells	Annually
	Groundwater sampling	
Surface Water	Water-level gauging at surveyed gauging locations	Annually
	Water-level gauging at mini-piezometers	Twice a year until surface water goals are met, then discontinued
	Surface water and mini-piezometer groundwater sampling	Twice a year; sampling at mini-piezometers will be discontinued after surface water goals are met
	Ditch B SWTS influent sampling	Monthly

After surface water goals have been met, Tyco will discontinue monitoring using mini-piezometers. Surface water samples will continue to be collected at the same locations; however, the mini-piezometers (which may need to be installed and removed annually) will be removed permanently. Groundwater sampling at mini-piezometers will also be discontinued.

3.6 Monitoring Scope and Schedule Changes

As monitoring is completed, Tyco will review results to assess whether the current scope and frequency of the LTM Plan remain appropriate. Changes to the plan may be recommended if these data reviews indicate that:

- Additional data points are needed to meet LTM Plan objectives.
- Alternate sampling or monitoring locations are identified as more useful than ones currently in the plan.
- Sampling or monitoring frequency of certain data should be modified.
- Sampling or monitoring locations are no longer needed.

Changes to the scope of the LTM Plan may be reviewed for alignment with other potential monitoring programs enacted for the project in the future. All recommended changes to the plan will be provided to WDNR in writing for consideration, in accordance with Natural Resources (NR) 724.13(3).

3.7 Contingency Actions

If an unplanned shutdown to the GETS occurs, monitoring will continue according to the plan above, to the extent feasible. Planned samples from extraction wells will not be collected if the treatment plant or individual well pumps are offline.

Supplemental monitoring relating to unplanned shutdowns or other treatment system operational upsets will occur according to the contingency plan presented in Section 3.5 of the Commissioning Plan (**Appendix A**). This supplemental monitoring contingency plan is intended to continue to be applicable during system operation after the Startup Phase (i.e., when the Commissioning Plan will be implemented). Operational upsets may occur due to process, mechanical, electrical and instrumentation upsets or failure. Note that contingency plan monitoring is focused on treatment system operation to achieve WPDES permit limits. No supplemental monitoring in Ditch B is planned in the event of an unplanned system shutdown because work will be focused on determining the cause of the unplanned shut down.

To assess how quickly system interruptions may affect conditions in Ditch B, a one-time supplemental rebound monitoring program will be implemented in the event of a planned system shut-down lasting 4 or more days. This program would be implemented no sooner than 1 month after the Complete System Stage of Startup (Section 3.3.3 of the Commissioning Plan; **Appendix A**). The rebound monitoring will include:

- Gauging surface water levels and relative groundwater levels at the five mini-piezometers in Ditch B to assess changes is the gradient between groundwater and surface water.
- Collecting a surface water PFAS sample at the influent of the Ditch B SWTS to assess potential changes in surface water concentrations.

The monitoring described above will be performed on a decreasing sampling frequency for up to 1 month. The number of events will be contingent on the length of the shutdown, based on the following schedule:

- One monitoring event 1 to 2 days prior to system shutdown
- On days 2, 4 and 7 days after shutdown
- Weekly after the first 7 days for up to 3 weeks.

Note that the above rebound monitoring program will only be conducted once, if a planned shutdown is needed. If a planned shutdown is not needed, the rebound monitoring will not be conducted (i.e., the system will not be taken offline for an extended period expressly to complete the rebound program.)

4 Field Methods

The field methodologies for groundwater and surface water monitoring are described in this section.

4.1 Groundwater Monitoring

4.1.1 Manual Water-Level Measurements

Water elevations will be manually measured using a water-level meter at existing and proposed monitoring wells/piezometers (**Table 2**). When gauging and sampling events occur concurrently, water elevations will be measured prior to sample collection. Monitoring wells will be gauged for depth to water and depth to the bottom of the well.

4.1.2 Groundwater Sample Collection

Low-flow sampling procedures will be implemented for groundwater sampling, using a peristaltic pump and dedicated down-well disposable tubing, at existing and proposed monitoring wells/piezometers and proposed extraction wells (**Table 2**). Analytical samples will be collected after groundwater parameters measured with a field probe, including dissolved oxygen, pH, specific conductivity, and oxidation-reduction potential, are shown to have stabilized at each well in accordance with the QAPP (Arcadis 2020) procedures. Samples will be collected for PFAS analysis following the procedures described in **Section 5**.

A subset of groundwater samples will be periodically collected and analyzed for additional analytical parameters at selected wells (**Table 2**). Additional parameters that may be included in the analyses of select wells are as follows: target analyte list total and dissolved metals, total dissolved solids, total suspended solids, alkalinity, sulfate, nitrate, nitrite, ammonia, total Kjeldahl nitrogen, chloride, salinity, volatile organic compounds, semi-volatile organic compounds, total organic carbon, dissolved organic carbon, total and dissolved biological oxygen demand, total and dissolved chemical oxygen demand, pH, and Langelier Saturation Index.

4.2 Surface Water Monitoring

4.2.1 Ditch B Flow Measurements

Continuous flow measurements will be recorded at the Ditch B SWTS station using the existing SonTek-IQ Series stream flowmeter. The stream flowmeter is connected to the treatment system power supply and telemetry system for data logging. The telemetry system records on a 5-minute interval the stream velocity (feet per second) and depth (inches) measurements and the calculated stream flow (cubic feet per second). The instrument uses SonTek's exclusive SmartPulse$^{HD®}$ adaptive sampling technology, which has four, pulsed Doppler velocity beams for measuring the velocity of the channel cross section. The instrument also uses a self-calibrating water-level vertical beam and pressure sensor for measuring depth. The channel cross-section geometry was entered into the instrument software by the manufacturer during the installation and calibration of the instrument. The instrument software has specialized flow algorithms that use the measured cross-sectional area of the channel along with the velocity and depth measurements to calculate the stream flow at that location.

4.2.2 Ditch B Stage Measurements

Measurements of the surface elevation of Ditch B will be collected at surveyed benchmarks at locations where the ditch is crossed by roads. A clearly marked surveyed measuring point will be established at each location on a permanent structure (e.g., bridge deck or culvert lip) where water level may be measured using a tape or rod extending directly down to the water surface.

Continuous stage measurements will be collected using data-logging pressure transducers deployed in stilling wells. The stilling wells will be constructed of slotted polyvinyl chloride (PVC) pipe anchored in the ditch to a secure post or mounted to a culvert/overpass or other structures, with the bottom of the pipe approximately 4 inches above the sediment surface. Transducers will be secured in each stilling well and programmed to record relative change in water level every 30 minutes. Relative water levels will be converted to absolute elevations by making synchronous manual water-level measurements at adjacent surveyed measuring points.

4.2.3 Mini-Piezometer Installation

Each mini-piezometer will be constructed of a ¾-inch inner-diameter well point with a stainless steel 6-inch-long 50-mesh (297-micrometer) well screen attached to galvanized metal standpipe. The mini-piezometers will be manually driven into the sediment until the top of the screened interval is approximately 3 feet below the ditch bottom. The locations of each mini-piezometer will be recorded using a hand-held global positioning system device. The temporary mini-piezometers will be removed from the ditch prior to the ditch freezing over (i.e., late November/early December).

4.2.4 Manual Water-Level Measurements

Relative groundwater and surface water-level measurements will be taken at mini-piezometers (i.e., depth to groundwater inside mini-piezometer and depth to surface water adjacent to mini-piezometer, both referencing a common point on the top of the standpipe) identified in **Table 1**.

4.2.5 Sample Collection

The influent to the existing Ditch B SWTS will continue to be monitored. Additionally, surface water and groundwater sampling at mini-piezometers is included in the pre-startup, startup, and short-term phases of the monitoring plan (**Table 1**). Surface water samples will be collected by dipping a sample bottle below the surface of the water. Groundwater samples at mini-piezometers will be collected using a disposable bailer. Samples will be analyzed for PFAS following the procedures described in **Section 5**.

5 Quality Assurance and Quality Control

5.1 Special Considerations for PFAS Sampling

The detection of PFAS compounds at very low concentrations can be influenced by common PFAS-containing materials that may be present at the sampling site. Therefore, to minimize the potential for cross-contamination, special attention will be given to sampling materials (e.g., tubing), decontamination procedures, and clothing and personal care products used by sampling personnel. Detailed standard operating procedures that will be followed during investigation activities are provided in the Draft QAPP submitted to WDNR on April 15, 2020 (Arcadis 2020).

Quality assurance samples are specified in the QAPP for each type of media to be sampled. Sampling for PFAS compounds will include the submission of one laboratory-supplied field reagent blank per day to detect the presence of ambient PFAS in the sampling area that may influence samples during collection. PFAS-free water used for the field reagent blank sample will be brought to the Site in a laboratory-supplied bottle. Field staff will transfer the laboratory-supplied PFAS-free water into an empty sample bottle. This field reagent blank will be placed in the same cooler as other samples intended for PFAS analyses.

Equipment will be decontaminated with PFAS-free water between use at each sampling location. Only Alconox, Liquinox, or methanol will be used as decontamination materials. To assess the adequacy of the decontamination process, an equipment rinsate blank will be collected every 20 samples or per day, whichever is more frequent. To prepare a rinsate blank, a sample of PFAS-free water will be poured over or through decontaminated field equipment before collection of environmental samples.

5.2 Regulatory Analysis

The sampling and analysis of environmental media described in this LTM Plan will be conducted in accordance with NR 724.17 and specifically the environmental standards established in Wisconsin and regulated by WDNR. The laboratory analytical methods, method detection limits, and reporting limits are outlined in the QAPP (Arcadis 2020), and the method detection limits and reporting limits will be lower than the applicable standards.

Surface water analytical results will be compared to 420 ng/L for PFOA and 11 ng/L for PFOS, which are the values used by WDNR to evaluate compliance with the conditions of the General Permit to Discharge under the Wisconsin Pollutant Discharge Elimination System (Permit WI-0046566-07-0), specifically Section 4.5 of the permit. The groundwater analytical results will be compared to the Wisconsin Department of Health Services recommended groundwater quality enforcement standards for PFAS compounds (Cycle 11 recommended values).

5.3 Laboratory Methods and Analysis

Details regarding the analytical methods to be used for each media are provided in the QAPP (Arcadis 2020). The laboratory methods to be used for the proposed analytical parameters, along with the recommended frequency for collection of matrix spike/matrix spike duplicate and duplicate samples, are provided in **Table 3**. Media analyzed for PFAS will be analyzed for the 36 PFAS analytes required by WDNR (WDNR 2020) and listed in the QAPP.

6 Reporting

Progress reports summarizing the results of LTM Plan activities will be prepared and submitted in accordance with NR 724.13(3). According to NR 724.17(3m), reports of monitoring results are to be submitted after any sampling event, and are to be submitted in accordance with the notification requirements outlined in NR 716.14; however, because the monitoring activities will be completed routinely for many years, an alternate notification schedule has been approved by WDNR. Specifically, monitoring results will be incorporated into the progress reports completed on the following schedule:

- **Pre-Startup Phase:** A pre-startup monitoring data package will be provided to WDNR at least 15 days prior to initiating operations of the GETS. The data package will minimally include the following:
  - Summary tables of gauged water levels, validated analytical results, and flow and stage measurements
  - An updated well construction table (inclusive of final extraction well and proposed piezometer constructions)
  - Soil boring logs and well construction logs associated with piezometer and extraction well installations
  - A description of how the pre-startup monitoring results affected the design or proposed operations of the GETS
  - Laboratory analytical reports.

- **Startup Phase:** Weekly reports will be prepared for the first eight weeks of GETS operation. Each report will be submitted 10 days after the end of the week it describes. After the initial eight-week period, progress reports will be provided monthly, submitted 15 days after each monthly reporting period. Progress reports will include, as applicable to the reporting period, the following:
  - Summaries of the GETS operation, maintenance, and monitoring (OMM) activities, optimizations, modifications, and contingency actions, if taken
  - GETS operational data (e.g., influent/effluent rates and volumes; sample results associated with WPDES permitting)
  - Summary tables of gauged water levels, validated analytical results, and stage measurements (collected at monthly or quarterly intervals, as detailed in the LTM Plan)
  - Summary table and plot of continuous flow measurements collected at the existing Ditch B treatment system (to be provided monthly)
  - Laboratory analytical reports.

- **Short-Term Phase:** Semi-annual progress reports will be submitted in accordance with NR 724.13(3). The progress reports will be sequentially numbered, with the first report being prepared 6 months after startup of the GETS interim action (i.e., at the end of the Startup Phase). Semi-annual progress reports are proposed to be provided to WDNR within 45 days of the end of each 6-month period. The semi-annual progress reports will include the following:
  - Summary of the GETS OMM activities, optimizations, modifications, and contingency actions taken, if any
  - GETS operational data (e.g., influent/effluent rates and volumes; sample results associated with WPDES permitting)
  - Summary tables, plots, and figures, as applicable, of gauged water levels, validated analytical results, and stage measurements (collected at monthly, quarterly, or semi-annual intervals, as detailed in the LTM Plan)
  - Attainment or exceedance of applicable criteria and a preliminary analysis of the potential cause(s)

- Summary table and plot of continuous flow measurements collected at the existing Ditch B treatment system
- Laboratory analytical reports.

The summarized data will be processed and evaluated using the parameters described in **Table 4**.

- **Long-Term Phase:** An updated Long Term Monitoring Plan will be submitted to WDNR at the completion of the planned Short-Term Phase. Monitoring and reporting associated with the Short-Term Phase will continue for an additional 6 month-period or until WDNR reviews and approves the updated Long Term Monitoring Plan, whichever is the shorter time period.

7 References

Arcadis. 2020. Draft Quality Assurance Project Plan, Tyco Per- and Polyfluoroalkyl Substances (PFAS) Site Investigation and Private Well Sampling Activities, Marinette, Wisconsin. April 15.

Arcadis. 2021. Remedial Action Design Report, Tyco Fire Technology Center, 2700 Industrial Parkway, Marinette, Wisconsin, BRRTS#: 02-38-580694. February 26.

WDNR. 2020. Letter from David Neste. May 27.

Tables

Table 1
Surface Water and Streambed Groundwater Monitoring Network
Long Term Monitoring Plan for the Groundwater Extraction and Treatment System:
Pre-Startup Through Initial Years of Operation
Marinette, Wisconsin

Monitoring Location ID		Manual Water Level Gauging	Continuous Stage Measurement	Continuous Flow Measurement	Surface Water Sample	Mini-Piezometer Groundwater Sample
Surface Water Location	Mini-Piezometer					
SW-U10	NA	x	x		x	
SW-U03	TPZ-U03	x			x	x
SW-M09	TPZ-M09	x	x		x	x
SW-M07	TPZ-M07	x			x	x
SW-M04	TPZ-M04	x			x	x
SW-M01	TPZ-M01	x			x	x
SW-L09	NA	x			x	
Ditch B T.S. Influent	NA		x	x	x	

Notes:
x = Location will be monitored as specified in Section 3 of the Long Term Monitoring Plan for the Groundwater Extraction and Treatment System
TPZ = temporary mini-piezometer
T.S. = Treatment System
NA = not applicable

Table 2
Groundwater Monitoring Network
Long Term Monitoring Plan for the Groundwater Extraction and Treatment System:
Pre-Startup Through Initial Years of Operation
Marinette, Wisconsin

Well ID	Area	Year Installed	Zone Screened	Depth to Top of Screen (feet bgs)	Depth to Bottom of Screen (feet bgs)	Top of Casing Elevation (feet amsl)	Surface Finish	Top of Screen Elevation (feet amsl)	Bottom of Screen Elevation (feet amsl)	Manual Water Level Gauging	Quarterly Groundwater Sampling for PFAS	Baseline and Semi-Annual Sampling for PFAS	Baseline and Annual Sampling for Supplemental Analytes [2]
Existing Monitoring Wells and Piezometers													
PZ-1D	FTC	2010	BR	63.5	68.5	606.23	Stickup	542.7	537.7	x		x	
PZ-3	FTC	2010	OB	38	43	609.2	Stickup	571.2	566.2	x[3]	x[3]	x[3]	x[3]
PZ-4D	FTC	2010	BR	68.5	73.5	607.86	Stickup	539.4	534.4	x		x	
PZ-9	FTC	NA	OB	38	43	611.16	Stickup	573.2	568.2	x			
PZ-14S	FTC	NA	OB	4	19	610.77	Stickup	606.8	591.8	x			
PZ-14D	FTC	NA	OB	25	35	611.15	Stickup	586.2	576.2	x			
PZ-15S	FTC	NA	OB	4	19	608.21	Stickup	604.2	589.2	x		x	
PZ-15D	FTC	NA	OB	22	32	608.19	Stickup	586.2	576.2	x		x	
PZ-16S	FTC	NA	OB	4	19	608.93	Stickup	604.9	589.9	x		x	
PZ-16D	FTC	NA	OB	28	38	608.61	Stickup	580.6	570.6	x	x	x	x
PZ-17S	FTC	NA	OB	4	19	609.14	Stickup	605.1	590.1	x			
PZ-17D	FTC	NA	OB	23	33	609.14	Stickup	586.1	576.1	x			
PZ-18D	FTC	NA	OB	37	47	609.61	Stickup	572.6	562.6	x[3]	x[3]	x[3]	x[3]
PZ-22S	FTC	NA	OB	10	20	605.91	Stickup	595.9	585.9	x		x	
PZ-22D	FTC	NA	OB	31	41	605.79	Stickup	574.8	564.8	x[3]	x[3]	x[3]	x[3]
PZ-45-31	FTC	2020	OB	20.8	30.8	607.90	Stickup	587.1	577.1	x			
PZ-23	Off Site	2017	OB	35	40	601.73	Flush	566.7	561.7	x	x	x	
PZ-24-17	Off Site	2019	OB	7	17	605.46	Flush	598.5	588.5	x		x	
PZ-24-47	Off Site	2019	OB	37	47	605.27	Flush	568.3	558.3	x	x	x	x
PZ-25-17	Off Site	2019	OB	7	17	598.74	Flush	591.7	581.7	x	x	x	
PZ-26-11	Off Site	2019	OB	6	11	598.13	Flush	592.1	587.1	x			
PZ-26-49	Off Site	2020	BR	39	49	596.29	Flush	557.3	547.3	x			
PZ-29-17	Off Site	2019	OB	7	17	594.02	Flush	587.0	577.0	x		x	
PZ-29-48	Off Site	2019	OB	38	43	593.94	Flush	555.9	550.9	x	x	x	
PZ-29-68	Off Site	2020	BR	58	68	593.46	Flush	535.5	525.5	x		x	
PZ-30-12	Off Site	2019	OB	7	12	594.75	Flush	587.8	582.8	x		x	
PZ-30-45	Off Site	2019	OB	35	45	594.72	Flush	559.7	549.7	x	x	x	
PZ-30-59	Off Site	2019	OB	54	59	594.64	Flush	540.6	535.6	x		x	
PZ-31-17	Off Site	2019	OB	7	17	595.74	Flush	588.7	578.7	x		x	
PZ-31-40	Off Site	2019	OB	35	40	595.75	Flush	560.8	555.8	x	x	x	
PZ-31-53	Off Site	2019	OB	48	53	595.79	Flush	547.8	542.8	x		x	
PZ-32-18	Off Site	2019	OB	8	18	591.73	Flush	583.7	573.7	x		x	
PZ-32-72	Off Site	2019	OB	67	72	591.73	Flush	524.7	519.7	x	x	x	
PZ-33-12	Off Site	2019	OB	7	12	594.79	Flush	587.8	582.8	x			
PZ-33-33	Off Site	2019	OB	28	33	594.77	Flush	566.8	561.8	x			
PZ-33-67	Off Site	2019	OB	57	67	594.79	Flush	537.8	527.8	x			

Table 2
Groundwater Monitoring Network
Long Term Monitoring Plan for the Groundwater Extraction and Treatment System:
Pre-Startup Through Initial Years of Operation
Marinette, Wisconsin

Well ID	Area	Year Installed	Zone Screened	Depth to Top of Screen (feet bgs)	Depth to Bottom of Screen (feet bgs)	Top of Casing Elevation (feet amsl)	Surface Finish	Top of Screen Elevation (feet amsl)	Bottom of Screen Elevation (feet amsl)	Manual Water Level Gauging	Quarterly Groundwater Sampling for PFAS	Baseline and Semi-Annual Sampling for PFAS	Baseline and Annual Sampling for Supplemental Analytes [2]
Proposed Monitoring Wells and Piezometers[1]													
A	FTC	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD	x	x	x	x
B	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD	x	x	x	x
C	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD	x	x	x	x
D1	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD	x		x	
D2	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD	x	x	x	
E	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD	x			
F	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD	x			
G	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD	x			
H	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD	x			
I	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD	x			
J	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD	x			
K	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD	x			
Existing and Proposed Extraction Wells													
EX-1	Off Site	2020	OB	17	32	608.05	Stickup	591.1	576.1		x[4]	x	
EX-2	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD		x[4]	x	
EX-3	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD		x[4]	x	
EX-4	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD		x[4]	x	
EX-5	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD		x[4]	x	
EX-6	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD		x[4]	x	
EX-7	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD		x[4]	x	
EX-8	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD		x[4]	x	
EX-9	Off Site	Proposed 2021	OB	TBD	TBD	TBD	TBD	TBD	TBD		x[4]	x	

Notes:
x = Location will be monitored as specified in Section 3 of the Long Term Monitoring Plan for the Groundwater Extraction and Treatment System.
1 = Proposed monitoring well and piezometer locations are presented on Figure 3.
2 = Locations to be sampled for supplemental analyte list, as described in Table 3.
3 = PZ-3, PZ-22D, and PZ-18D will be sampled during the baseline event, and only one of the three wells will continue to be monitored based on sample results. PZ-22D is the default selection for inclusion in the monitoring program unless PFAS concentrations at either of the other wells is significantly higher (i.e., more than 15%) than concentrations observed at PZ-22D. If this occurs,the well with the highest concentration will be substituted for PZ-22D.
4 = During the six-month startup phase, each extraction well will be sampled monthly after pumping is initiated at the well.

amsl = above mean sea level
bgs = below ground surface
BR = bedrock
EX = extraction well
FTC = Fire Technology Center
MW = monitoring well
NA = not available
OB = overburden
PZ = piezometer
TBD = to be determined after installation
Vertical Datum: North American Vertical Datum (NAVD) 1988

Table 3
Laboratory Methods and Quality Assurance/Quality Control Frequency
Long Term Monitoring Plan for the Groundwater Extraction and Treatment System:
Pre-Startup Through Initial Years of Operation
Marinette, Wisconsin

Matrix	Parameter	Laboratory Method	Matrix Spike/ Matrix Spike Duplicate Frequency	Field Duplicate Frequency
All Monitoring Events / All Locations				
Water	PFAS	Modified USEPA 537 (36 compounds)	1/20	1/10
Supplemental Analytes- Baseline and Annual Events Only - Select Locations (see Note 1)				
Water	Volatile Organic Compounds	8260B	1/20	1/10
Water	Semivolatile Organic Compounds	8270D	1/20	1/10
Water	Metals, Total	6020A	1/20	1/10
Water	Metals, Dissolved	6020A (field filtered)	1/20	1/10
Water	Mercury, Total	7470A	1/20	1/10
Water	Mercury, Dissolved	7470A (field filtered)	1/20	1/10
Water	Nitrogen, Total Kjeldahl	4500 NH3 H	1/20	1/10
Water	Nitrate	9056A	1/20	1/10
Water	Nitrite	9056A	1/20	1/10
Water	Sulfate	9056A	1/20	1/10
Water	Chloride	9056A	1/20	1/10
Water	Total Organic Carbon	9060A	1/20	1/10
Water	Dissolved Organic Carbon	9060A (field filtered)	1/20	1/10
Water	Alkalinity	SM 2320B	1/20	1/10
Water	Salinity	SM 2520B	1/20	1/10
Water	Total Suspended Solids	SM 2540D	1/20	1/10
Water	Total Dissolved Solids	SM 2540C	1/20	1/10
Water	pH	SM 4500 H+ B	-	1/10
Water	Ammonia	SM4500 NH3 G	1/20	1/10
Water	Biological Oxygen Demand, 5-Day	SM 5210B	1/20	1/10
Water	Dissolved Biological Oxygen Demand, 5-Day	SM 5210B (field filtered)	1/20	1/10
Water	Chemical Oxygen Demand	SM 5220C	1/20	1/10
Water	Dissolved Chemical Oxygen Demand	SM 5220C (field filtered)	1/20	1/10
Water	Langelier Saturation Index	SM 2330B	-	-

Notes:

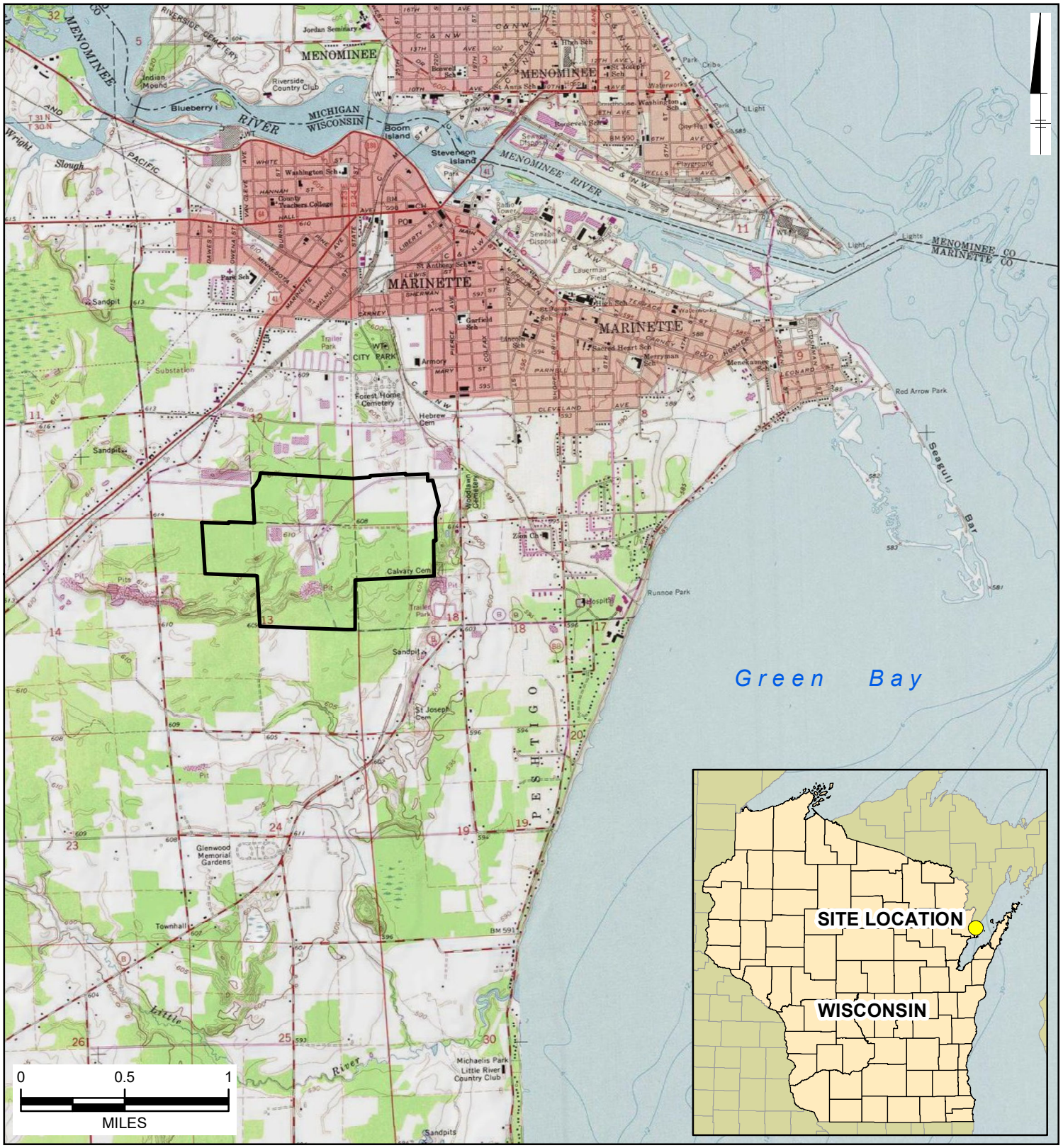
1 - Supplemental analyte to be included for groundwater samples only, at locations listed in Table 2.

Table 4
Performance Parameters for Reporting GETS Outcomes
Long Term Monitoring Plan for the Groundwater Extraction and Treatment System:
Pre-Startup Through Initial Years of Operation
Marinette, Wisconsin

Performance Parameter	Evaluation Process
Document reductions of upwelling in upper, middle, and lower reaches of Ditch B and/or identify locations or conditions contributing to observed upwelling	Calculate and track (in a table) head differentials in mini-piezometers and surface water
	Calculate and track (in a table) the average system effluent rate and stream flow rate (at the existing Ditch B system) on days that mini-piezometers and surface water are gauged
	Calculate and track (in a table) daily average flow rate in Ditch B and daily average effluent discharge rate and stream gauge measurements (when available)
Monitor and assess groundwater migration from the FTC (as it relates to the GETS and Ditch B specifically)	Create tables and graphical plots (as needed) to summarize groundwater and surface water levels within the area of the GETS
	Create figures illustrating groundwater elevations and approximate capture zones of the extraction wells
	Create cross-sections through the monitoring area (including Ditch B) illustrating wells, groundwater elevations, and approximate capture zones of the extraction wells
Document PFAS reductions in Ditch B surface water and/or identify locations or conditions contributing to potential increases	Create tables summarizing PFAS concentrations detected in groundwater and surface water PFAS concentrations at mini-piezometers.
	Create post-maps and trend plots illustrating PFOA and PFOS concentrations in groundwater and surface water at mini-piezometers over time.
	Create graphical trend plots showing contemporaneous flow rates and PFOA and PFOS concentrations for both GETS effluent and Ditch B surface water.
Document PFAS trends in groundwater (decreasing, stable, increasing) within the area of the GETS	Create tables to summarize groundwater PFAS concentrations at monitoring wells over time
	Create graphical plots (as needed) to track concentration trends of specific PFAS constituents (e.g., PFOA, PFOS, PFHxA, and FTSA) at monitoring wells
	Create figures (e.g., isoconcentrations and cross-sections) illustrating concentrations of specific PFAS constituents (e.g., PFOA) in groundwater within the area of the GETS
Document PFAS mass removal over time	Create a tabular summary of the average operating flow rate, run time, and volume of groundwater removed per month in each extraction well
	Calculate and track (in tables and graphical plots) estimates of PFAS mass extracted from each well for the reporting period, and include updated cumulative estimated mass of PFAS extracted from each well since startup
	Create a tabular summary of the total volume of groundwater extracted and treated per reporting period and cummulatively since GETS startup
	Create a tabular summary of the influent and effluent concentrations of PFAS from the GETS during the reporting period
	Calculate and track (in tables and graphical plots) estimates of PFAS mass removed by the GETS for the reporting period, and include updated cumulative estimated mass of PFAS removed since startup
Evaluate sustainability of the GETS operation in accordance with NR 722.09(2m)	Create a tabular summary of run time and down time of the GETS during the reporting period
	Estimate energy usage by the GETS per reporting period and cumulatively
	Summarize the carbon regeneration volume/mass per reporting period and cumulatively
	Summarize the disposal volume/mass for filters and ion exchange resin per reporting period and cumulatively

Notes:
FTSA = 6:2 fluorotelomer sulfonic acid
GETS = Groundwater Extraction and Treatment System
PFHxA = perfluorohexanoic acid
PFOA = perfluorooctanoic acid
PFOS = perfluorooctanesulfonic acid

Figures



LEGEND:

APPROXIMATE SITE PROPERTY BOUNDARY

NOTES:

1. TOPOGRAPHIC MAP SOURCE: COPYRIGHT:© 2013 NATIONAL GEOGRAPHIC SOCIETY, I-CUBED, ACCESSED JULY 2021.

TYCO FIRE TECHNOLOGY CENTER
MARINETTE, WISCONSIN

LONG-TERM MONITORING PLAN FOR THE GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

SITE LOCATION

ARCADIS

FIGURE 1

LEGEND:

- MONITORING WELL
- PIEZOMETER
- SURFACE WATER SAMPLE
- FORMER TEMPORARY PIEZOMETER
- EXISTING EXTRACTION WELL
- PROPOSED EXTRACTION WELL
- APPROXIMATE SITE PROPERTY BOUNDARY
- APPROXIMATE MARINETTE CITY BOUNDARY
- PARCEL BOUNDARY
- ROAD
- DITCH/STREAM
- GROUNDWATER EXTRACTION TREATMENT SYSTEM
- WATERBODY
- DITCH TREATMENT SYSTEM

NOTES:

1. CITY BOUNDARY DATA SOURCE: WISCONSIN LEGISLATIVE TECHNOLOGY SERVICES BUREAU, WISCONSIN COUNTY CLERKS AND LAND INFORMATION OFFICES, ACCESSED FALL 2017.
2. DITCH/STREAM AND WATERBODY DATA SOURCE: U.S. GEOLOGICAL SURVEY NATIONAL HYDROGRAPHY DATASET, ACCESSED FALL 2017.
3. ROAD DATA SOURCE: OPEN STREET MAP, ACCESSED FALL 2017.
4. LOCATIONS OF THE GROUNDWATER EXTRACTION AND TREATMENT SYSTEM, AND PROPOSED EXTRACTION WELLS ARE APPROXIMATE.

0 750 1,500

GRAPHIC SCALE IN FEET

TYCO FIRE TECHNOLOGY CENTER
MARINETTE, WISCONSIN

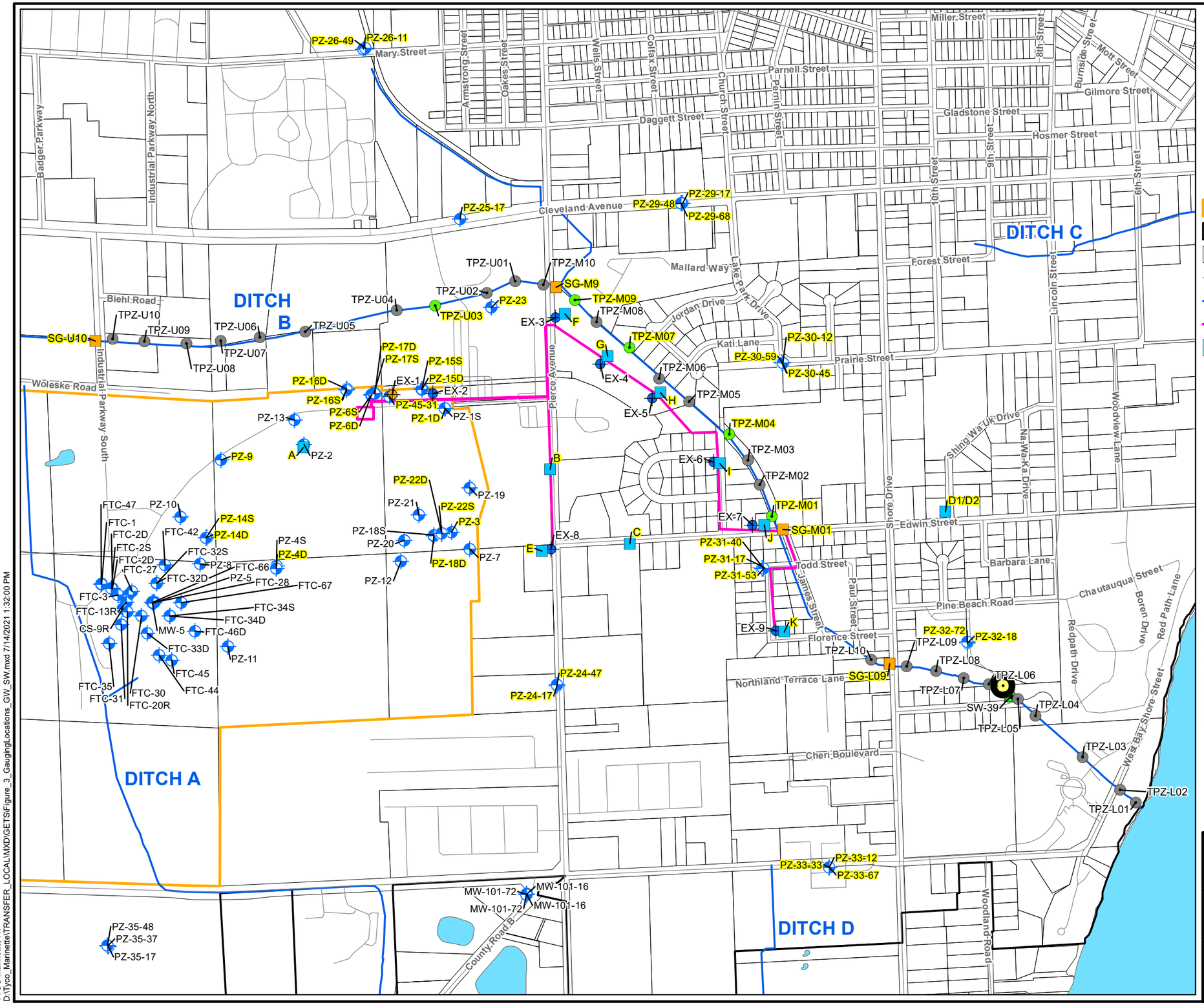
LONG-TERM MONITORING PLAN FOR THE GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

GETS LONG-TERM MONITORING AREA

ARCADIS

FIGURE 2

City: Minneapolis/Citrix Div/Group: IMDVC Created By: Last Saved By: MSMiller
TYCO Marinette, WI
D:\Tyco_Marinette\TRANSFER_LOCAL\MXD\GETS\fIGURE___GETS_LONG_TERM_MONITORING AREA.mxd 7/14/2021 2:03:37 PM



LEGEND:

- PROPOSED STAFF GAUGE LOCATION
- PROPOSED PIEZOMETER LOCATION
- MONITORING WELL
- PROPOSED MINI-PIEZOMETER LOCATION
- FORMER TEMPORARY PIEZOMETER
- EXISTING EXTRACTION WELL
- PROPOSED EXTRACTION WELL
- APPROXIMATE SITE PROPERTY BOUNDARY
- APPROXIMATE MARINETTE CITY BOUNDARY
- PARCEL BOUNDARY
- ROAD
- DITCH/STREAM
- GROUNDWATER EXTRACTION TREATMENT SYSTEM
- WATERBODY
- DITCH B TREATMENT SYSTEM
- CONTINUOUS STAGE/FLOW (INFLUENT DITCH B TREATMENT SYSTEM)

PZ-29-68 = PROPOSED GROUNDWATER OR SURFACE WATER GAUGING LOCATION

NOTES:

1. CITY BOUNDARY DATA SOURCE: WISCONSIN LEGISLATIVE TECHNOLOGY SERVICES BUREAU, WISCONSIN COUNTY CLERKS AND LAND INFORMATION OFFICES, ACCESSED FALL 2017.
2. DITCH/STREAM AND WATERBODY DATA SOURCE: U.S. GEOLOGICAL SURVEY NATIONAL HYDROGRAPHY DATASET, ACCESSED FALL 2017.
3. ROAD DATA SOURCE: OPEN STREET MAP, ACCESSED FALL 2017.
4. LOCATIONS OF THE GROUNDWATER EXTRACTION AND TREATMENT SYSTEM, PROPOSED PIEZOMETERS, AND PROPOSED EXTRACTION WELLS ARE APPROXIMATE.

0 750 1,500

GRAPHIC SCALE IN FEET

TYCO FIRE TECHNOLOGY CENTER
MARINETTE, WISCONSIN
LONG-TERM MONITORING PLAN FOR THE GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

PROPOSED GROUNDWATER AND SURFACE WATER GAUGING LOCATIONS

ARCADIS

FIGURE 3

City: Minneapolis/Citrix Div/Group: IMDVC Created By: Last Saved By: MSMiller
TYCO Marinette, WI
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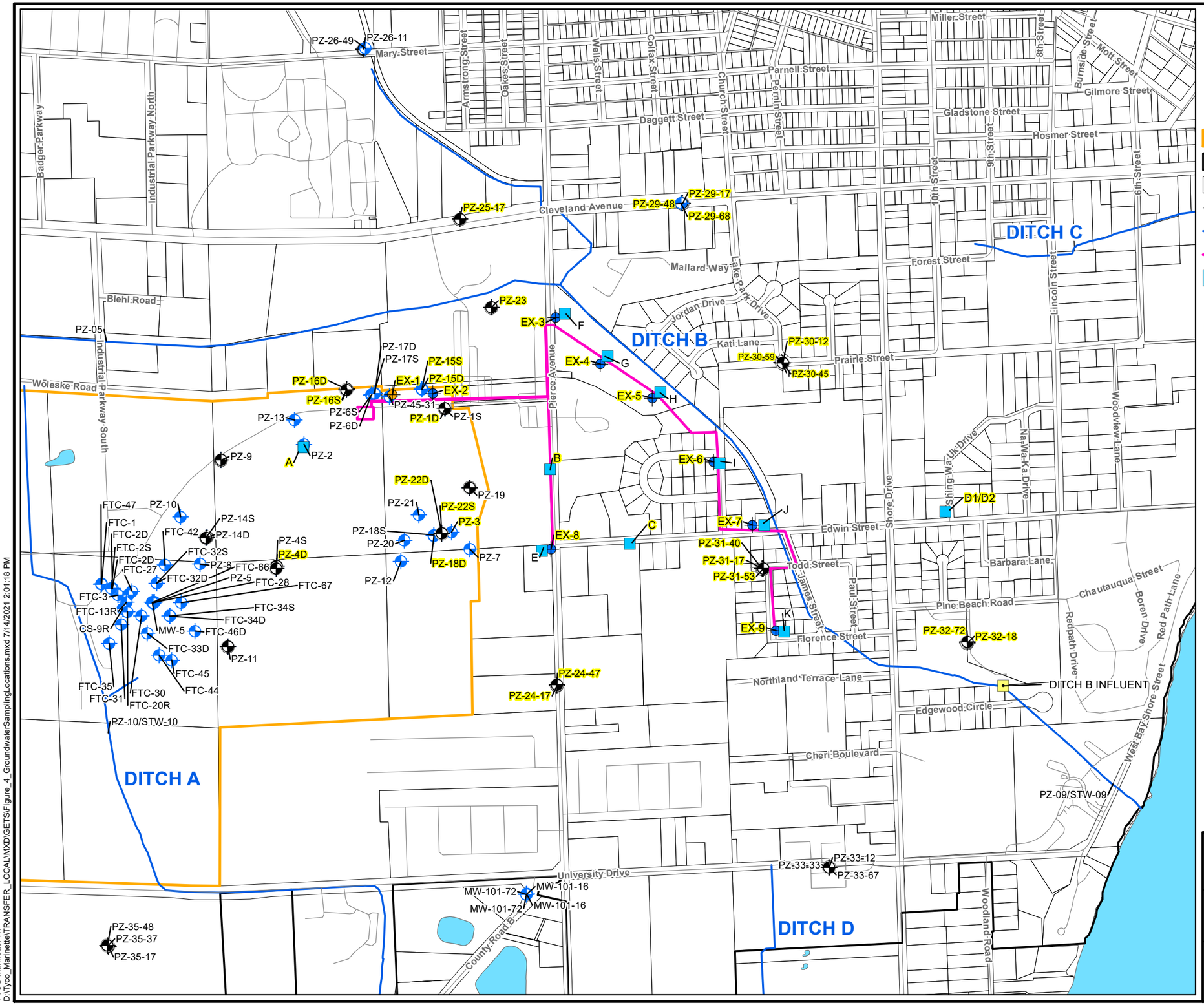

LEGEND:

- PROPOSED PIEZOMETER LOCATION
- EXISTING EXTRACTION WELL
- PROPOSED EXTRACTION WELL
- MONITORING WELL
- APPROXIMATE SITE PROPERTY BOUNDARY
- APPROXIMATE MARINETTE CITY BOUNDARY
- PARCEL BOUNDARY
- ROAD
- DITCH/STREAM
- GROUNDWATER EXTRACTION TREATMENT SYSTEM
- WATERBODY
- DITCH B TREATMENT SYSTEM

PZ-1D = GROUNDWATER SAMPLING LOCATION

NOTES:

1. CITY BOUNDARY DATA SOURCE: WISCONSIN LEGISLATIVE TECHNOLOGY SERVICES BUREAU, WISCONSIN COUNTY CLERKS AND LAND INFORMATION OFFICES, ACCESSED FALL 2017.
2. DITCH/STREAM AND WATERBODY DATA SOURCE: U.S. GEOLOGICAL SURVEY NATIONAL HYDROGRAPHY DATASET, ACCESSED FALL 2017.
3. ROAD DATA SOURCE: OPEN STREET MAP, ACCESSED FALL 2017.
4. LOCATIONS OF THE GROUNDWATER EXTRACTION AND TREATMENT SYSTEM, PROPOSED PIEZOMETERS, AND PROPOSED EXTRACTION WELLS ARE APPROXIMATE.

0 750 1,500

GRAPHIC SCALE IN FEET

TYCO FIRE TECHNOLOGY CENTER
MARINETTE, WISCONSIN

LONG-TERM MONITORING PLAN FOR THE GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

PROPOSED GROUNDWATER SAMPLING LOCATIONS

ARCADIS

FIGURE 4

City: Minneapolis/Citrix Div/Group: IMDVC Created By: Last Saved By: MSMiller
TYCO Marinette, WI
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LEGEND:

- PROPOSED STAFF GAUGE LOCATION
- PROPOSED PIEZOMETER LOCATION
- MONITORING WELL
- PIEZOMETER
- SURFACE WATER SAMPLE
- PROPOSED MINI-PIEZOMETER LOCATION
- FORMER TEMPORARY PIEZOMETER
- EXISTING EXTRACTION WELL
- PROPOSED EXTRACTION WELL
- APPROXIMATE SITE PROPERTY BOUNDARY
- APPROXIMATE MARINETTE CITY BOUNDARY
- PARCEL BOUNDARY
- ROAD
- DITCH/STREAM
- GROUNDWATER EXTRACTION TREATMENT SYSTEM
- WATERBODY
- DITCH B TREATMENT SYSTEM

PZ-MO4 = PROPOSED SURFACE WATER SAMPLING LOCATION

NOTES:

1. CITY BOUNDARY DATA SOURCE: WISCONSIN LEGISLATIVE TECHNOLOGY SERVICES BUREAU, WISCONSIN COUNTY CLERKS AND LAND INFORMATION OFFICES, ACCESSED FALL 2017.
2. DITCH/STREAM AND WATERBODY DATA SOURCE: U.S. GEOLOGICAL SURVEY NATIONAL HYDROGRAPHY DATASET, ACCESSED FALL 2017.
3. ROAD DATA SOURCE: OPEN STREET MAP, ACCESSED FALL 2017.
4. LOCATIONS OF THE GROUNDWATER EXTRACTION AND TREATMENT SYSTEM, PROPOSED PIEZOMETERS, PROPOSED EXTRACTION WELLS, AND PROPOSED MINI-PIEZOMETERS ARE APPROXIMATE.

0 750 1,500

GRAPHIC SCALE IN FEET

TYCO FIRE TECHNOLOGY CENTER
MARINETTE, WISCONSIN

LONG-TERM MONITORING PLAN FOR THE GROUNDWATER EXTRACTION AND TREATMENT SYSTEM

PROPOSED SURFACE WATER SAMPLING LOCATIONS

ARCADIS

FIGURE 5

City: Minneapolis/Citrix Div/Group: IMDVC Created By: Last Saved By: MSMiller
TYCO Marinette, WI
D:\Tyco_Marinette\TRANSFER_LOCAL\MXD\GETSIFigure_5_SurfaceWaterSamplingLocations.mxd 7/14/2021 1:39:41 PM

Appendix A

GETS Commissioning Plan

Prepared for:

Tyco Fire Products LP

GROUNDWATER EXTRACTION AND TREATMENT SYSTEM INTERIM REMEDIAL ACTION COMMISSIONING PLAN

Tyco Fire Technology Center – PFCS
Marinette, Wisconsin

WPDES Permit No. WI-0046566-07-0

BRRTS No. 02-38-580694

Prepared by:

Geosyntec consultants

engineers | scientists | innovators

309 N. Water Street, Suite 350
Milwaukee, Wisconsin 53202

Project Number: CHW8327

July 16, 2021

Groundwater Extraction and Treatment System Interim Remedial Action Commissioning Plan

Tyco Fire Technology Center – PFCS
Marinette, Wisconsin

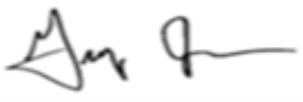
WPDES Permit No. WI-0046566-07-0
BRRTS No. 02-38-580694

Prepared for

Tyco Fire Products, LP

Prepared by

Geosyntec Consultants, Inc.
309 N. Water Street, Suite 350
Milwaukee, Wisconsin 53202



Jeff Tracy, P.G.
Senior Geologist

Greg Johnson, P.H., P.G., P.E.
Senior Engineer

Project Number: CHW8327

July 16, 2021

TABLE OF CONTENTS

LIST OF TABLES

ACRONYMS AND ABBREVIATIONS

BTEX	benzene, toluene, ethylbenzene, xylene
ft	feet
FTC	Fire Technology Center
GAC	granular activated carbon
GETS	groundwater extraction and treatment system
gpm	gallons per minute
IX	ion exchange
LTM	long-term monitoring
OM&M	operation, maintenance, and monitoring
PAH	polycyclic aromatic hydrocarbon
PFAS	per- and poly-fluoroalkyl substances
PFOA	perfluorooctanoic acid
PFOS	perfluorooctanesulfonic acid
PLC	programmable logic controller
RADR	remedial action design report
SCADA	supervisory control and data acquisition
TOC	total organic carbon
TSS	total suspended solids
Tyco	Tyco Fire Products LP
VOC	volatile organic compound
WDNR	Wisconsin Department of Natural Resources
WPDES	Wisconsin Pollutant Discharge Elimination System

SECTION 1

INTRODUCTION

This Commissioning Plan is part of the Long-Term Monitoring (LTM) Plan for the groundwater extraction and treatment system (GETS) associated with the Tyco Fire Products LP (Tyco) Fire Technology Center (FTC) located at 2700 Industrial Parkway South in Marinette, Wisconsin. This Commissioning Plan was developed in response to the Wisconsin Department of Natural Resources (WDNR) Conditional Approval of Groundwater Extraction and Treatment System (GETS) Interim Remedial Action Design Report (RADR; Arcadis, February 2021) dated May 18, 2021. As presented in the LTM Plan, GETS operation will commence using a phased approach. This Commissioning Plan outlines the procedures that will be followed during the startup phase of the GETS.

1.1 Purpose

The purpose of this Commissioning Plan is to describe the sequencing of startup and monitoring of the extraction wells and treatment system and covers the first six months of operation of the GETS. Data collected during the startup phase (as described in the LTM and this Commissioning Plan) will be used to evaluate initial system performance, optimize system operation, and begin to develop an understanding of the sensitivity of system operations to changing seasonal conditions. In accordance with Wisconsin Administration Code NR 724.13(2) this Commissioning Plan addresses the following elements:

- Sequential startup of the groundwater extraction wells;
- Startup of the treatment system;
- A monitoring and decision framework for selecting the extraction well pumping rates and analytical parameters and contingency plans based on monitoring results; and
- Decision criteria that will be consistent with a Discharge Management Plan and based on monitoring of the influent and effluent from the treatment system and the response measured in the surface water and groundwater monitoring network.

The remainder of this Commissioning Plan describes the proposed sequential startup of extraction wells, startup of the treatment system, monitoring data objectives, schedule, and methods to be employed as the GETS is brought online. Once the GETS goes online, sampling and monitoring will follow the Startup Phase of the LTM. Sampling protocols, analytical methods, and quality assurance/quality control measures applicable to this plan are documented in the Draft Quality Assurance Project Plan (QAPP; Arcadis, 2020).

SECTION 2

STARTUP OF EXTRACTION WELLS

2.1 Sequential Extraction Well Startup

The purpose for sequential startup is to demonstrate drawdown in each extraction well and observe effects on groundwater levels at nearby piezometers, evaluate the performance of each extraction well pump, and adjust the operating parameters based on initial performance. The effectiveness of the entire GETS network will be evaluated after each extraction well is operating at their design capacities and groundwater levels in the extraction wells and the piezometer monitoring points in **Table 3** achieve steady state. Water generated during the extraction well startup period will be conveyed to the GETS for treatment.

Start-up of the extraction wells will occur in sequence from lower to higher per- and poly-fluoroalkyl substances (PFAS) concentration based on testing of groundwater samples collected following development of the extraction wells. Each extraction well will be started at its low flow operational set point that will provide sufficient head to convey the extracted groundwater to the Equalization Tank per the pump operating curve. **Table 1** provides the extraction well pump design conditions. **Table 2** lists commissioning parameters that will be monitored. A subset of these parameters will be monitored and recorded up to six times over the course of two days (12 samples) or until steady state conditions are approached (< 10% variance in monitored parameters), whichever is earlier, as each extraction well is made operational. This subset of parameters will include, iron, manganese, pH, and dissolved oxygen. Iron, manganese, pH and dissolved oxygen may be analyzed at the onsite laboratory.

After two days of operation and monitoring, or when steady state conditions are approached, the next extraction well will be started and monitored. This process will continue over the course of approximately one month, until all nine extraction wells have been brought online and the GETS is fully operational.

Groundwater elevations will be collected every 10 minutes during extraction well startup at the monitoring points described in **Table 3**. Groundwater elevations will be collected using pressure transducers installed at each of the monitoring points.

2.2 Aquifer Tests of Extraction Wells EX-1 through EX-9

Aquifer testing will be conducted during the startup phase (the complete system stage of system testing [Section 3.3.3]) to further evaluate aquifer properties. A constant rate pumping test for a minimum of 48 hours will be conducted after the pumping rate has stabilized at each extraction well. The constant rate test at each extraction well may not require any deviation from the general startup procedure. For each constant rate test, transducers and data loggers will be installed in select monitoring wells; in the extraction wells in piezometers near the extraction wells and as indicated in **Table 3**. The transducers and data loggers will be installed and begin recording data

at least 24 hours prior to beginning the 48-hour constant rate test. As indicated on **Table 3**, the data logger recording frequencies during the 48 hour pump test will be one minute in monitoring wells greater than 100 feet (ft) from the active extraction well, 10 seconds in the active extraction well, and 20 seconds in monitoring wells less than 100 ft from the active extraction well. Groundwater levels will be measured with a depth to groundwater meter and will be recorded before adding transducers in each extraction well, and twice a day during the 48-hour tests.

The preliminary design basis extraction is 25 gallons per minute (gpm) per extraction well, with a possible range of 25 to 40 gpm (Arcadis, 2021). Groundwater level data will be analyzed and recorded during the commissioning of the GETS using aquifer type curves to provide refined estimates of aquifer parameters including

1. transmissivity and hydraulic conductivity of the target extraction interval,
2. vertical hydraulic conductivity of the material between the extraction interval and Ditch B, which constrains the hydraulic connection between the extraction wells and Ditch B, and
3. storage coefficients of aquifer materials.

2.3 Hydraulic Response Contingency

There are two likely causes for hydraulic responses to pumping recorded in monitoring wells that are less than expected. First, there is greater transmissivity (and hydraulic conductivity) than previously estimated. Second, there is limited hydraulic connection between the monitoring location, extraction wells, and Ditch B. The action to take under these circumstances, based solely on whole system performance and not individual extraction wells, is to adjust the pumping rates for extraction wells near the monitoring location in which the response is less than expected to attempt to meet GETS objectives.

SECTION 3

STARTUP OF THE TREATMENT SYSTEM

The startup of the treatment system includes initial system testing, troubleshooting, and performance monitoring activities. These activities will begin after pre-startup phase completion and will extend through completion of the treatment system testing. Prior to startup of the treatment system, the operator will confirm that pre-startup preparations were completed for the control systems and major equipment, per the manufacturers' instructions.

In general, the treatment system and components will be functionally started up in order of their mechanical and electrical completion and system flow sequence, along with their successful completion of prerequisite tests and checkout. To reduce the amount of wastewater generated during the startup activities, a recirculation loop will be constructed to allow returning of the treated water and wastewater streams back to the Equalization Tank and form a closed test loop before testing the system under normal throughput conditions

The treatment system startup activities will be performed in three stages:

1. Loop stage: Startup activities of individual components of the treatment system using potable water
2. Throughput stage: Startup activities as each extraction well is brought online
3. Complete system stage: Startup activities when all nine extraction wells are operational, and the system is operating under design flow conditions (the constant rate pump test [Section 2.2] will be completed during the complete system stage)

Startup stages are summarized in **Table 4**, and details are provided in Section 3.3.

3.1 General Startup Sequence

The general sequence of startup progression is planned as follows:

1. Test the utility systems such as compressed air, electric, and service water because the remaining system tests will rely on them.
2. Test chemical dosing systems because they are integral to the major process systems and represent contained system equipment areas. Chemical dosing systems will be tested with water during the loop-test stage as described in Section 3.3.1.
3. Test effluent pumps because they will be relied on for the loop-test stage.
4. With the test loop established, testing of unit process equipment systems will begin in the general order of their mechanical and electrical completion and system flow sequence.
5. Fill the Effluent/Backwash Supply Tank with potable water to accommodate initial backwash water.

6. After fresh carbon media are loaded into the granular activated carbon (GAC) Adsorbers, backwashes for each vessel will be performed to washout carbon fines.
7. After fresh ion exchange (IX) resin is loaded into the IX Vessels, the initial forward rinse of the resin will be performed to washout debris and condition the resin as recommended by the manufacturer.
8. After media are loaded into the Greensand Filters, activation and backwash for each vessel will be performed as recommended by the manufacturer.
9. Once checkout has been conducted in loop mode, progress to the throughput test mode via operation of the groundwater extraction and conveyance system to deliver water into the facility.
10. A pre-final checkout of the permanganate, coagulant, and sulfuric acid (the need for sulfuric acid will depend on pH increase through the pretreatment process, and influent water quality) feed systems, along with the process systems, will be conducted with chemicals and the process media loaded into the systems.
11. Final checkout of the unit processes will occur following the treated effluent from the Effluent/Backwash Tank being discharged to the outfall located in Ditch B.

3.2 Treatment System Startup Testing Criteria

3.2.1 General Criteria

A variety of metrics will be employed to demonstrate successful functional testing and operation of the treatment system components and systems. These will include the following:

- Function and operation of each system component individually and in coordination with other system components for stable system operation with respect to pump speeds, tank levels, pressures, flow rates, online analyzer/sensor readings, and identification of operational parameters to be within their respective design ranges.
- System ability to handle and recover from induced alarms, process upsets, and emergency conditions. Emergency conditions include random equipment or process failures, tank overflows, surges, interlocks, and/or bypasses.
- Process equipment monitoring using inline pressure and flow monitoring equipment to gauge conformance with design operating points. Relevant factory test data, supervisory control and data acquisition (SCADA) system, and data communication via testing of remote monitoring systems.

The main treatment system components will be evaluated based on their ability to meet prescribed performance criteria.

3.2.2 System Performance Criteria

Metrics specific to each system are identified in **Table 5.**

3.2.3 Test Response Contingency

The tests will be monitored and inspected by authorized personnel, with appropriate sign offs for each component and system checkout forms. Unsuccessful tests will be documented but will not be signed off. The general sequence of a failed test response is as follows:

1. Testing personnel will diagnose the cause of test failures and determine a course of corrective action prior to retest, as appropriate.
2. Subcontractors and equipment manufacturer representatives will be engaged as necessary to assist in the identification and correction of issues for successful completion of the test metric.
3. Once actions have been taken, the failed test will be rescheduled and reconducted by authorized personnel.
4. The above procedure will be followed until a successful test result is achieved. Authorized personnel will address the issues identified during testing, in a timely fashion.

For example, if a unit process experiences a rapid differential pressure increase according to the criteria listed in **Table 5**, the test would be terminated, and potential causes investigated. These might include tasks such as inspecting the media to determine the nature of the foulant, checking upstream processes and pipelines for proper flushing and absence of suspended solids, and instrument readings monitoring raw water quality. If investigative tasks do not result in resolution of the test failure, then subcontractors and or equipment manufacturers will be contacted.

3.3 Treatment System Startup Stages

Treatment system startup activities includes three stages: loop stage, throughput stage, and complete system stage.

3.3.1 Loop Stage

During loop stage testing, processed water will be recirculated back to the Equalization Tank. The groundwater extraction and conveyance system will not be connected and tested until the throughput stage. Loop stage startup activities will use potable water to fill the Equalization Tank and startup system components individually.

Apart from the groundwater extraction and conveyance system, the loop stage will allow each individual system component to be tested without the need for extracting groundwater from system wells. Also, since this stage will be a closed loop procedure, the test water will be looped through the treatment processes without needing to be disposed/discharged. Bag Filters will be loaded into their vessels to remove accumulated solids from the loop. Media for the GAC Adsorbers and resin for the IX Vessels will be loaded and backwashed and forward rinsed, respectively, prior to loop stage testing of that respective component.

During this phase, closed loop recirculation of water from the Equalization Tank through the Clarifier, Greensand Filters, initial Bag Filters, GAC Adsorbers, IX Vessels, and effluent Bag Filters will be utilized. There may be an extended gap in time between the initial rinse of the IX Vessels to completion of this phase, during which closed loop recirculation of water from the Equalization Tank will be utilized to reduce the risk of negative impacts to the media/resin that may occur in the absence of flow (e.g., bacterial growth).

The proposed test loop will allow time to perform thorough checks and troubleshooting of most of the pre- and post-treatment system components without concern for disposal and a steady supply of test water. Actual chemicals will not be employed, but the chemical dosing systems will be tested from a hydraulic and control perspective using water in lieu of chemicals.

3.3.2 Throughput Stage

Upon successful completion of the loop stage, any temporary piping used can be disconnected. The groundwater extraction and conveyance system will be tested in the throughput stage following the steps below:

1. Position valves properly to facilitate testing.
2. Check inputs/outputs of instrumentation locally against feedback in the control panels and control screens.
3. Start one extraction well pump at a time at its low flow operational set point as described in Section 2.1. These pumping rates have been selected such that each extraction well pump can provide sufficient head to convey the extracted groundwater to the Equalization Tank, per the pump operating curves. Monitor piping integrity and potential leaks along the line, through the wellhead piping, ending at the final pipe going above ground to the Equalization Tank by monitoring flow output from the extraction well pump and level in the Equalization Tank.
4. Start extraction well pumps sequentially until all the pumps are in operation (note: the wells will discharge and fill the equalization tank, and the treatment system draws water from the equalization tank; therefore, the extraction well and system flow rates are not completely dependent);
5. By changing the alarm set points to create alarm conditions, test alarm message display, alarm response, and recovery after alarm conditions are no longer present.
6. Repair leaks or equipment malfunction during the test as needed.

The treatment system will be operated at low flow (150 gpm) conditions as each extraction well is brought online. Each extraction well, pumping at a flow rate between 25 to 40 gpm will be conveyed to the treatment system and fill the Equalization Tank. The remainder of the treatment system will be started once the Equalization Tank has sufficient volume and operate at a flow rate of 150 gpm to maintain minimum flow conditions and prevent operational upsets. Treated effluent will be discharged to the outfall located in Ditch B, while backwash waste will be collected in the Backwash/Sludge Tank for solids processing.

When all nine extraction wells are brought online, the treatment system flow will be increased to design flow conditions.

Chemicals will be loaded into storage tanks and used during a portion of the throughput stage to allow demonstration of chemical addition system functionality with actual process chemicals. The Chemical Tanks will be drained of water so that residual water remaining in the tanks does not exceed the limits recommended by metering pump vendors and causes no significant interference with chemical pump calibration. Chemical metering pumps will be calibrated with the actual chemical, not water.

During the throughput stage, functions, interlocks, and alarms will be checked and the treatment will have been continuously operational in automated mode.

3.3.3 Complete System Stage

After successful operation in the throughput stage with all nine extraction wells in operation, that stage is considered complete and the complete system startup stage will start. To prepare for complete plant testing, the following items will be in place:

1. The treatment system will be shut down from the SCADA control, following throughput stage testing.
2. Chemical Tanks will be refilled with chemicals as needed after the throughput stage testing.
3. The control loops, functions, interlocks, alarms, inputs and outputs, SCADA system, and data logging will be functional per design specifications.
4. Temporary piping and equipment during prior testing will be disconnected and moved or stored (if applicable).
5. Manual valves will be properly positioned at normal operation and motorized valves placed on auto mode along with unit processes.
6. Treated effluent during the complete system stage will be set up to discharge to the outfall located in Ditch B.
7. Other equipment, setup, and accessories will be in working condition as if the treatment system is fully online.

During the complete system stage of startup activities, treatment system operations will be fine-tuned based on influent analytical parameters. The monitoring and sampling conducted during this stage will be used to optimize the treatment system performance for long term operations. The complete system stage will also be used to establish baseline performance metrics for the treatment system.

3.4 Monitoring and Sampling

This subsection outlines the monitoring and sampling undertaken as the GETS is brought online. When each extraction well is brought online, water will be pumped and conveyed to the treatment system Equalization Tank. Baseline parameters collected from the extraction well (**Table 2**) will be used to adjust chemical dose for the pretreatment and confirm hydraulic loading rates for the Clarifier, Greensand Filters, GAC Adsorbers and IX Vessels. The treatment system will be operated at the minimum hydraulic flow rate of 150 gpm. When all nine extraction wells are operational, the treatment system will be operated at the design flow rate of 225 gpm.

The monitoring components related to the treatment system are divided into two categories: laboratory analytical monitoring and system parametric monitoring.

3.4.1 Laboratory Analytical Monitoring

Parameters to be monitored and the frequencies of sampling of the process water for the purpose of evaluating the startup performance are presented in the Startup Sampling and Analysis Plan, included in **Table 6.** The Startup Sampling and Analysis Plan will be utilized to monitor the performance of the startup of the GETS and make interventions proactively to optimize system operation. The Startup Sampling and Analysis Plan therefore includes monitoring at locations throughout the treatment process to assess the performance of the treatment system.

The parameters to be monitored in the process water for the purpose of assessing system performance include:

1. Influent (SP1): Influent samples will be collected to assess the characteristics of the incoming water to the treatment system by monitoring PFAS, volatile organic compounds (VOCs), total organic carbon (TOC), total suspended solids (TSS), and select organic and inorganic compound concentrations throughout the life of the project. System influent samples will be collected from a sample port located in the influent line.
2. Clarifier Effluent (SP2): Clarifier effluent samples will be collected and analyzed for TSS, TOC, pH, iron, and manganese to evaluate the performance of the iron oxidation/precipitation operation. Sample ports will be located prior to the Greensand Filters.
3. Greensand Filter Effluent (SP3): Greensand Filter effluent samples will be collected to and analyzed for TSS, TOC, pH, iron, and manganese to evaluate the performance of the iron oxidation/precipitation and filtration unit operations. Sample ports will be located prior to the GAC Adsorbers.
4. GAC Adsorber Effluent (SP4, SP5, SP6): GAC Adsorber effluent samples will be collected to assess the performance of TOC, PFAS, VOCs, benzene, toluene ethylbenzene, and xylene (BTEX), polycyclic aromatic hydrocarbons (PAHs) and other select organic compounds removal and develop GAC changeout schedules. Sample ports will be located at the effluent of each pair of GAC Adsorbers.

5. IX Vessel Effluent (SP7, SP8): IX Vessel effluent samples will be collected to assess the performance of PFAS removal and develop IX Vessel changeout schedules. Sample ports will be located downstream of each IX Vessel.
6. Treated Effluent (SP9): To assess the overall treatment efficiency of the system and demonstrate that the treatment system would comply with the surface water discharge criteria required by the Wisconsin Pollutant Discharge Elimination System (WPDES) permit, samples will be collected at the effluent of the treatment system; monitored effluent parameters will include BTEX, PAHs, VOCs, perfluorooctanoic acid (PFOA), perfluorooctanesulfonic acid (PFOS) and pH as required by Section 4.2 of the WPDES permit. System treated effluent samples will be collected from a sample port located immediately prior to the treated effluent discharge exiting the treatment system building.

Monitoring frequencies for each parameter are provided in **Table 6**. Results from SP1 through SP8 will be utilized for internal GETS performance optimization. Analytical results from SP9, the treated effluent from the GETS will be part of the startup progress reports detailed in Section 3.6.

3.4.2 System Parametric Monitoring

The treatment system has been designed with SCADA capabilities, which allow monitoring and control from a remote location. The following are key parameters to be monitored continuously via the SCADA system: influent flow rate, treated effluent flow rate, system piping pressures, filter unit differential pressures, system tank water levels, and in-stream piezometer and extraction well water levels. Other parameters such as pressure (as indicated on pressure gauges) will be monitored and recorded on the routine operation, maintenance, and monitoring (OM&M) log maintained by the operator. System parametric monitoring including routine OM&M logs, weekly, monthly, quarterly, and semi-annual monitoring and maintenance logs will be documented in the final treatment system OM&M Plan once the GETS has been constructed. The following key parameters will be continuously monitored by the programmable logic controller (PLC) system and recorded as needed but no less frequently than once every two weeks:

- Water Flow Rate: Water flow rates will be monitored via flow meters to evaluate groundwater extraction rates across the Site, document overall groundwater removal volumes, track and record treated effluent discharge rates, and evaluate process equipment performance.
- Pressure: Pipeline pressures throughout the extraction and treatment process will be monitored via pressure transmitters to evaluate process equipment performance and to identify potential upset conditions (e.g., high pressure, low pressure) that can indicate the need for equipment maintenance or pipe blockages/leaks.
- Differential Pressure: Differential pressures across the Bag Filters, Greensand Filters, GAC Adsorbers, and IX Vessels will be monitored to determine when a filter changeout or backwash is required.
- Tank Water Levels: Treatment process tank water levels (Equalization Tank, Decant Tanks, etc.) will be continuously monitored via level transmitters and switches with

SCADA to control pump operation and identify upset conditions (e.g., leaks, pump malfunctions).

- Other: Water levels and flow rates at each of the extraction wells will be monitored and tied into the GETS SCADA to evaluate extraction well performance and adjust pumping rates accordingly and to protect the pumps from excessive drawdown conditions. In-stream water level monitoring at Ditch B will be conducted at the existing location upstream of the Ditch B SWTS as well as at a proposed location where Ditch B crosses Pierce Road. Ditch B water-level monitoring will include data-logging capabilities at a minimum but may not be tied into the GETS SCADA.

3.5 Contingency Plan

During the throughput and complete system startup stages, the treatment system will discharge treated effluent to the outfall located in Ditch B while the system operations and performance are being optimized. While the treatment system is designed to comply with the surface water discharge criteria required by the WPDES permit, operational upsets may occur during startup until system operations are optimized. These upsets could be due to process, mechanical, electrical and instrumentation upsets or failure. To mitigate the impacts of any operational upsets during startup, modifications outlined in **Table 7** will be followed.

This procedure will be followed after the commissioning period for the duration of system operation. Changes to these procedures may be requested by Tyco but will not be implemented without approval from the WDNR.

For PFOA and PFOS exceedances, a tiered approach that was developed in consultation with the WDNR, outlined in **Table 7** will be adopted to rectify upsets. The tiered approach was developed with WDNR collaboration based on the laboratory method detection and reporting limits for PFAS, and inherent operational challenges, such as channeling, bed compaction, brief concentration exceedance due to effluent leakage etc., of the best available technology (GAC and IX). This is a proactive approach to rapidly address any system upsets resulting in criteria exceedance with a defined process to correct operational issues. The tiered approach was developed to allow Tyco to evaluate whether an initial sample result over the WPDES discharge limits from the compliance sample location where a brief exceedance occurs and to allow for the corrective action plan to be implemented if a supplemental sample collected from the compliance sample location (collected within 48 hours of receipt of the initial sample results) remained above the WPDES permit limits. Implementation of the corrective actions that were agreed to with the WDNR would allow Tyco to make changes to the system and collect data to demonstrate compliance.

Since the system utilizes physical/chemical processes for treatment, system tuning and optimization will be required during startup until steady state is reached. Corrective actions outlined in **Table 7** will be followed in case of WPDES permit exceedance only after the treatment system has reached steady state operations.

For example, likely causes for exceedance of permit limits for PFAS at the effluent sample collection point could include carbon or ion bed channeling or compaction, effluent rollover/overshoot, and GAC and IX breakthrough. An exceedance will be addressed in a step wise fashion (Tier 1, Tier 2, etc.) so that if the exceedance is resolved in one Tier, the following Tiers would not be implemented. The tiered approach for an initial, non-recurring exceedance of permit limits for PFAS at the effluent sample collection point would include the following actions:

- Tier 1: Trigger additional sampling within 48 hours of an initial, non-recurring exceedance to determine if the exceedance is a brief occurrence
- Tier 2: Provide the WDNR with the intermediate sample location data to demonstrate effective GETS performance
- Tier 3: Implement operational modifications such as recirculation, reduction of flow through system, pretreatment performance checks, system parameter checks for channeling, bed compaction, leaks etc.
- Tier 4: GAC/IX swap or changeout and sample within 48 hours to demonstrate compliance

Table 7 provides actions that would be implemented using the tiered approach for other parameters that may exceed WPDES Permit limits.

3.6 Reporting

Weekly reports will be prepared for the first eight weeks of GETS operation. Each report will be submitted 10 days after the end of the week it describes. After the initial eight-week period, progress reports will be provided monthly, submitted 15 days after each monthly reporting period. Progress reports will include, as applicable to the reporting period, the following:

- Summaries of the GETS operation, maintenance, and monitoring (OMM) activities, optimizations, modifications, and contingency actions, if taken
- GETS operational data (e.g., influent/effluent rates and volumes; sample results associated with WPDES permitting)
- Summary tables of gauged water levels, validated analytical results, and stage measurements (collected at monthly or quarterly intervals, as detailed in the LTM Plan)
- Summary table and plot of continuous flow measurements collected at the existing Ditch B treatment system (to be provided monthly)
- Laboratory analytical reports

SECTION 4

REFERENCES

Arcadis. 2020. Draft Quality Assurance Project Plan, Tyco Per- and Polyfluoroalkyl Substances (PFAS) Site Investigation and Private Well Sampling Activities, Marinette, Wisconsin. April 15.

Arcadis. 2021. Groundwater Extraction and Treatment System Interim Remedial Action Design Report. Tyco Fire Technology Center – PFCS, Marinette, Wisconsin. 2700 Industrial Parkway, Marinette, Wisconsin. BRRTS No. 02-38-580694. February 26.

TABLES

TABLE 1

Groundwater Extraction Pump Design Conditions

Tyco Fire Technology Center

Marinette, Wisconsin

Extraction Well Pump	Total Dynamic Head at 15 gpm (ft w.c.)	Total Dynamic Head at 25 gpm (ft w.c.)	Total Dynamic Head at 40 gpm (ft w.c.)	Pump Horsepower (HP)
EX-1	43	46	54	1
EX-2	46	53	70	1
EX-3	69	94	152	3
EX-4	73	104	174	3
EX-5	77	113	195	5
EX-6	84	136	254	5
EX-7	82	130	238	5
EX-8	52	82	150	3
EX-9	93	156	304	5

Acronyms:

ft = feet

gpm = gallons per minute

w.c. = water column

HP = horsepower

TABLE 2
GETS Commissioning Monitoring Parameters
Tyco Fire Technolgoy Center
Marinette, Wisconsin

Commissioning Parameters	
Parameter	**Laboratory Method**
Volatile Organic Compounds	8260B
Semivolatile Organic Compounds	8270D
Metals, Total	6020A
Metals, Dissolved	6020A (field filtered)
Mercury, Total	7470A
Mercury, Dissolved	7470A (field filtered)
Nitrogen, Total Kjeldahl	4500 NH3 H
Nitrate	9056A
Nitrite	9056A
Sulfate	9056A
Chloride	9056A
Total Organic Carbon	9060A
Dissolved Organic Carbon	9060A (field filtered)
Alkalinity	SM 2320B
Salinity	SM 2520B
Total Suspended Solids	SM 2540D
Total Dissolved Solids	SM 2540C
pH	SM 4500 H+ B
Ammonia	SM4500 NH3 G
Biological Oxygen Demand, 5-Day	SM 5210B
Dissolved Biological Oxygen Demand, 5-Day	SM 5210B (field filtered)
Chemical Oxygen Demand	SM 5220C
Dissolved Chemical Oxygen Demand	SM 5220C (field filtered)
PFAS	Modified USEPA 537 (36 compounds)
Langelier Saturation Index	SM 2330B

Accronyms:
PFAS = per- and polyfluoroalkyl substances

TABLE 3
GETS Commisioning Plan Groundwater Elevation Monitoring
Tyco Fire Technology Center
Marinette, Wisconsin

Well ID	Approximate Distance from EX Well (ft)	Data logger monitoring frequency (during initial startup and commissioning period)	Data logger monitoring frequency (during 48 hour constant rate pump test)	Depth to Top of Screen (feet bgs)	Depth to Bottom of Screen (feet bgs)	Top of Casing Elevation (feet)	Top of Screen Elevation (feet amsl)	Bottom of Screen Elevation (feet amsl)
Monitoring for Extraction Well 1								
EX-1	0	10 minutes	10 seconds	17	32	608.05	591.1	576.1
EX-2	331	10 minutes	1 minute	TBD	TBD	TBD	TBD	TBD
PZ-16S	370	10 minutes	1 minute	4	19	608.93	604.9	589.9
PZ-16D	370	10 minutes	1 minute	28	38	608.61	580.6	570.6
PZ-17S	158	10 minutes	1 minute	4	19	609.14	605.1	590.1
PZ-17D	158	10 minutes	1 minute	23	33	609.14	586.1	576.1
Monitoring for Extraction Well 2								
EX-2	0	10 minutes	10 seconds	TBD	TBD	TBD	TBD	TBD
EX-1	331	10 minutes	1 minute	17	32	608.05	591.1	576.1
PZ-15S	106	10 minutes	1 minute	4	19	608.21	604.2	589.2
PZ-15D	106	10 minutes	1 minute	22	32	608.19	586.2	576.2
PZ-1S	158	10 minutes	1 minute	36	41	606.36	570.4	565.4
PZ-1D	158	10 minutes	1 minute	63.5	68.5	606.23	542.7	537.7
Monitoring for Extraction Well 3								
EX-3	0	10 minutes	10 seconds	TBD	TBD	TBD	TBD	TBD
EX-4	496	10 minutes	1 minute	TBD	TBD	TBD	TBD	TBD
PZ-F	70	10 minutes	20 seconds	TBD	TBD	TBD	TBD	TBD
Monitoring for Extraction Well 4								
EX-4	0	10 minutes	10 seconds	TBD	TBD	TBD	TBD	TBD
EX-3	496	10 minutes	1 minute	TBD	TBD	TBD	TBD	TBD
PZ-G	84	10 minutes	20 seconds	TBD	TBD	TBD	TBD	TBD
Monitoring for Extraction Well 5								
EX-5	0	10 minutes	10 seconds	TBD	TBD	TBD	TBD	TBD
EX-4	498	10 minutes	1 minute	TBD	TBD	TBD	TBD	TBD
PZ-H	89	10 minutes	20 seconds	TBD	TBD	TBD	TBD	TBD
Monitoring for Extraction Well 6								
EX-6	0	10 minutes	10 seconds	TBD	TBD	TBD	TBD	TBD
EX-7	650	10 minutes	1 minute	TBD	TBD	TBD	TBD	TBD
PZ-I	66	10 minutes	20 seconds	TBD	TBD	TBD	TBD	TBD
Monitoring for Extraction Well 7								
EX-7	0	10 minutes	10 seconds	TBD	TBD	TBD	TBD	TBD
EX-6	650	10 minutes	1 minute	TBD	TBD	TBD	TBD	TBD
PZ-J	63	10 minutes	20 seconds	TBD	TBD	TBD	TBD	TBD
Monitoring for Extraction Well 8								
EX-8	0	10 minutes	10 seconds	TBD	TBD	TBD	TBD	TBD
PZ-E	59	10 minutes	20 seconds	TBD	TBD	TBD	TBD	TBD
Monitoring for Extraction Well 9								
EX-9	0	10 minutes	10 seconds	TBD	TBD	TBD	TBD	TBD
PZ-K	54	10 minutes	20 seconds	TBD	TBD	TBD	TBD	TBD
PZ-31-17	158	10 minutes	1 minute	7	17	608.93	601.9	591.9
PZ-31-40	158	10 minutes	1 minute	35	40	608.61	573.6	568.6
PZ-31-53	158	10 minutes	1 minute	48	53	609.14	561.1	556.1

Acronyms:
bgs = below ground surface
EX = extraction
amsl = at mean sea level
PZ = piezometer
TBD = to be determined after installation

TABLE 4
Summary of Startup Test Stages for Treatment System
Tyco Fire Technology Center
Marinette, Wisconsin

Test Stage	Loop Stage	Throughput Stage		Complete System Stage
Test Purpose	Individual systems except for groundwater extraction and conveyance[1]	Groundwater extraction and conveyance system	Functionality of the whole GETS	Testing under Normal Operation
Involved Systems	All treatment system components	All systems		All systems
Source of Influent	Potable water	Groundwater		Groundwater
Destination of Treated Water	Equalization tank	Outfall		Outfall
Destination of Wastewater	Equalization tank	Sludge tank		Sludge tank
Use of Chemicals	No	Yes		Yes
Flowrate	-	Low flowrate		Design flowrate

Notes:
1. Treated water is defined as groundwater that flows through all the treatment system steps. Wastewater is the water produced through backwashing of filters and clarifier underflow during treatment system operations.

TABLE 5

Performance Metrics of Individual Unit Processes for GETS

Tyco Fire Technology Center

Marinette, Wisconsin

Unit Process	Performance Metrics
Groundwater Extraction and Conveyance	Pressures and flow rates are stable from operating extraction wells, and are consistent with extraction pump performance curves. Extraction well water levels are stable, and within operable ranges.
Equalization Tank, Recirculation and Feed Pumps	Tank level is stable. Timely level alarm activities to notify the operator or shut down the treatment plant or pumps for above or below level setpoint water levels. Influent flow rate matches effluent pump flow rate. Pump pressure and flow are consistent with pump performance curve. Smooth operation of variable speed controls without creating hydraulic surges.
Permanganate Dosing System	Proper operation of metering pumps and dosing. Verification of ORP measurement downstream of permanganate dosing point.
Coagulant Dosing System	Proper operation of metering pumps and dosing.
Clarifier System	Proper flow profile through the different clarifier chambers. Smooth operation of mixers in the clarifier. Proper settling of solids in the clarification chamber. Oxidation and settling of iron and manganese present in the influent.
Greensand Filters	Targeted iron and manganese concentrations in the effluent are non-detect. Proper activation of greensand media using permanganate. Flow rates are evenly distributed among operating vessels. Backwash is initiated at the differential pressure of 10 psi or timer setpoint

TABLE 5

Performance Metrics of Individual Unit Processes for GETS

Tyco Fire Technology Center

Marinette, Wisconsin

Unit Process	Performance Metrics
Break Tank, and Filter Feed Pumps	Tank level is stable. Timely level alarm activities to notify the operator or shut down the treatment plant or pumps for above or below level setpoint water levels. Influent flow rate matches effluent pump flow rate. Pump pressure and flow are consistent with pump performance curve. Smooth operation of variable speed controls without creating hydraulic surges.
Initial and Secondary Bag Filters	Filters are effectively trapping solids, which will be checked by taking samples from downstream of the filters and analyzing for turbidity less than 1.0 nephelometric turbidity unit (NTU) or Total Suspended Solids (TSS) less than 2 milligrams per liter (mg/L). Differential pressure across each vessel not to exceed 15 psi.
GAC System	Targeted PFAS concentrations in the effluent are below required limit. Flow rates are evenly distributed between the pairs of vessels. Differential pressure across each lead/lag pair of vessels not to exceed 15 psi.
IX System	Targeted PFAS concentrations in the effluent are required permit limit. Flow rates are evenly distributed among operating lead/lag vessel pairs. Differential pressure across each lead/lag pair of vessels not to exceed 20 psi.
Backwash Tank and Decant Pump	Tank level is stable. Timely level alarm activities to notify the operator or shut down the treatment plant or pumps for above or below level setpoint water levels. Solids from backwash and the clarifier settle at the bottom of the tank. Pump pressure and flow are consistent with pump performance curve.

TABLE 5

Performance Metrics of Individual Unit Processes for GETS

Tyco Fire Technology Center

Marinette, Wisconsin

Unit Process	Performance Metrics
Polymer Dosing System	Proper operation of metering pump, activation chamber and dosing. Verification of polymer flow meter measurements downstream of dosing point.
Filter Press and Filter Press Feed Pump	Proper functioning of the Filter Press producing dry cake. Filtrate from the press having sufficient pressure to drain to the treatment system sump. Filter Press feed pump operating at required flow rates and pressure, consistent with the pump performance curves.
Effluent Bag Filters	Filters are effectively trapping solids, which could be checked by taking samples from downstream of the filters and analyzing for turbidity less than 1.0 nephelometric turbidity unit (NTU) or Total Suspended Solids (TSS) less than 2 milligrams per liter (mg/L). Differential pressure across each vessel not to exceed 15 psi.
Effluent Pumps	No abnormal noise, vibration, or overheating is observed. Pressure and flow rate are consistent with pump performance curves. Smooth operation of variable speed controls without creating hydraulic surges.
Clean Backwash Pump	No abnormal noise, vibration, or overheating is observed. Pressure and flow rate are consistent with pump performance curves. Smooth operation of variable speed controls without creating hydraulic surges.
Sulfuric Acid Dosing System	Proper operation of metering pumps and dosing. Verification of pH measurement downstream of sulfuric acid dosing point.

Table 6
GETS Commissioning Treatment System Sampling and Analysis Plan
Tyco Fire Technology Center
Marinette, Wisconsin

Parameter[10]	Measurement Type	Analytical Method	Method Detection Limit[3]	Effluent Target[4,8]	Sample Type	Sample Collection - GETS Discharge Startup[5]								
						SP1[6]	SP2[6]	SP3[6]	SP4[6]	SP5[6]	SP6[6]	SP7[6]	SP8[6]	SP9[11]
Flow Rate[12]	Field Parameter	--	--	gpd	Estimated	1x/ day	--	--	--	--	--	--	--	1x/ day
pH[12]		--	--	6.0 s.u.	Grab	1x/ day	1x/ day	1x/ day	--	--	--	--	--	a
		--	--	9.0 s.u.										
TSS		--	--	40 mg/L	Grab	1x/ week	1x/ week	1x/ week	--	--	--	--	--	b
Chlorine, Total Residual		See Note [14]	--	19 µg/L	Grab	1x/ week	--	--	--	--	1x/ week	--	--	c
Iron	Lab Analysis	EPA Method 200.7	6.2 ug/L	--	Grab	1x/ week	1x/ week	1x/ week	--	--	--	--	--	--
Manganese		EPA Method 200.8	0.04 ug/L	--	Grab	1x/ week	1x/ week	1x/ week	--	--	--	--	--	--
Oil & Grease (Hexane)		EPA Method 1664	1.5 mg/L	10 mg/L	Grab	1x/ week	--	--	--	--	1x/ week	--	--	
BTEX, Total		EPA Method 8021b	1.0 ug/L	750 µg/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
PAHs[1]		EPA Method 610	2.3 ug/L[7]	0.1 µg/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
Benzo(a)pyrene		EPA Method 610	0.023 ug/L	0.1 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
Naphthalene		EPA Method 610	1.8 ug/L	70 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
Bromoform		EPA Method 8260D	0.12 ug/L	120 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
Carbon Tetrachloride		EPA Method 8260D	0.02 ug/L	150 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
Chloroform		EPA Method 8260D	0.04 ug/L	120 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
Dichlorobromomethane		EPA Method 501.3	0.07 ug/L	120 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
1,2-Dichloroethane		EPA Method 8260D	0.03 ug/L	180 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	a
1,1-Dichloroethylene		EPA Method 8260B	0.12 ug/L	50 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
Methyl Bromide		EPA Method 8260B	0.14 mg/L	120 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
Methyl Chloride		EPA Method 8260B	0.05 mg/L	120 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
1,1,2,2-Tetrachloroethane		EPA Method 8260D	0.20 ug/L	50 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
Tetrachloroethylene		EPA Method 8260D	0.05 ug/L	50 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
1,1,2-Trichloroethane		EPA Method 8260D	0.08 ug/L	50 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
1,1,1-Trichloroethane		EPA Method 8260D	0.04 ug/L	50 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
Trichloroethylene		EPA Method 8260D	0.19 ug/L	50 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
Vinyl Chloride		EPA Method 8260D	0.17 ug/L	10 ug/L	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	--	--	
PFOA[2]		Modified EPA 537.1	0.77 ng/L	<20 ug/L[9]	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	1x/ week	1x/ week	1x/ week
PFOS[2]			0.49 ng/L											
Other PFAS		Modified EPA 537.1	2.8 ng/L[13]	--	Grab	1x/ week	--	--	1x/ week	1x/ week	1x/ week	1x/ week	1x/ week	--
TOC		EPA 9060A	1 mg/L	--	Grab	1x/ week	1x/ week	1x/ week	1x/ week	1x/ week	1x/ week	--	--	--

Notes:
1. Calculated for the PAH group of 10 using toxicity equivalent factors.
2. Target limits under the WPDES permit
3. Method Detection Limit subject to change based on laboratory selection, methods, dilution and other factors.
4. Effluent targets are derived from contaminated groundwater from remedial action operations for surface water discharge outlines in section 4.2 of the WPDES Permit excluding the limits for PFOA and PFOS, see note 9.
5. SP1- GETS influent; SP2- Clarifier effluent; SP3- Greensand effluent; SP4- 1st GAC pair effluent; SP5- 2nd GAC pair effluent, SP6- final GAC pair effluent; SP7- Lead IX effluent; SP8- Lag IX effluent; SP9- Final GETS effluent.
6. These are voluntary sample locations. Voluntary samples are not required by the WPDES permit, but are collected for internal assessment of GETS performance and O&M needs. Sampling parameters and collection frequencies are initial values and may be modified based on analytical data.
7. The method detection limit shown is the highest method detection limit using this method. This corresponds to Acenaphylene with UV detection. Other compounds are associated with lower method detection limits.
8. Any excursions from these limits will result in review of operations and maintenance of the GETS to determine response action(s) as described in Table 7 of the Commissioning Plan.
9. Combined PFOA/PFOS effluent target set based on discussions with the WDNR.
10. Parameters included are from the surface water discharge requirements in section 4 of the WPDES permit, benzene is already below 1/5 of permit limit in the GETS influent has not been included.
11. Effluent sample point. Results from this sample locaiton will be provided as part of the startup progress report to the WDNR. In case of any target excursions, corrective actions outlined in the Operational Modification Plan (Table 7) will be followed.
12. These parameters are monitored on the GETS PLC/HMI system and will recorded continuously.
13. Based on the highest PFAS detection limit in the standard for NEtFOSAA.
14. Test methods will be determined based on those approved in Wis. Adm. Code Chapter NR 219 - Table B.
a. 1x at start of discharge, 1x weekly for the first 4 weeks of discharge, 1x monthly after the first 4 weeks if data indicates substantial compliance with effluent limits. If sampling frequency is at monthly or quarterly and an excursion occurs, the sampling frequency will be reduced back to weekly until compliance is demonstrated for 8 consecutive weeks.
b. Monitoring required only when cleaning wastewaters are discharged from the system or when groundwater is pumped from construction pits or trenches.
c. Monitoring required only when there is a discharge of equipment cleaning wastewaters.

Acronyms:
SP = Sample Point
TSS= Total suspended solids
BTEX = benzene, toluene, ethylbenzene, xylene
gpd = gallons per day
PAHs = polycyclic aromatic hydrocarbon
s.u. = standard units
mg/L = milligram per liter
ug/L = microgram per liter
ng/L = nanogram per liter

TABLE 7
Commissioning Plan Operational Modifications Table for Treatment System
Tyco Fire Technology Center
Marinette, Wisconsin

Parameter	Causes and Actions/ Modifications Taken
Turbidity	Likely causes for exceedance of turbidity include clarifier carryover in the overflow and bag filter breakthrough. Actions: • Review clarifier operations and adjust chemical dosing, sludge removal to reduce carry over in overflow. • Perform bag filter changeouts. • Perform greensand filter backwash. • Change filter bag rating if necessary to capture fines.
pH	Likely causes of pH fluctuating outside of acceptable range is the chemical oxidation in pretreatment and pH spikes associated with new GAC media. Actions: • Review chemical oxidant dosing and adjust if necessary. • Implement acid or caustic dosing downstream of the ion exchange vessels if pH exceedances persist.
TSS	Likely causes for exceedance of TSS include clarifier carryover in the overflow and bag filter breakthrough. Actions: • Review clarifier operations and adjust chemical dosing, sludge removal to reduce carry over in overflow. • Perform bag filter changeouts. • Change filter bag rating if necessary to capture fines.
Iron & Manganese	Likely causes for poor removal of iron and manganese include clarifier upsets, chemical dosing upsets, greensand filter upsets and changes to influent concentrations. Actions: • Review clarifier operations and adjust chemical dosing, sludge removal to reduce carry over in overflow. • Check influent concentrations and adjust chemical dosing if necessary. • Change filter bag rating if necessary to capture fines. • Backwash/regenerate greensand filters if necessary.
VOCs, BTEX, PAHs	Likely causes for excursion of VOCs, BTEX and PAHs limits include insufficient removal through pretreatment, channeling, bed compaction, effluent rollover/overshoot and GAC breakthrough. Actions: • Tier 1: If exceedance is observed, trigger additional sampling within 48 hours to confirm observed excursion. •Tier 2: Share intermediate sample location data to show GETS performance. •Tier 3: Operational modifications such as recirculation, reduction of flow through system, pretreatment performance checks, system parameter checks for channeling, bed compaction, leaks etc. •Tier 4: GAC swap changeout and sample within 48 hours of changeout.
PFAS	Likely causes for excursion of PFAS limits include channeling, bed compaction, effluent rollover/overshoot and GAC and IX breakthrough. Actions: •Tier 1: Trigger additional sampling within 48 hours to confirm excursion. •Tier 2: Share intermediate sample location data to show GETS performance. •Tier 3: Operational modifications such as recirculation, reduction of flow through system, pretreatment. performance checks, system parameter checks for channeling, bed compaction, leaks etc. •Tier 4: GAC/IX swap or changeout and sample within 48 hours of changeout.

Notes:
1. Limits for VOCs, BTEX, PAHs, and PFAS are provided in Table 6 as the Effluent Target.

Acronyms:

TSS = total suspended solids
GAC = granular activated carbon
BTEX = benzene, toluene, ethylbenzene, xylene
PAHs = polycyclic aromatic hydrocarbons.
VOCs = volatile organic compounds.
PFAS = per- and polyfluoroalkyl substances.

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