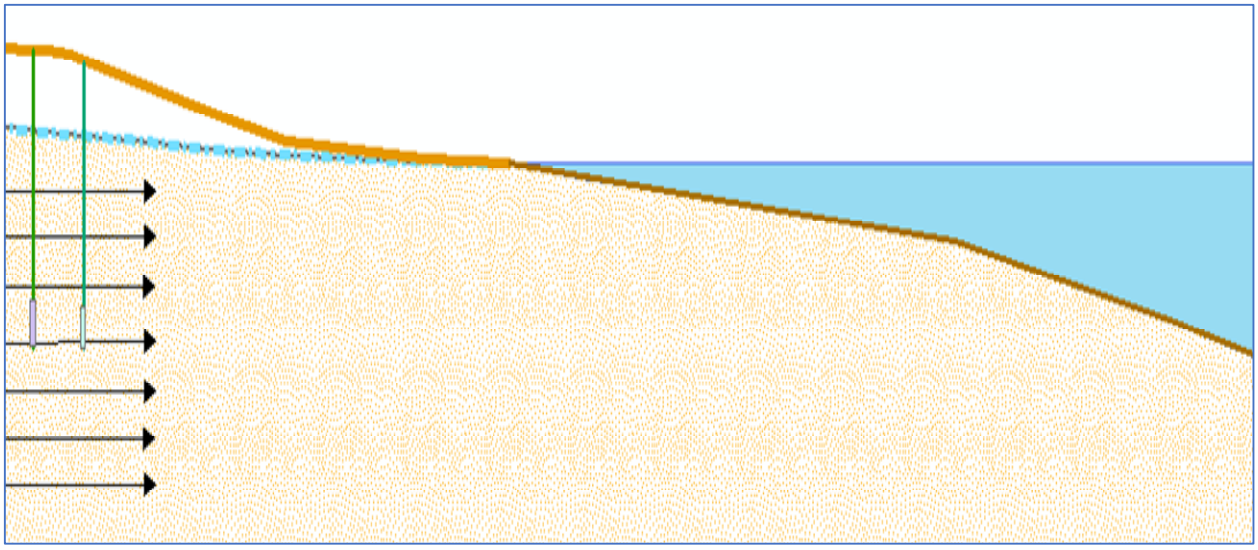
Van Etten Lake – Groundwater-Surface Water Interface (GSI), Evaluation of Perfluorooctane Sulfonate (PFOS)

Former Wurtsmith Air Force Base, Oscoda, Michigan

By the Michigan Department of Environment, Great Lakes, and Energy, Remediation and Redevelopment Division, Superfund Section, Geology and Defense Site Management Unit



EGLE

July 2019

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Executive Summary

A GSI evaluation of PFOS was performed along the western shoreline of Van Etten Lake, Iosco County, Michigan. Horizontal groundwater flow and groundwater concentrations of PFOS were reviewed with respect to the GSI pathway. The horizonal groundwater flow and groundwater concentrations of PFOS are primary data sets used in the evaluation. Supplemental data in the evaluation consisted of surface water temperature profiling and thermal imaging data to select porewater and surface water sampling locations, porewater sampling data, surface water sampling data, and foam sampling data. Five areas were identified during the evaluation: Beach 1, Air Force Beach, Pierce's Point, LF30/31 (YMCA Beach), and Defense Reutilization and Marketing Office (DRMO). The data shows conclusively that the groundwater venting to Lake Etten Lake from the former Wurtsmith Air Force Base (WAFB) has concentrations of PFOS that exceed the GSI criteria established under Part 201, Environmental Remediation, of the Natural Resources and Environmental Protection Act, Act 451 of 1994, as amended (NREPA). Recommendations for each area consist of adding permanent monitoring wells to the groundwater/surface water monitoring well network, collecting additional data from permanent monitoring wells, and vertical aquifer sampling to further characterize the vertical and horizontal extent of PFOS contamination.

Purpose

The purpose of this report is to summarize and interpret horizontal groundwater flow data and concentration of PFOS in groundwater samples (greater than the groundwater/surface water interface [GSI] Criteria of 12 parts per trillion [ppt]) collected at selected monitoring locations along the west shore of Van Etten Lake. The interpretation of the data is to determine if groundwater, above the GSI criteria, is venting to Van Etten Lake. Additional supplemental data (surface water temperature profiling and thermal imaging, pore water sampling, surface water sampling, and foam sampling) will also be evaluated.

GSI Evaluation Elements

GSI Relevance Statement

The GSI pathway is relevant when a remedial investigation (RI) or application of best professional judgment leads to the conclusion that a hazardous substance in groundwater can be reasonably expected to vent to surface waters of the state in concentrations that exceed the generic GSI criteria (Section 20120e(3) of Part 201) currently or in the future. The GSI pathway may be relevant for all land uses if there is a hydraulic connection between the groundwater and surface water. (2018, MDEQ)

Key elements in determining pathway relevancy include the following:

- There must be a hydraulic connection between the contaminated groundwater and surface water to have a GSI. This includes an intermittent stream or water body that has flow until the groundwater table drops below the stream bottom. Intermittent streams are protected for acute and chronic risks. An ephemeral stream or water body only has flow during periods of surface runoff (rain or snowmelt). An ephemeral stream would not have a GSI.

- The hydraulic connection must transport contaminated groundwater to the surface water; a 'losing' surface water body would have a hydraulic connection with groundwater but would not transport contaminated groundwater to the surface water body.

- The designation of groundwater "not in an aquifer" does not eliminate the need to evaluate the GSI pathway. Groundwater "not in an aquifer" may be hydraulically connected to a surface water body and may vent or be reasonably expected to vent in concentrations that exceed generic GSI risk-based screening levels (RBSLs)/criteria (see definition of generic GSI risk-based screening levels/criteria).

- The applicable generic GSI RBSLs/criteria for all appropriate hazardous substances released or otherwise affected (reactions, breakdown byproducts, etc.) and appropriate Water Quality Standards (WQS) for physical characteristics are or could be exceeded in representative samples at GSI monitoring points.

- Contaminated groundwater is discharging into a separate storm sewer that discharges to a surface water body.

The Michigan Department of Environment, Great Lakes, and Energy (EGLE) has promulgated rules that establish specific GSI criteria (Cleanup Criteria Requirements for Response Activity, Mich. Admin. Code R 299.1 *et seq.*) that establish cleanup criteria under Part 201. In

March 2014, 12 ppt was established as the GSI criterion for PFOS pursuant to Section 20120e(1)(a) of Part 201.

EGLE Definitions

GSI (Section 20120e(23)(c) of Part 201): Groundwater Surface Water Interface that is the location at which groundwater enters a surface water body.

GSI Monitoring Well (Section 20120e(23)(d) of Part 201): A vertical well installed in the saturated zone as close as practicable to surface water with a screened interval or intervals that are representative of the groundwater venting to the surface water.

EGLE Evaluation of Primary GSI Data

Primary Data:

- Horizontal groundwater flow data using the difference in groundwater elevation between selected monitoring wells

- Concentration of PFOS in groundwater samples (GSI Criteria of 12 ppt) collected at selected monitoring locations along the west shore of Van Etten Lake.

Horizontal Flow Determination

Groundwater elevation data was summarized from selected monitoring wells from 2006-2018 with respect to the following per- and polyfluoroalkyl substances (PFAS) areas: Beach 1, Air Force Beach LF30/31 (YMCA Beach), DRMO, and Pierce's Point (see Attachment 1), as designated by EGLE. The groundwater elevation data and charts of groundwater elevation are presented in Attachment 2.

Groundwater Quality Data – PFOS Greater Than GSI Criteria

Groundwater data collected from 2011-2018 by EGLE designated personnel and by Air Force Civil Engineer Center (AFCEC) designated personnel was compared to the GSI criteria of 12 ppt. Only the groundwater samples equal to or greater than 12 ppt are presented in Attachment 3.

Primary Data Conclusions:

Beach 1

Question: Is the source of the PFOS the result of United States Air Force (USAF) activities?
Response: PFOS concentrations in groundwater are consistent with detections of other compounds associated with previously investigated releases from USAF areas of concern.

Question: Is groundwater venting into Van Etten Lake?
Response: Yes. Analysis of groundwater elevation data up gradient from Van Etten Lake indicates a horizontal component of groundwater flow that is venting into Van Etten Lake within this area.

Question: Are the concentrations of groundwater samples collected from within the area above EGLE GSI PFOS criteria of 12 ppt?

Response: Yes. Groundwater samples collected from temporary locations and permanent locations by the designated AFCEC and EGLE representatives have concentrations above the GSI criteria for PFOS within this area.

Recommendations

The highest concentration of PFOS (3,870 ppt) is located at temporary sample location VAS01034 from 31 to 35 feet below ground level. A permanent monitoring well, A1-MW9D, was installed in this interval. A map view of this area is provided in Attachment 4.

- Add permanent monitoring wells A1-MW7S, A1-MW-7D, A1-MW8S, A1-MW-8D. A1-MW9S, and A1-MW-9D to the GSI monitoring well network.

The highest concentration of PFOS was detected at permanent monitoring well A1-MW5S (PFOS=34.8 ppt). A map view of this area is provided in Attachment 4.

- Add permanent monitoring wells A1-MW5S, A1-MW-5D, A1-MW6S, A1-MW6D, and AF15-MW2 to the GSI monitoring well network.

Air Force Beach

Question: Is the source of the PFOS the result of USAF activities?
Response: PFOS concentrations in groundwater are consistent with detections of other compounds associated with previously investigated releases from USAF areas of concern.

Question: Is groundwater venting into Van Etten Lake?
Response: Yes. Analysis of groundwater elevation data up gradient from Van Etten Lake indicates a horizontal component of groundwater flow that is venting into Van Etten Lake within this area.

Question: Are the concentrations of groundwater samples collected from within the area above the EGLE GSI PFOS criteria of 12 ppt?
Response: Yes. Groundwater samples collected from temporary locations and permanent locations by the designated AFCEC and EGLE representatives have concentrations above the GSI criteria for PFOS within this area.

The highest concentration of PFOS is located at permanent monitoring well A1-MW12D (PFOS=11,800 ppt). A map view of this area and a cross-section are provided in Attachment 5.

Recommendations:

- Install a permanent monitoring well at VAS15010 from 40 to 45 feet below ground level.
- Install a permanent monitoring well at VAS15011 from 25 to 30 feet below ground level.
- Add permanent monitoring wells A1-MW11S, A1-MW11D, A1-MW12S, and A1-MW12D to the GSI monitoring well network.

LF30/31 (YMCA Beach)

Question: Is the source of the PFOS the result of USAF activities?
Response: PFOS concentrations in groundwater are consistent with detections of other compounds associated with previously investigated releases from USAF areas of concern.

Question: Is groundwater venting into Van Etten Lake?
Response: Yes. Analysis of groundwater elevation data up gradient from Van Etten Lake indicates a horizontal component of groundwater flow that is venting into Van Etten Lake within this area.

Question: Are the concentrations of groundwater samples collected from within the area above the EGLE GSI PFOS criteria of 12 ppt?
Response: Yes. Groundwater samples collected from temporary locations and permanent locations by the designated EGLE representatives have concentrations above the GSI criteria for PFOS within this area. The following data indicates concentrations of PFOS above the GSI: VAS17002-27-30 (November 8, 2016) = 32.2 ppt; VAS17002-46.5-49.5 (November 8, 2016) = 14.1 ppt; YMCA Y-6 (November 9, 2016) = 17 ppt; LF30-MW3 (November 9, 2016) = 37 ppt.

The highest concentration of PFOS was detected at permanent monitoring well LF31-MW5 (PFOS=220 ppt). A map view of this area is provided in Attachment 6.

Recommendations:

- It is recommended additional data be collected. Collect groundwater samples from existing well network along Van Etten Lake for four quarters and compare results to GSI criteria.

ST-69, DRMO Storage Facility

Question: Is the source of the PFOS the result of USAF activities?
Response: PFOS concentrations in groundwater are consistent with detections of other compounds associated with previously investigated releases from USAF areas of concern.

Question: Is groundwater venting into Van Etten Lake?
Response: Inconclusive due to insufficient groundwater elevation monitoring points down gradient from ST-69/OT45.

Question: Are the concentrations of groundwater samples collected from within the area above the EGLE GSI PFOS criteria of 12 ppt?

Response: Inconclusive due to insufficient down gradient characterization from the detection of PFOS (i.e. monitoring well OT45-MW-1). There are no GSI monitoring wells down gradient from the OT45-MW-1(OT45-MW-1, PFOS=74,100 ppt, collected April 27, 2016).

Elevated concentration of PFOS was detected in groundwater at the DRMO (permanent monitoring well OT45-MW1, PFOS=74,100 ppt). Groundwater samples collected down gradient from the DRMO from both permanent and temporary well locations adjacent to Van Etten Lake detected concentrations of PFOS above the GSI criteria of 12 ppt. A map view of this area and a cross-section are provided in Attachment 7.

Recommendations:

- The extent of PFOS has not been defined at permanent monitoring well LF30-MW3 and additional characterization north of this monitoring well along the area adjacent to Van Etten Lake is recommended. Based upon groundwater flow direction, it is unclear if the detection of PFOS in LF30-MW3 came from the DRMO.
- Install a permanent monitoring well at VAS17002 from 25 to 30 feet below land surface.

- Sample existing well network with screen elevations between 563 and 578 feet above mean sea level along Van Etten Lake in this area for four quarters and compare results to GSI criteria.

Pierce's Point

Question: Is the source of the PFOS the result of USAF activities?
Response: PFOS concentrations in groundwater are consistent with detections of other compounds associated with previously investigated releases from USAF areas of concern.

Question: Is groundwater venting into Van Etten Lake?
Response: Yes. Analysis of groundwater elevation data up gradient from Van Etten Lake indicates a horizontal component of groundwater flow that is venting into Van Etten Lake within this area.

Question: Are the concentrations of groundwater samples collected from within the area above EGLE GSI PFOS criteria of 12 ppt?
Response: Yes. Groundwater samples collected from temporary locations and permanent locations by the designated AFCEC and EGLE representatives have concentrations above the GSI criteria for PFOS within this area.

Two locations have elevated concentrations of PFOS within this area. One area, permanent monitoring well A4-MW1 has PFOS=1,240 ppt. The other area, A4-MW2 has PFOS=2,760 ppt. A map view of this area and a cross-section are provided in Attachment 8.

Recommendations:

- At A4-MW-1 – Perform vertical aquifer sampling on either side of this monitoring well to determine the horizontal extent of PFOS. Add this well to the GSI monitoring well network.
- At A4-MW2 – Collect groundwater samples from existing monitoring wells on either side of the SS-05 cross-section line (see Attachment 5) with screen elevations between 563 and 581 feet above mean sea level. If no monitoring wells exist within the stated screen interval, then perform vertical aquifer sampling.

GSI Area of Impact Observation – Beach 1 and Air Force Beach

Data collected from both temporary and permanent monitoring wells along Van Etten Lake indicate an extensive continuous area of groundwater exceeding the PFOS GSI criteria of 12 ppt. Attachment 9 depicts the area northwest and southeast of Air Force Beach along Van Etten Lake. This area is associated with various installation restoration programs sites located up gradient.

GSI Evaluation of Supplemental Data

Supplemental Data:

- Surface water temperature profiling and thermal imaging data to select porewater and surface water sampling locations.
- Pore water sampling data
- Surface water sampling data
- Foam sampling data

Surface Water Temperature Profiling Data:

Surface water temperature profiling was performed in July 2017 along the west shore of Van Etten Lake. Data analysis was performed along the shore of the LF30/31 (YMCA Beach), DRMO and Pierce's Point. Surface water temperature profiling data was used to (1) Understand potential groundwater discharge into Van Etten Lake; (2) Identify potential PFAS to discharge into surface water; and (3) Develop a better understanding of groundwater flow to improve the base-wide Conceptual Site Model (CSM). This data was used to determine where groundwater was venting into Van Etten Lake. The results of the profiling indicated a significant contrast between the temperature of the groundwater and the temperature of the surface water of Van Etten Lake. This data was used to select locations for surface water and pore water samples. The full report is presented in Attachment 10.

Thermal Imaging, Surface Water and Pore Water Sampling Analysis:

Surface water and pore water samples were collected in December 2018 at Beach 1 and Air Force Beach using thermal imaging data. The purpose of the sampling was to identify potential PFAS discharging locations along the west shore of Van Etten Lake. Results indicate concentrations of PFAS in the surface water and pore water. The full report is presented in Attachment 11.

Foam Sampling Analysis:

Foam samples were collected between 2012 and 2018 at various locations around Van Etten Lake. Foam on a surface water body has been associated with the presence of PFAS in the surface water. Results indicate the range of concentration of PFOS in the foam from 7,120 ppt at the east shoreline to 148,000 ppt at the west shoreline at Air Force Beach. A figure with the foam sampling results for PFOS is presented in Attachment 12.

Supplemental Data Conclusions:

The surface water temperature profiling data and thermal imaging, surface water and pore water data, and foam data qualitatively support the venting of groundwater containing PFOS above the GSI criteria.

References

Section 324.20120e, Part 201, Environmental Remediation, Natural Resources and Environmental Protection Act (NREPA), PA 451, 1994, as amended. http://legislature.mi.gov/doc.aspx?mcl-324-20120e

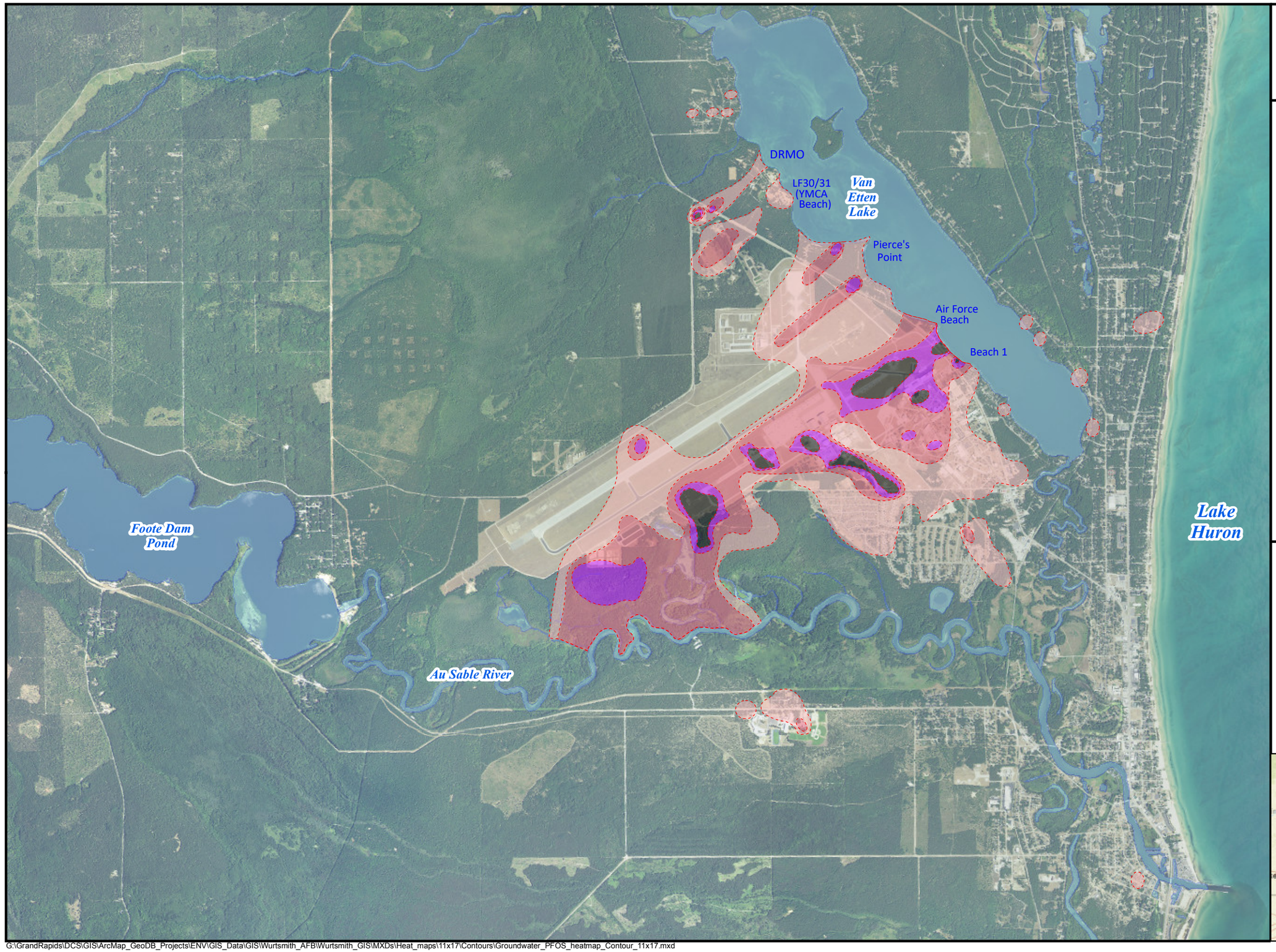
Section 324.21304a, Part 213, Environmental Remediation, Natural Resources and Environmental Protection Act (NREPA), PA 451, 1994, as amended. http://legislature.mi.gov/doc.aspx?mcl-324-21304a

2019, Air Force Civil Engineer Center, *SSI Monitoring Well Sampling Results, Fall 2018, Former Wurtsmith Air Force Base*, January 16, 2019 SSI Update Meeting presentation and supplemental materials.

2018, Bay West LLC, *Draft Final 2017 Annual Remedial Action Operation Report for Installation Restoration Program Sites LF-27, OT-16, SS-05, SS-08, SS-51, SS-71, SS-72, ST-68, ST-69, and WP-04, Former Wurtsmith Air Force Base, Oscoda, Michigan*, prepared for United States Air Force Civil Engineer Center, Revision 00, November 2018.

2018, Michigan Department of Environmental Quality, Remediation and Redevelopment Division, *Groundwater-Surface Water Interface Pathway Compliance Options, Remediation and Redevelopment Division Resource Materials*, April 2018.

Attachment 1 – EGLE Designated PFAS Areas



EGLE

6/20/2019

Legend

PFOS Plume

Concentration (ppt)

- 12
- 70
- 1,000
- 5,000

GROUNDWATER AND RESIDENTIAL SAMPLING RESULTS PFOS CONTOURS

FORMER WURTSMITH AIR FORCE BASE IOSCO COUNTY, MICHIGAN

N

0 3,400 6,800

Feet

G:\GrandRapids\DCS\GIS\ArcMap_GeoDB_Projects\ENV\GIS_Data\GIS\Wurtsmith_AFB\Wurtsmith_GIS\MXDs\Heat_maps\11x17\Contours\Groundwater_PFOS_heatmap_Contour_11x17.mxd

Attachment 2 – 2006 to 2018 Groundwater Elevation Data Used for Horizontal Flow Determination

Groundwater-Surface Water Interface - Van Etten Lake

Groundwater Elevation Data - Horizontal Flow Determination - Grouped by EGLE PFAS Area

Former Wurtsmith Air Force Base, Oscoda, Michigan

Depth to Water			Nov-17	Nov-16	Nov-15	Dec-14	Nov-13	Mar-12	Apr-11	Apr-10	Sep-09	Apr-08	Oct-07	Sep-07	Nov-06	Apr-06	Sep-05	May-04	Sep-03	May-03	Sep-02
LOCATION NAME	SITE	MDEQ PFAS Area Number	DEC. 2018 WATER LEVEL from TOC	NOV. 2017 WATER LEVEL from TOC	NOV. 2016 WATER LEVEL from TOC	NOV. 2015 WATER LEVEL from TOC	DEC. 2014 WATER LEVEL from TOC	NOV. 2013 WATER LEVEL from TOC	MARCH 2012 WATER LEVEL from TOC	APRIL 2011 WATER LEVEL from TOC	APRIL 2010 WATER LEVEL from TOC	SEPT. 2009 WATER LEVEL from TOC	APRIL 2008 WATER LEVEL from TOC	OCT. 2007 WATER LEVEL from TOC	SEPT. 2007 WATER LEVEL from TOC	NOV. 2006 WATER LEVEL from TOC	APRIL 2006 WATER LEVEL from TOC	SEPT. 2005 WATER LEVEL from TOC	MAY 2004 WATER LEVEL from TOC	SEPT. 2003 WATER LEVEL from TOC	MAY 2003 WATER LEVEL from TOC
H78D	LF30/LF31	YMCA Beach and DRMO	NM	NM	NM	NM	25.57	NM	NM	25.11	NM	NM	NM	24.20	NM	NM	NM	NM	23.91	24.54	25.23
H78S	LF30/LF31	YMCA Beach and DRMO	25.29	24.75	25.70	25.14	25.58	25.43	25.44	25.10	24.67	23.91	25.11	24.20	NM	NM	24.00	24.53	23.92	24.53	25.25
H35S	LF30/LF31	YMCA Beach and DRMO	NM	18.45	19.1	18.72	19.03	18.92	18.76	18.28	18.08	17.56	18.53	17.73	NM	NM	17.59	17.92	17.45	18.01	18.35
H79D	LF30/LF31	YMCA Beach and DRMO	NM	NM	NM	NM	25.05	NM	NM	24.78	NM	NM	NM	23.86	NM	NM	NM	NM	NM	24.11	24.96
H79S	LF30/LF31	YMCA Beach and DRMO	24.64	24.14	25.11	24.69	24.92	25	24.90	24.68	24.20	23.45	24.68	23.75	NM	NM	NM	NM	23.49	NM	24.85
H33S	LF30/LF31	YMCA Beach and DRMO	17.29	16.88	17.58	17.25	17.45	17.37	17.31	17.97	16.70	16.16	17.13	16.35	NM	NM	16.31	16.59	16.04	16.65	17.06
Groundwater Elevation																					
H78D	LF30/LF31	YMCA Beach and DRMO	NM	NM	NM	NM	592.79	NM	NM	593.25	NM	NM	NM	594.16	NM	NM	NM	NM	594.45	593.82	593.13
H78S	LF30/LF31	YMCA Beach and DRMO	593.06	593.60	592.65	593.21	592.77	592.92	592.91	593.25	593.68	594.44	593.24	594.15	NM	NM	594.35	593.82	594.43	593.82	593.10
H35S	LF30/LF31	YMCA Beach and DRMO	NM	591.56	590.91	591.29	590.98	591.09	591.25	591.73	591.93	592.45	591.48	592.28	NM	NM	592.42	592.09	592.56	592.00	591.66
H79D	LF30/LF31	YMCA Beach and DRMO	NM	NM	NM	NM	593.07	NM	NM	593.34	NM	NM	NM	594.26	NM	NM	NM	NM	NM	594.01	593.16
H79S	LF30/LF31	YMCA Beach and DRMO	593.59	594.09	593.12	593.54	593.31	593.23	593.33	593.55	594.03	594.78	593.55	594.48	NM	NM	NM	NM	594.74	NM	593.38
H33S	LF30/LF31	YMCA Beach and DRMO	592.03	592.44	591.74	592.07	591.87	591.95	592.01	591.35	592.62	593.16	592.19	592.97	NM	NM	593.01	592.73	593.28	592.67	592.26
Depth to Water																					
SS05-MW5	SS05	Pierce's Point	19.46	19.02	20.08	19.99	19.80	19.69	19.94	21.45	21.00	19.80	NM	20.08	NM	NM	NM	NM	20.35	NM	21.98
SS05-MW1	SS05	Pierce's Point	21.42	20.88	21.46	20.97	21.56	21.1	21.09	21.03	21.17	20.36	NM	20.41	NM	NM	NM	NM	20.26	20.83	21.16
Groundwater Elevation																					
SS05-MW5	SS05	Pierce's Point	595.24	595.68	594.62	594.71	594.90	595.01	594.76	593.25	593.70	594.90	NM	594.62	NM	NM	NM	NM	594.35	NM	592.72
SS05-MW1	SS05	Pierce's Point	589.85	590.39	589.81	590.30	589.71	590.17	590.18	590.24	590.10	590.91	NM	590.86	NM	NM	NM	NM	591.01	590.44	590.11
Depth to Water																					
SS71-MW3	SS71	Air Force Beach	18.89	18.61	20.04	20.27	19.21	19.67	19.82	21.47	21.21	19.84	21.03	20.41	NM	NM	20.64	21.77	NM	NM	NM
SS71-MW4	SS71	Air Force Beach	17.6	17.08	18.12	17.90	17.84	17.7	17.80	18.75	18.83	17.43	18.65	17.86	NM	NM	NM	NM	NM	NM	NM
Groundwater Elevation																					
SS71-MW3	SS71	Air Force Beach	595.81	596.09	594.66	594.43	595.49	595.03	594.88	593.23	593.49	594.86	593.67	594.29	NM	NM	594.06	592.93	NM	NM	NM
SS71-MW4	SS71	Air Force Beach	593.18	593.70	592.66	592.88	592.94	593.08	592.98	592.03	591.95	593.35	592.13	592.92	NM	NM	NM	NM	NM	NM	NM

Depth to Water				Dec-18	Nov-17	Nov-16	Nov-15	Dec-14	Nov-13	Mar-12	Apr-11	Apr-10	Sep-09	Apr-08	Oct-07	Sep-07	Nov-06	Apr-06	Sep-05	May-04	Sep-03
H136S	SS21	Beach 1	18.47	18.47	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
A1-MW8S	Area 1	Beach 1	15.35	15.35	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
Groundwater Elevation																					
H136S	SS21	Beach 1	590.12	590.12	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM
A1-MW8S	Area 1	Beach 1	587.24	587.24	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM	NM

NM = Not measured.

Groundwater-Surface Water Interface - Van Etten Lake

Groundwater Elevation Data - Horizontal Flow Determination - Grouped by EGLE PFAS Area

Former Wurtsmith Air Force Base, Oscoda, Michigan

Depth to Water

LOCATION NAME	SITE	MDEQ PFAS Area Number	SEPT. 2002 WATER LEVEL from TOC	Total Depth of Well from TOC	Stick up	Screen Length (ft.)	Depth to Top of Screen from TOC	Surveyed Northing NAD-83	Surveyed Easting NAD-83	Top of Casing Elev. (ft)
H78D	LF30/LF31	YMCA Beach and DRMO	24.27	53.90	1.54	4	49.90	423579.9688	19943027.580	618.36
H78S	LF30/LF31	YMCA Beach and DRMO	24.28	36.02	1.48	4	32.02	423588.5171	19943022.948	618.35
H35S	LF30/LF31	YMCA Beach and DRMO	17.81	18.39	1.79	4	14.39	423599.9145	19943303.462	610.01
H79D	LF30/LF31	YMCA Beach and DRMO	23.94	50.51	1.56	4	46.51	423310.3137	19943153.821	618.12
H79S	LF30/LF31	YMCA Beach and DRMO	23.83	35.95	1.48	4	31.95	423316.9910	19943153.967	618.23
H33S	LF30/LF31	YMCA Beach and DRMO	16.40	29.92	1.13	4	25.92	423346.8096	19943363.6865	609.32

Groundwater Elevation

H78D	LF30/LF31	YMCA Beach and DRMO	594.09
H78S	LF30/LF31	YMCA Beach and DRMO	594.07
H35S	LF30/LF31	YMCA Beach and DRMO	592.20
H79D	LF30/LF31	YMCA Beach and DRMO	594.18
H79S	LF30/LF31	YMCA Beach and DRMO	594.40
H33S	LF30/LF31	YMCA Beach and DRMO	592.92

Depth to Water

SS05-MW5	SS05	Pierce's Point	20.49	71.12	1.96	5	66.12	421038.9895	19945361.4611	614.70
SS05-MW1	SS05	Pierce's Point	20.61	49.63	-0.18	5	44.63	421467.4933	19945959.1176	611.27

Groundwater Elevation

SS05-MW5	SS05	Pierce's Point	594.21
SS05-MW1	SS05	Pierce's Point	590.66

Depth to Water

SS71-MW3	SS71	Air Force Beach	NM	28.74	2.50	10	18.74	418518.823	19947322.647	614.70
SS71-MW4	SS71	Air Force Beach	NM	38.90	2.30	5	33.90	418856.507	19948140.964	610.78

Groundwater Elevation

SS71-MW3	SS71	Air Force Beach	NM
SS71-MW4	SS71	Air Force Beach	NM

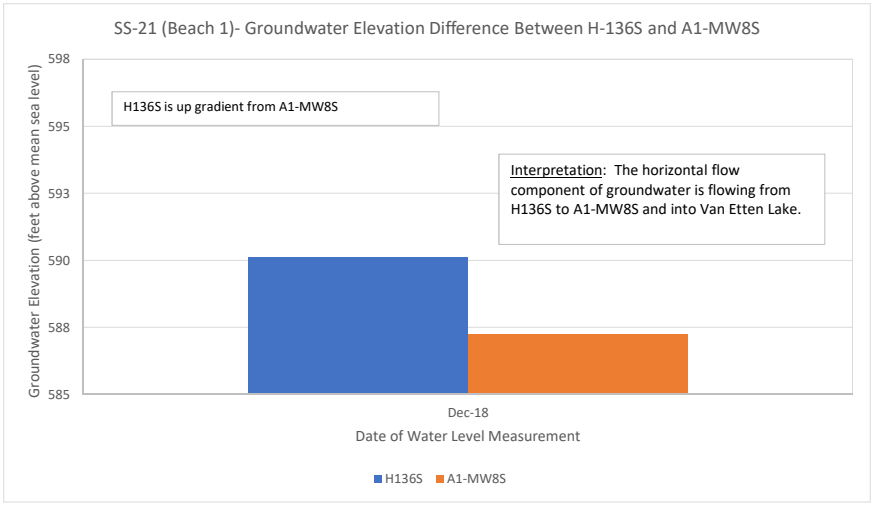
Depth to Water May-03

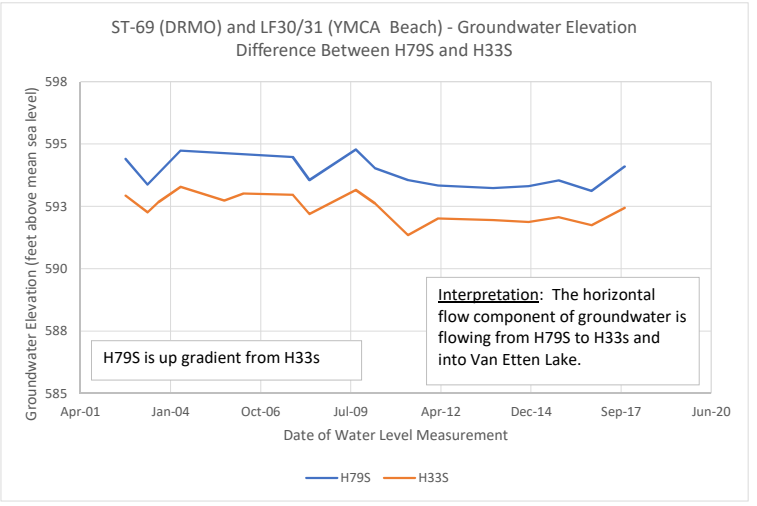
H136S	SS21	Beach 1	NM	32.66	1.88	4	28.66	417370.1257	19949811.23	608.59
A1-MW8S	Area 1	Beach 1	NM	30.53	-0.5	5	25.53	417372.331	19950462.38	602.59

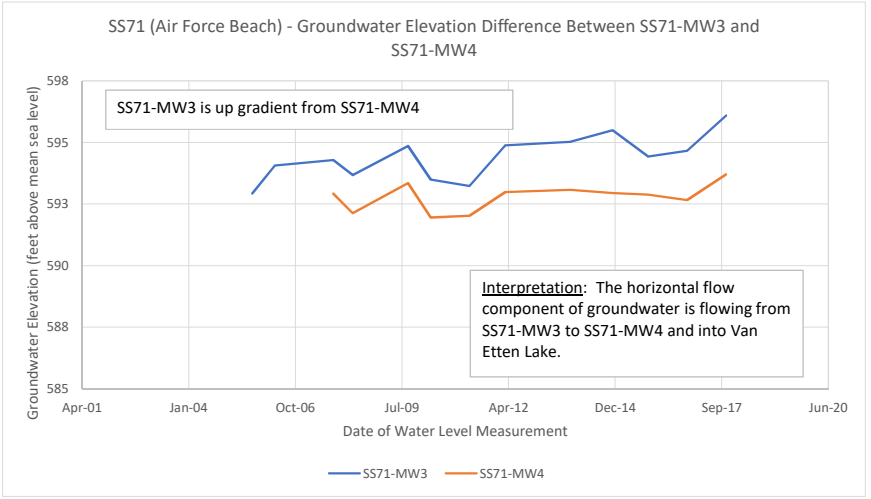
Groundwater Elevation

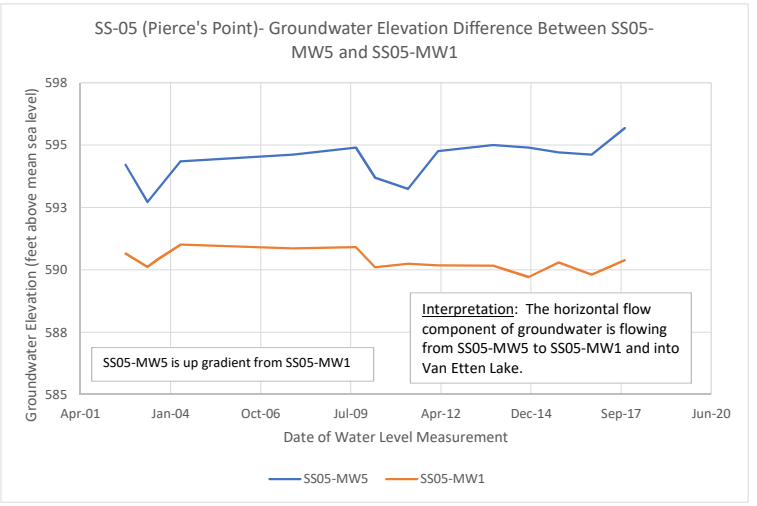
H136S	SS21	Beach 1	NM
A1-MW8S	Area 1	Beach 1	NM

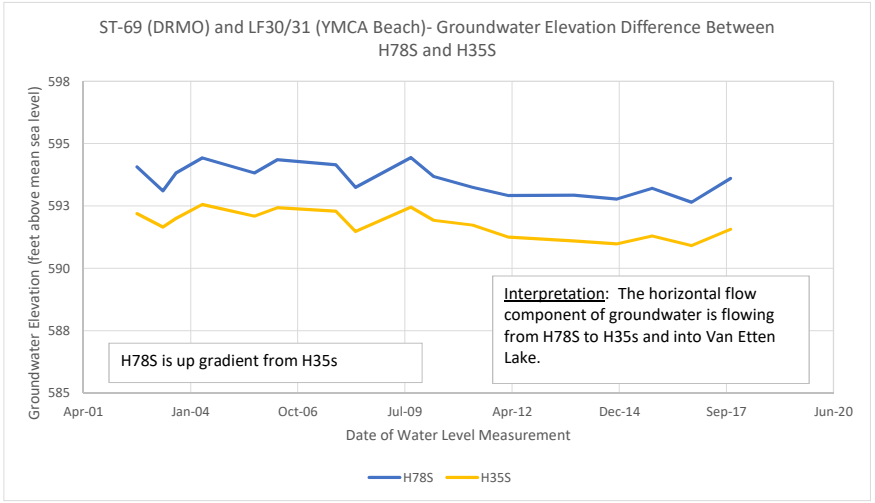
NM = Not measured.


SS-21 (Beach 1)- Groundwater Elevation Difference Between H-136S and A1-MW8S
Groundwater Elevation (feet above mean sea level)
598
595
593
590
588
585
H136S is up gradient from A1-MW8S
Interpretation: The horizontal flow component of groundwater is flowing from H136S to A1-MW8S and into Van Etten Lake.
Dec-18
Date of Water Level Measurement
H136S
A1-MW8S


ST-69 (DRMO) and LF30/31 (YMCA Beach) - Groundwater Elevation Difference Between H79S and H33S
Groundwater Elevation (feet above mean sea level)
598
595
593
590
588
585
H79S is up gradient from H33s
Interpretation: The horizontal flow component of groundwater is flowing from H79S to H33s and into Van Etten Lake.
Apr-01
Jan-04
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Date of Water Level Measurement
H79S
H33S


SS71 (Air Force Beach) - Groundwater Elevation Difference Between SS71-MW3 and SS71-MW4
Groundwater Elevation (feet above mean sea level)
598
595
593
590
588
585
SS71-MW3 is up gradient from SS71-MW4
Interpretation: The horizontal flow component of groundwater is flowing from SS71-MW3 to SS71-MW4 and into Van Etten Lake.
Apr-01
Jan-04
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Date of Water Level Measurement
SS71-MW3
SS71-MW4


SS-05 (Pierce's Point)- Groundwater Elevation Difference Between SS05-MW5 and SS05-MW1
Groundwater Elevation (feet above mean sea level)
598
595
593
590
588
585
SS05-MW5 is up gradient from SS05-MW1
Interpretation: The horizontal flow component of groundwater is flowing from SS05-MW5 to SS05-MW1 and into Van Etten Lake.
Apr-01
Jan-04
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Date of Water Level Measurement
SS05-MW5
SS05-MW1


ST-69 (DRMO) and LF30/31 (YMCA Beach)- Groundwater Elevation Difference Between H78S and H35S
Groundwater Elevation (feet above mean sea level)
598
595
593
590
588
585
Apr-01
Jan-04
Oct-06
Jul-09
Apr-12
Dec-14
Sep-17
Jun-20
Date of Water Level Measurement
H78S
H35S
H78S is up gradient from H35s
Interpretation: The horizontal flow component of groundwater is flowing from H78S to H35s and into Van Etten Lake.

Attachment 3 – 2011 to 2018 Groundwater Quality Data, PFOS Only, Concentration Values Above GSI Criteria

Groundwater-Surface Water Interface - Van Etten Lake

Per- and polyfluoroalkyl substances (PFAS) Monitoring In Groundwater - PFOS Only - Groundwater Samples Above the GSI Criteria

Former Wurtsmith Air Force Base, Oscoda, Michigan

PFOS GSI Criteria = 12 ppt

MDEQ PFAS Area	IRP/Site Name	Location/Well ID	Concentraiton of PFOS (ppt)	Collection Date	Collected by	Comments
Beach 1	East of SS-47	VAS01034 (21-25 feet)	32	7/11/2018	AFCEC	
Beach 1	East of SS-47	VAS01034 (31-35 feet)	3,870	7/12/2018	AFCEC	
Beach 1	East of SS-47	VAS01034 (39-43 feet)	65	7/12/2018	AFCEC	
Beach 1	East of SS-47	A1-MW9S	93.9	9/11/2018	AFCEC	
Beach 1	East of SS-47	A1-MW9D	3,320	9/11/2018	AFCEC	
Beach 1	East of SS-47	VAS01001 (17-20 feet)	18.5	5/2/2016	EGLE	
Beach 1	East of SS-47	VAS01001 (37-40 feet)	238	5/2/2016	EGLE	
Beach 1	East of SS-47	VAS01001 (47-50 feet)	401	5/2/2016	EGLE	
Beach 1	East of SS-47	VAS01002 (17-20 feet)	20.8	5/2/2016	EGLE	
Beach 1	East of SS-47	VAS01002 (47-50 feet)	15.3	5/2/2016	EGLE	
Beach 1	East of SS-47	H36S	17.8	4/28/2016	EGLE	
Beach 1	East of SS-47	H36D	54	4/28/2016	EGLE	
Beach 1	East of SS-47	VAS01001 (53-58 feet)	16.7	12/11/2017	AFCEC	
Beach 1	East of SS-47	VAS01033 (26-30 feet)	45.6	7/11/2018	AFCEC	
Beach 1	East of SS-47	VAS01033 (36-40 feet)	15	7/11/2018	AFCEC	
Beach 1	East of SS-47	VAS01034 (11-15 feet)	73	7/11/2018	AFCEC	
Air Force Beach	SS-56 (Air Force Beach)	VAS15005 (17-20 feet)	88	5/24/2016	EGLE	
Air Force Beach	SS-56 (Air Force Beach)	VAS15005 (27-30 feet)	1,040	5/25/2016	EGLE	
Air Force Beach	SS-56 (Air Force Beach)	A1-MW11S	1,100	10/12/2018	AFCEC	
Air Force Beach	SS-56 (Air Force Beach)	A1-MW11D	5,170	10/5/2018	AFCEC	
Air Force Beach	SS-56 (Air Force Beach)	VAS15012 (18-21 feet)	1,090	10/27/2016	EGLE	
Air Force Beach	SS-56 (Air Force Beach)	VAS15012 (28-31 feet)	4,700	10/27/2016	EGLE	
Air Force Beach	SS-56 (Air Force Beach)	VAS15012 (38-41 feet)	18.3	10/27/2016	EGLE	
Air Force Beach	SS-56 (Air Force Beach)	A1-MW12S	1,950	10/2/2018	AFCEC	
Air Force Beach	SS-56 (Air Force Beach)	A1-MW12D	11,800	10/2/2018	AFCEC	
Between Beach 1 and Air Force Beach	SS-56 (Air Force Beach)	VAS15010 (40-43 feet)	62.3	10/28/2016	EGLE	Install permanent well from 40 to 45 feet.
YMCA Beach	LF-30/31	VAS17002 (27-30 feet)	32.2	11/8/2016	EGLE	Additional wells need to be sampled.
YMCA Beach	LF-30/31	VAS17002 (46.5-49.5 feet	14.1	11/8/2016	EGLE	
YMCA Beach	LF-30/31	LF30-MW3	37	11/9/2011	EGLE	Extent has not been defined.
	LF-30/31	Y6	17	11/9/2011	EGLE	
DRMO	ST-69 (DRMO)	Not Available.	Not Available.	Not Available.	Not Available.	Additional characterization down gradient from the source and along the shoreline.
Pierce's Point	SS-05	VAS04009 (39-43 feet)	1,030	6/12/2018	AFCEC	
Pierce's Point	SS-05	VAS04009 (49-53 feet)	66.8	6/12/2018	AFCEC	
Pierce's Point	SS-05	VAS04012 (31-35 feet)	72.8	6/18/2018	AFCEC	
Pierce's Point	SS-05	VAS04012 (41-45 feet)	215	6/18/2018	AFCEC	

Notes:

DRMO Defense Reutilization and Marketing Office Storage Facility

Attachment 4 – Beach 1 Map Views

Date: 2/14/2019

EGLE Data collected from 2010 to 2017

Note: Not all vertical aquifer sampling (VAS) data is shown due to labeling constraints.

Imagery Date: 2005

EGLE RRD-SUPERFUND
Geology and Defense
Site Management Unit

Beach 1 (East of SS-47, Base Gas Station, Building 468)
EGLE and AFCEC Groundwater Data with 2004 Groundwater Contours - PFOS Concentration (ppt)
Former Wurtsmith Air Force Base
Oscoda, Michigan

250 125 0 250 500 750 1,000
Feet

Date: 2/14/2019

Imagery Date: 2005

EGLE Data collected from 2010 to 2017

EGLE RRD-SUPERFUND
Geology and Defense
Site Management Unit

Beach 1 (East of SS-58, UST Leaks 1700-1800 Family Housing)
EGLE and AFCEC Groundwater Data with 2004 Groundwater Contours - PFOS Concentration (ppt)
Former Wurtsmith Air Force Base
Oscoda, Michigan

Note: Not all vertical aquifer sampling (VAS) data is shown due to labeling constraints.

250 125 0 250 500 750 1,000
Feet

Attachment 5 – Air Force
Beach Map Views and Cross-Sections

Install permanent monitoring well at VAS15010 from 40 to 45 feet below ground surface.

Install permanent monitoring well at VAS15011 from 25 to 30 feet below ground surface.

Add AFCEC permanent monitoring wells A1-MW11S and A1-MW11D to the GSI monitoring well network for Van Etten Lake.

Highest concentration of PFOS in this view.

Add AFCEC permanent monitoring wells A1-MW12S and A1-MW12D to the GSI monitoring well network for Van Etten Lake.

Van Etten Lake

N

62.3 0 4.34 7.83

2.08 2.6 51.5

220 0 26 141

1040 88 5.56 1100 4.97 5170

240 7 0 180 351 680 320 0 387 489 4510 90.3 0

896 476 3.05

5850 18.3 1090 6.18

90.2

402 70 645 1290

2830 208

519 47 54.7 2010

3870 64.6 31.7

6.4 4.7

238 401 5.38 18.2 0

Legend

- EGLE PFAS Sampling Location, Temporary
- EGLE PFAS Sampling Location, Permanent
- AFCEC PFAS Sampling Location, Temporary
- AFCEC PFAS Sampling Location, Permanent
- Air Force Beach Cross-Section Line

Date: 2/14/2019

Imagery Date: 2005

EGLE Data collected from 2010 to 2017

EGLE RRD-SUPERFUND
Geology and Defense
Site Management Unit

SS-56, Fuel Spill, Air Force Beach

EGLE and AFCEC Groundwater Data with 2004 Groundwater Contours - PFOS Concentration (ppt)

Former Wurtsmith Air Force Base

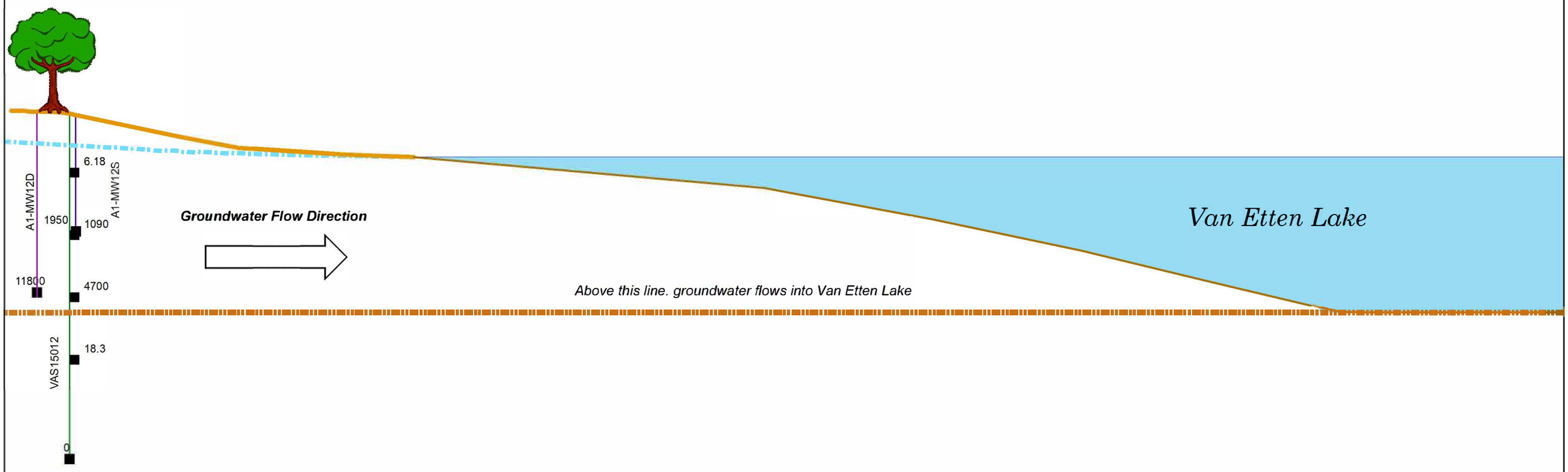
Oscoda, Michigan

Note: Not all vertical aquifer sampling (VAS) data is shown due to labeling constraints.

240 120 0 240 480 720 960 Feet

South

North



Legend

Estimate of Top of Water Table

Source: (1) AFCEC's excel table provided to EGLE staff after January 16, 2019 presentation at the SSI Update Meeting of the "SSI Monitoring Wells Sampling Results, Fall 2018". (2) EGLE Data from 2010 to 2016.

Date: 2/8/2019

Van Etten Lake, Air Force Beach - PFOS Concentration (ppt)

Former Wurtsmith Air Force Base
Oscoda, Michigan

EGLE RRD-SUPERFUND
Geology and Defense
Site Management Unit

Vertical Scale = Horizontal Scale

0 5 10 20 30 40 Feet

Attachment 6 – Landfills LF-30 and LF-31 Map View

Legend

- EGLE PFAS Sampling Location, Temporary
- EGLE PFAS Sampling Location, Permanent
- AFCEC PFAS Sampling Location, Temporary
- AFCEC PFAS Sampling Location, Permanent
- Extraction_Wells

Issue: Incomplete PFAS data set from GSI existing monitoring wells.
Action: Collect groundwater samples from existing monitoring wells adjacent to Van Etten Lake.

Sample exting well network along Van Etten Lake for four quarters and compare results to PFOS GSI criteria.

Highest concentration of PFOS in this view.

Landfills LF30 and LF31

Note: Not all vertical aquifer sampling (VAS) data is shown due to labeling constraints.

Date: 2/14/2019

EGLE Data collected from 2010 to 2017

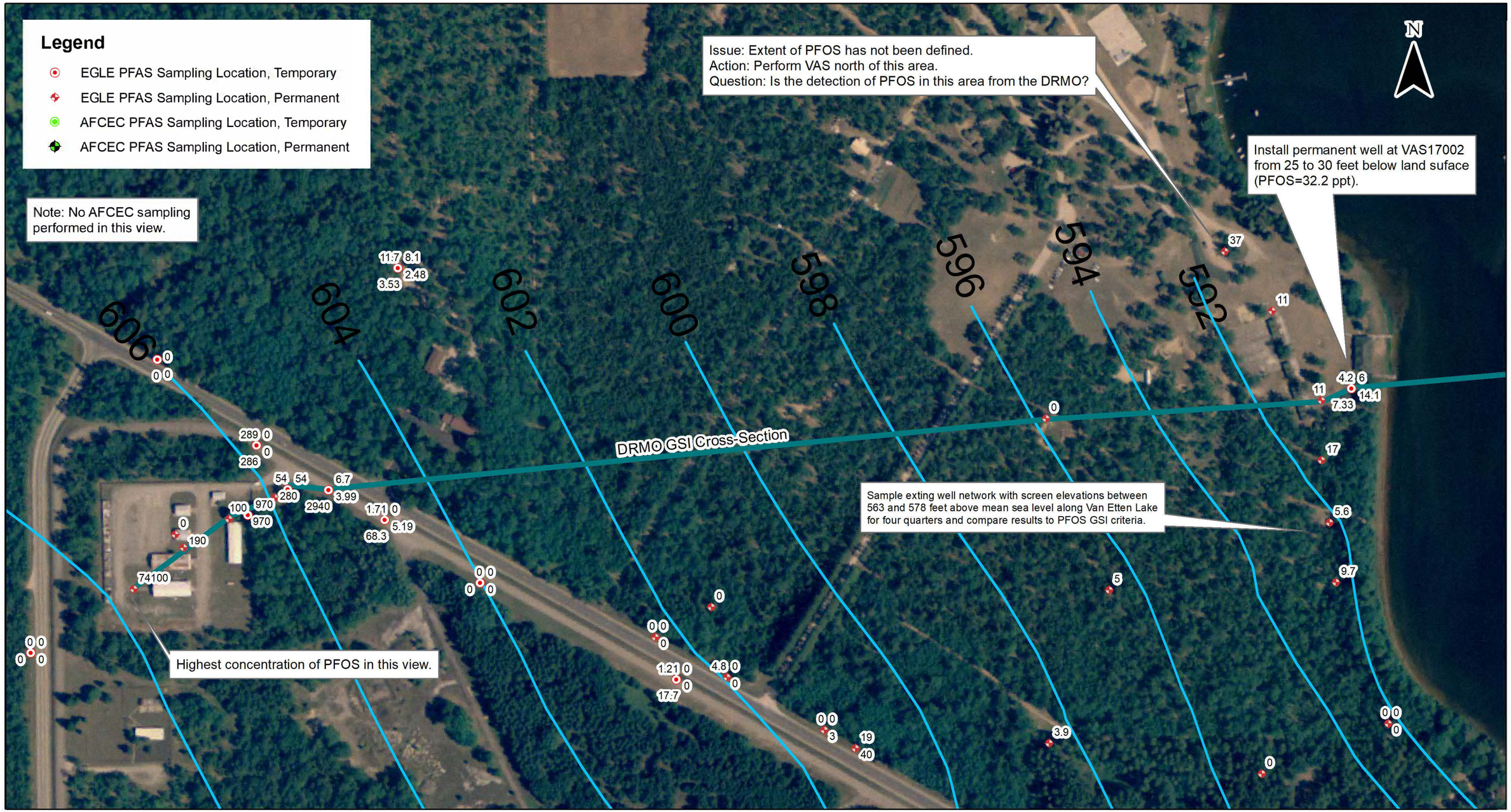
Imagery Date: 2005

EGLE RRD-SUPERFUND
Geology and Defense
Site Management Unit

Landfills LF30 and LF31
EGLE and AFCEC Groundwater Data with 2004 Groundwater Contours - PFOS Concentration (ppt)
Former Wurtsmith Air Force Base
Oscoda, Michigan

320 160 0 320 640 960 1,280 Feet

Attachment 7 – ST-69, Defense Reutilization and Marketing Office (DRMO) Storage Facility Map View and Cross-Section



Date: 2/14/2019

Imagery Date: 2005

EGLE Data collected from 2010 to 2017

EGLE RRD-SUPERFUND
Geology and Defense
Site Management Unit

ST-69 - Defense Reutilization and Marketing Office (DRMO) Storage Facility
EGLE and AFCEC Groundwater Data with 2004 Groundwater Contours - PFOS Concentration (ppt)
Former Wurtsmith Air Force Base
Oscoda, Michigan

Note: Not all vertical aquifer sampling (VAS) data is shown due to labeling constraints.

250 125 0 250 500 750 1,000
Feet

Southwest

Northeast

ST-69 (DRMO)

OT45-MW1

OT-45MW2

OT45-MW11

ST69-TW11

VAS05003

LF30-ML4D

VAS17002

74100

190

100

280

6.7

69.8

2940

3.99

6

11

32.2

7.33

14.1

0

2004 Water Table

Groundwater Flow Direction

Above this line, groundwater flows into Van Etten Lake

Van Etten Lake

Date: 2/7/2019

Van Etten Lake, Down Gradient from ST-69 (DRMO) - PFOS Concentration (ppt)

Former Wurtsmith Air Force Base

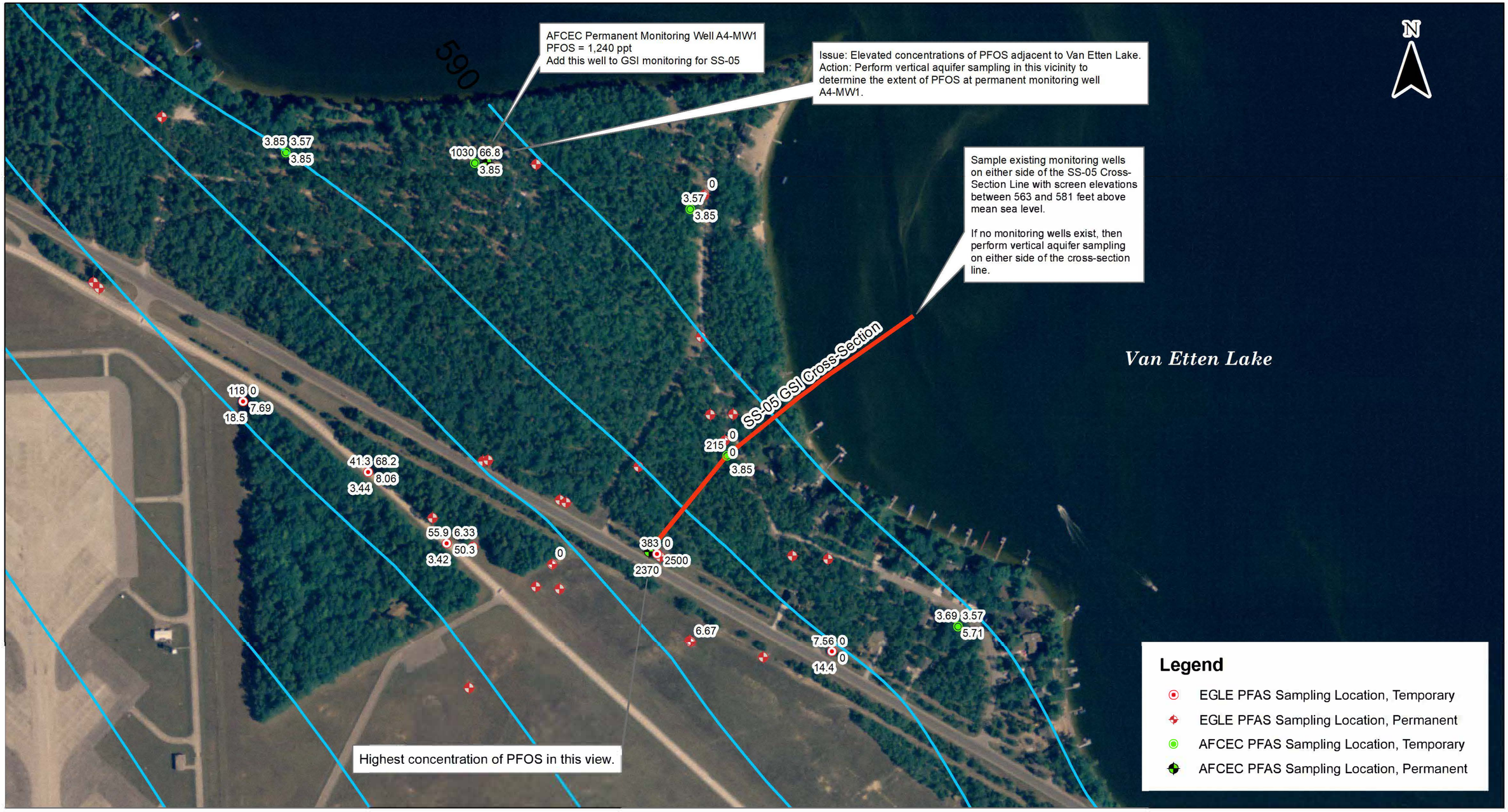
Oscoda, Michigan

EGLE RD-SUPERFUND
Geology and Defense
Site Management Unit

0 125 250 500 750 1,000 Feet

Vertical Scale = 25 times Horizontal Scale

Attachment 8 – Pierce's Point Map View and Cross-Section



Date: 2/14/2019

Imagery Date: 2005

EGLE Data collected from 2010 to 2017

EGLE RRD-SUPERFUND
Geology and Defense
Site Management Unit

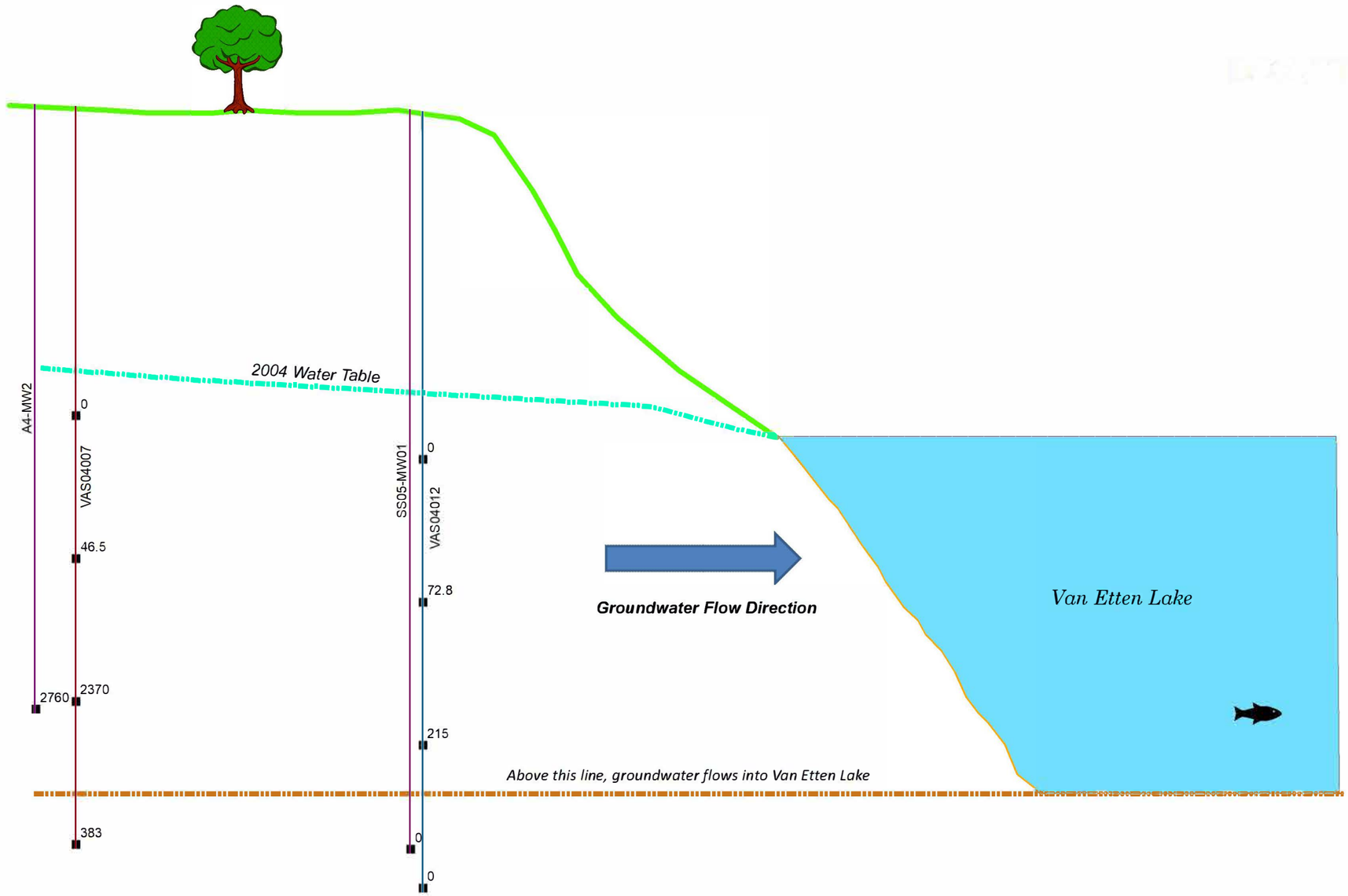
Pierce's Point (SS-05 - TCE Spill, Southwest of Strategic Air Command Apron)
EGLE and AFCEC Groundwater Data with 2004 Groundwater Contours - PFOS Concentration (ppt)
Former Wurtsmith Air Force Base
Oscoda, Michigan

Note: Not all vertical aquifer sampling (VAS) data is shown due to labeling constraints.

250 125 0 250 500 750 1,000 Feet

Southwest

Northeast



Date: 2/8/2019

Van Etten Lake, Pierce's Point (Down Gradient from SS-05) - PFOS Concentration (ppt)

Former Wurtsmith Air Force Base

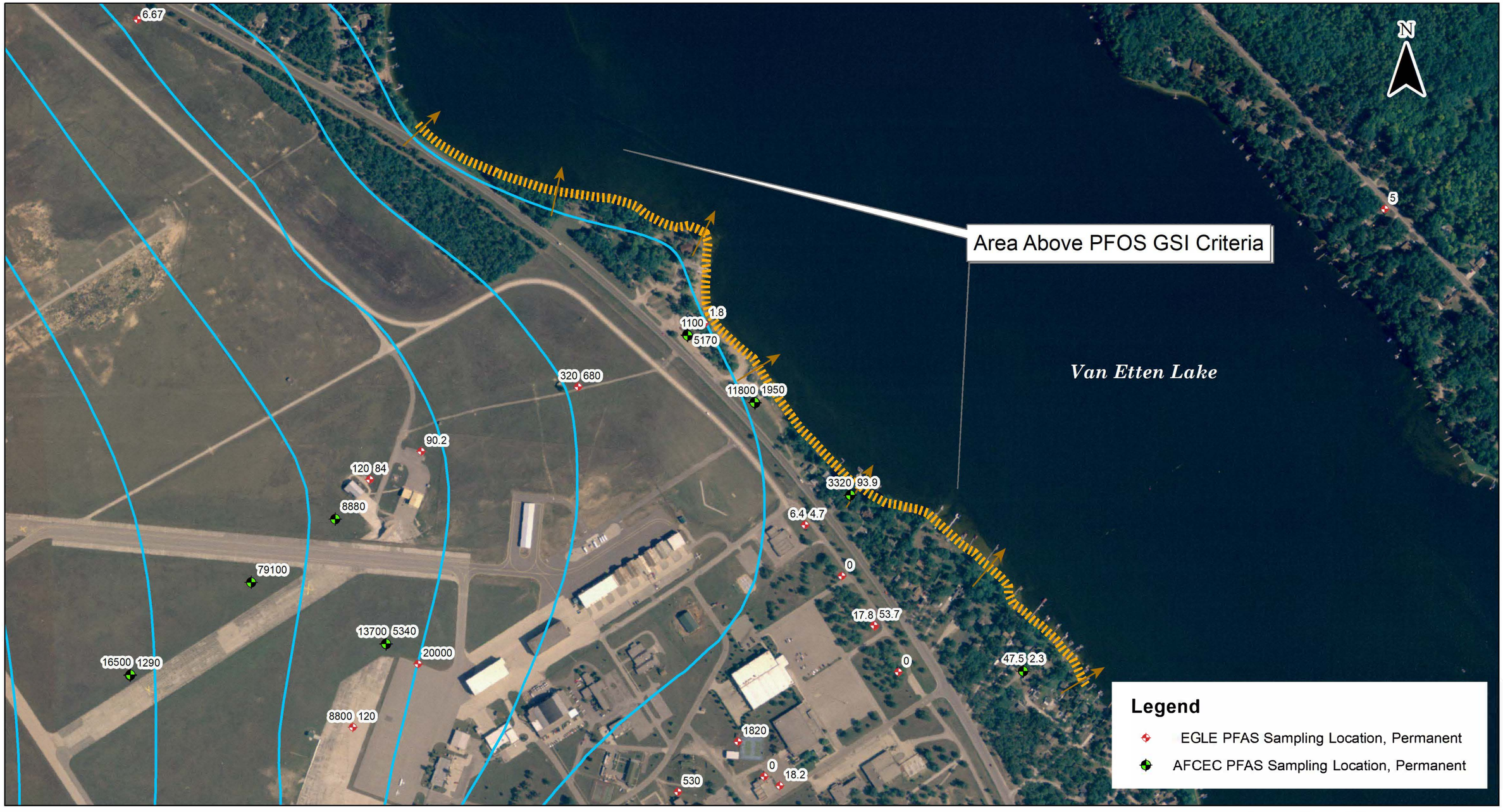
Oscoda, Michigan

EGLE RD-SUPERFUND
Geology and Defense
Site Management Unit

50 25 0 50 100 150 200
Feet

Vertical Scale = 10 times Horizontal Scale

Attachment 9 – Note – GSI Area of Impact Observation Map View



Date: 2/15/2019

Imagery Date: 2005

EGLE Data collected from 2010 to 2017

EGLE RRD-SUPERFUND
Geology and Defense
Site Management Unit

East of SS-56, Fuel Spill, Air Force Beach to East of SS-47, Base Gas Station, Building 468
EGLE and AFCEC Groundwater Data with 2004 Groundwater Contours - PFOS Concentration (ppt)
Former Wurtsmith Air Force Base
Oscoda, Michigan

Note: Not all vertical aquifer sampling (VAS) data is shown due to labeling constraints.

250 125 0 250 500 750 1,000
Feet

Attachment 10 – 2018 Temperature Mapping of the Au Sable River and Van Etten Lake by AECOM on behalf of the EGLE (formerly known as MDEQ)

AECOM Imagine it. Delivered.

Temperature Mapping of the Au Sable River and Van Etten Lake

Wurtsmith Air Force Base

Project number: 60518528

January 31, 2018

Prepared for:

Robert Delany, Jr.
Michigan Department of Environmental Quality
Remediation and Redevelopment Division
Constitution Hall, 5th Floor, South Tower
525 West Allegan Street
Lansing, Michigan 48933

Prepared by:

John M. Cuthbertson
Progam Manager
T: 616-574-8472
M: 616-647-7072
E: john.cuthbertson@aecom.com

AECOM
3950 Sparks Drive Southeast
Grand Rapids
MI, 49546
USA
aecom.com

Table of Contents

Figures

1. Introduction

This technical memorandum summarizes and reports the findings of the temperature study of Van Etten Lake and the Au Sable River performed between July 25 and 27, 2017. Van Etten Lake and the Au Sable River are located in Oscoda, MI adjacent to the former Wurtsmith Air Force Base (WAFB) (**Figure 1**). The objectives of the temperature study are to:

1. Understand potential groundwater discharge into the Au Sable River and Van Etten Lake;
2. Identify potential pathways for perfluoroalkyl and polyfluoroalkyl substances (PFAS) to discharge into surface water; and
3. Develop a better understanding of groundwater flow to improve the base-wide Conceptual Site Model (CSM).

2. Background

The geology at WAFB is generally characterized as lacustrine and eolian sands overlying lacustrine clay, till, and ultimately bedrock consisting of the Marshall Sandstone and Coldwater Shale. The lacustrine sands and gravels are a series of large deltaic deposits created by the Glacial Au Sable River where it entered an evolving series of late Wisconsinan pro-glacial lakes (**Figure 2**) (Burgis, 1977). As illustrated on **Figure 2**, WAFB is located on the northern limb of a large delta, designated as part of the Algonquin Delta with several nearby paleo shorelines.

Site stratigraphy consists of progradational deltaic sediments, which are expected to dip to the east/north-east. **Figure 3** is a general depositional model at the time of deposition (Larson and Schaetzl, 2001; Reineck and Singh, 1975). Upper layers of the delta deposits are expected to be sandy with only minor and spatially limited fine-grained (silt and clay) facies present in this system with a high sediment load modified by wave action. Delta mouth bar deposits of coarse sand, upward-fining (gravel to fine sand) distributary channel fills, and minor medium to fine-grained beach ridge/shore face sands will also be present until the transition to delta slope (foreset) beds. The focus of the investigation is on the distributary channels (i.e. paleo-channels) within the delta filled with coarse grained deposits that could provide preferential pathways for contaminant transport.

The sand and gravel aquifer is mostly under water-table conditions, with the depth to water ranging from less than 10 ft on the western side of the base to approximately 25 ft on the east. There is a northwest-southeast trending groundwater divide that extends across the base which directs the groundwater flow to the east towards Van Etten Lake and Van Etten Creek and south towards the Au Sable River (**Figure 4**). The subsurface geology influences how the groundwater flows, therefore, understanding WAFB's deltaic stratigraphy is key to the overall understanding potential groundwater discharge locations and the fate and transport of groundwater contaminants, including PFAS.

The approximate extent of PFAS-contaminated groundwater at WAFB using Michigan Department of Environmental Quality (MDEQ) and United States Air Force (USAF) sampling data is shown in **Figure 5**. This figure was developed from PFAS groundwater data collected between 2010 and 2016 by using the highest total PFAS concentration found at any location within the groundwater, regardless of its depth. Recently, PFAS-contaminated groundwater has been identified off the base to the south, north, across Van Etten Lake and Van Etten Creek, and in Van Etten Lake and the Au Sable River. One of the primary objectives of this study is to identify potential pathways for PFAS to discharge into these surface water bodies.

3. Temperature Study Methods

Beginning on July 25, 2017, AECOM, contracted with Affiliated Researchers, LLC, to provide temperature mapping services at the former WAFB along the lower Au Sable River and Van Etten Lake at the areas shown in **Figure 5**. The temperature survey areas were located near shore to observe potential groundwater discharge into the surface water bodies.

Affiliated Researchers integrated the data collection of water temperatures with GPS positions to collect continuous *in situ* temperature-position datasets along the nearshore of Van Etten Lake and the lower Au Sable River. This procedure provided accurate measurement, delineation, documentation, and mapping of surface water temperatures near the shores. The temperature mapping was completed during the end of July through the first part of August when ambient water temperatures are at their highest, offering the greatest differential to the groundwater temperatures.

A *Trimble R8* RTK-GPS survey system was used onboard the survey vessel. Survey data were collected using US State Plane, NAD83, NAVD88 using the units of U.S. Survey Feet. Geospatial accuracies during the water temperature mapping at Van Etten Lake were < 0.1 ft by means of obtaining continuous RTK corrections broadcasted via the NGS network of Continuously Operating Reference Stations (CORS).

Geospatial accuracies during the water temperature mapping at the Au Sable River were sub-meter (< 3 ft) by means of obtaining continuous corrections broadcastfrom the Federal Aviation Administration network of the Wide Area Augmentation System (WAAS).

A *YSI 600R* water temperature sonde was used to collect water temperature data at a resolution of 0.02 degrees Fahrenheit (º F) at a rate of 1 data point per second. *HYPACK* software installed on a hydrographic computer onboard the survey vessel was utilized to collect, combine, and record the temperature and geospatial data.

Transects were run along the shore at water depths of approximately 3 and 7 to 14 ft in Van Etten Lake, and 2 and 6 ft in the Au Sable River. The locations of the transects are shown in **Figure 5**. A manual downrigger, mounted on the gunwale of the survey vessel, was used to deploy the temperature sonde within 1 ft of the bottom while navigating the parallel transects. Since groundwater seepage occurs along the bottom of the surface water body, and the colder groundwater would tend to stratify along the bottom, the temperature sonde was kept close to the bottom where groundwater potentially discharges to the lake.

More than 10,500 temperature-position data points were collected during the temperature mapping of nearshore Van Etten Lake and approximately 6,500 points were collected along the Au Sable River.

A FLIR E8 infra-red (IR) camera was also used to identify potential groundwater seeps along the shorelines. The IR does not penetrate water, therefore the camera is limited to recording surface temperatures. The temperature range of the camera was adjusted to maximize the average groundwater temperature (approximately 55º F). The FLIR indicated seeps along the Au Sable River, but not along the shore of Van Etten Lake.

4. Results

The temperature data from each transect were evaluated by averaging the temperatures for each transect and then identifying measurements that exceeded 1 and 2 standard deviations from the average value as potential temperature anomalies.

4.1 Van Etten Lake

Van Etten Lake temperatures ranged from 73.9 to 77.7º F for the shallow transect (3 ft) and 71.4 to 78.4º F for the deep transect (7 to14 ft). The average temperature for the shallow and deep transects were 76.3 and 73.7º F, respectively. The deeper temperatures are expected to be less than shallow temperatures due to normal summertime thermal stratification in a lake. The standard deviation for the shallow transect was 0.7º F, resulting in 1 and 2 standard deviation lower temperatures of 75.7 and 75.0º F, respectively. The standard deviation for the deep transect was 1.2º F, with 1 and 2 standard deviation lower temperatures of 72.6 and 71.4º F, respectively.

Figure 6, Sheets 2 and 3 show the relationship of the 1 and 2 standard deviation temperature locations for the shallow and deep transects, respectively, and the PFAS plumes. The figures show 9 areas that exceed 2 standard deviations along the shallow transect and only 1 area that exceeds 2 standard deviations along the deep transect. The area that exceeds 2 standard deviations along the deep transect does not correspond to any of the areas observed in the shallow transect.

Soil borings located along the western side of the lake nearest the transects indicate a surficial, fine-grained sand overlying clay at a depth of 42 ft. No groundwater seeps were observed along the shoreline based on the FLIR camera observations. In addition, none of the areas (shallow or deep) that exceed 2 standard deviations correspond to locations where the maximum PFAS plume concentrations would be expected to discharge to the lake based on the groundwater PFAS data.

Figure 6, Sheets 2 and 3 also show the location and results of 10 surface water samples collected along the Van Etten Lake shoreline within the area that exceeds 1 and 2 temperature standard deviations. Total PFAS concentrations range from 14.7 to 184.1 ng/L in the surface water samples. One of the PFAS components, perfluorooctanesulfonic acid (PFOS) ranges from non-detect to 34.3 ng/L. These data suggest that PFAS-impacted groundwater is discharging to Van Etten Lake. The 34.3 ng/L PFOS concentration exceeds the MDEQ Part 201 Groundwater Surface Water Interface (GSI) criterion of 12 ng/L.

4.2 Au Sable River

Au Sable River temperatures ranged from 74.0 to 75.3º F for the shallow transect (2 ft) and 76.2 to 76.4º F for the deeper transect (6 ft). The average temperature for the shallow and deep transects were 74.4 and 76.3º F, respectively. This inverse in temperature may be due to the groundwater seeps observed along the river bank.

The standard deviation along the shallow transect in the Au Sable River was 0.1º F with 1 and 2 standard deviation lower temperatures of 74.3 and 74.2º F, respectively. The standard deviation for the deep transect was calculated as 0.03º F with 1 and 2 standard deviation lower temperatures of 76.26 and 76.23º F, respectively. The very small standard deviation in temperature measurements for the deep transect suggests that the river is well mixed. **Figure 6, Sheets 4 through 7** show the relationship of the 1 and 2 standard deviation temperature locations for the shallow and deep transects with respect to the PFAS plumes in groundwater. Only 1 area had temperatures that exceeded 2 standard deviations along the shallow transect (**Figure 6, Sheet 6**). Three areas had temperatures that exceeded 2 standard deviations along the deep transect (**Figure 6, Sheets 5 and 7**).

The FLIR photographs indicate a number of potential groundwater seeps along the north river bank as shown in **Figure 7**. **Figure 7** incorporates the FLIR camera photographs with the areas that exceed the 1 and 2 standard deviation locations. Each photograph has a temperature scale showing a range of temperatures with blue being the coolest (approximately 55º F) and red to white being the warmest (73º F and above). The temperature displayed in the upper left corner of each photograph corresponds to the temperature within the target at the center of the photograph.

There appears to be some correlation between the potential seeps identified in the FLIR photographs and the shallow transect data where temperatures exceed 1 standard deviation.

The area where surface water temperatures exceed 2 standard deviations (photographs 36 and 48 on **Figure 7, Sheet 6**) is just downstream of the Three Pipes Drain discharge point.

No soil borings are located adjacent to the river; however, up gradient borings indicate the presence of a medium sand grading to a fine sand at a depth of approximately 33 ft which overlies a clay at a depth of approximately 43 ft, similar to what is observed adjacent to the lake.

Figure 6, Sheets 4 through 7 also show the location and results of 28 surface water samples collected along the Au Sable River shoreline within the area that exceeds 1 and 2 temperature standard deviations. Total PFAS concentrations range from 4.2 to 6,354.2 ng/L in the samples. PFOS ranges from non-detect to 4,600 ng/L. These data suggest that PFAS-impacted groundwater is discharging to the Au Sable River. Six of the surface water sample locations have PFOS concentrations that exceed the MDEQ Part 201 GSI criterion of 12 ng/L.

5. Conclusions

The temperature evaluation of Van Etten Lake and the Au Sable River identifies areas where groundwater may be discharging to the surface water bodies.

Surface water temperatures in 10 areas (nine along the shallow transect and one along the deep transect) in Van Etten Lake are 2 standard deviations less than the average lake temperature. These areas are potential pathways for PFAS to discharge into Van Etten Lake. Additional evidence for groundwater discharge is provided by PFAS surface water data that exceed the GSI criterion for PFOS at one location.

Four areas (one along the shallow transect and three along the deep transect) in the Au Sable River had water temperatures 2 standard deviations less than the average river temperature. The shallow transect anomaly is located directly downstream from a major surface discharge source (Three Pipes Drain) and the deep transect anomalies are less than 0.1º F from the average river temperature. Surface water PFAS data also suggests discharge of PFAS-impacted groundwater based on six surface water sample locations that exceed the PFOS Part 201 GSI criterion.

6. References

Burgis, Winifred A., 1977. Late-Wisconsinan History of Northeastern Lower Michigan. PhD Thesis, University of Michigan.

Larson, Grahame and Randall Schaetzl, 2001. Origin and Evolution of the Great Lakes. Journal of Great Lakes Research, 27(4): 518-546.

Reineck, H.E. and I.B. Singh, 1975, Depositional Sedimentary Environments with reference to terrigenous clastics. Springer-Verlag, Berlin.

Figures

Drawn:	NS	12/16/2016
Approved:	DB	12/16/2016
Project #:	60514613	

Legend

Former Wurtsmith AFB Installation Boundary

N

0 2,000 4,000

Feet

FIGURE 1
SITE LAYOUT

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

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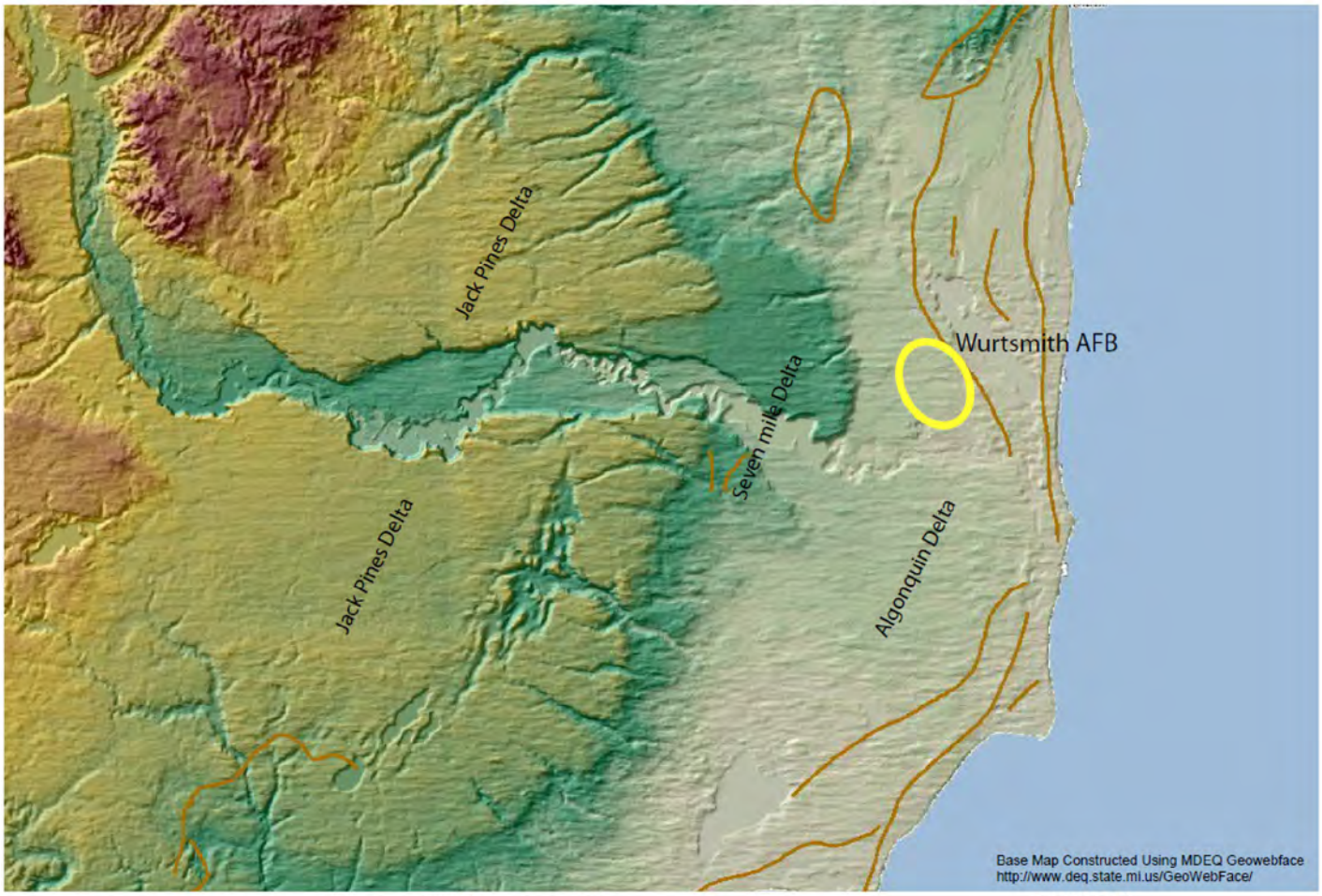


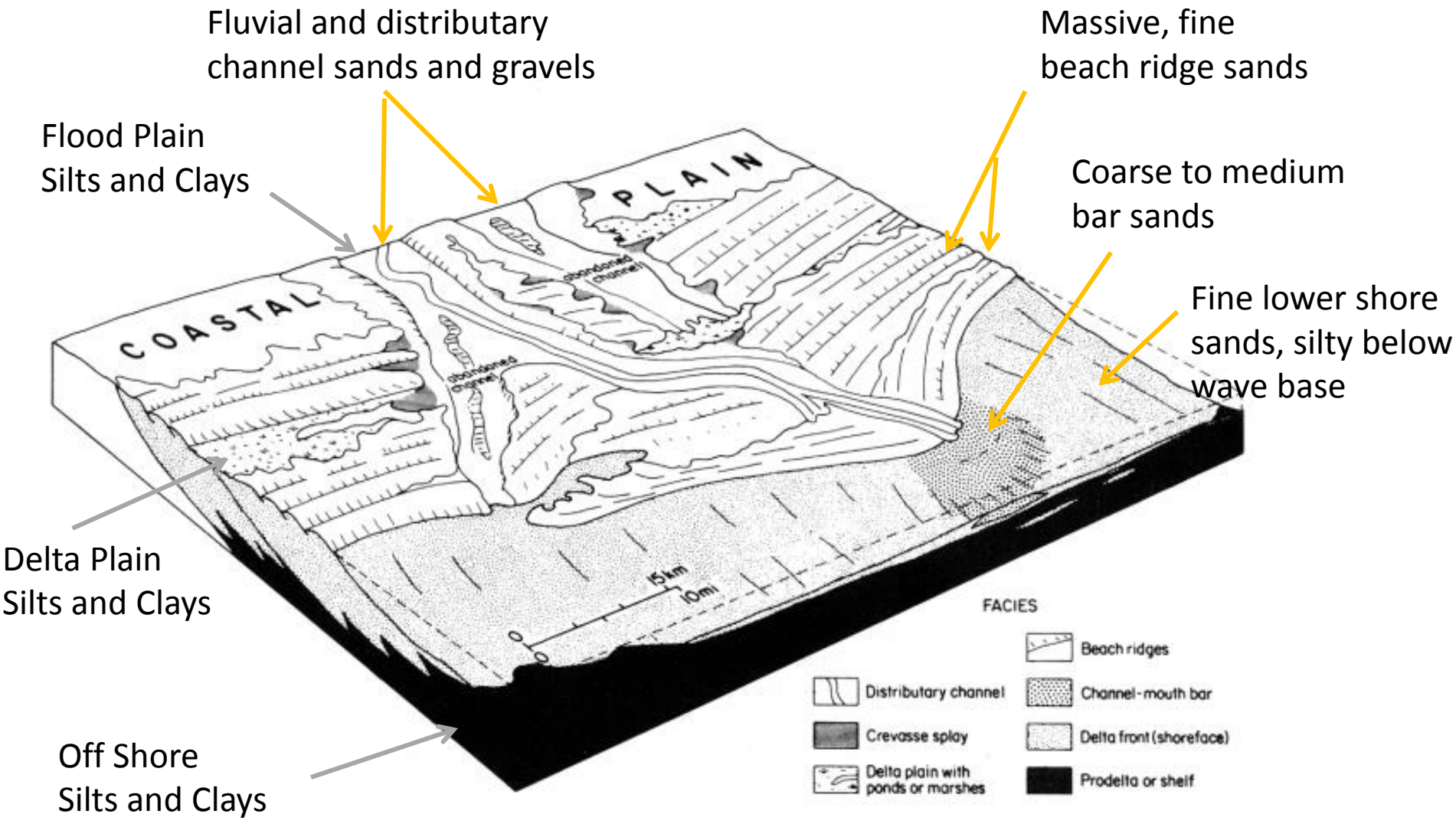
Drawn:	NS	12/15/2016
Approved:	DB	12/15/2016
Project #:	60514613	

FIGURE 2
WAFB RELATIVE TO PALEO
AU SABLE RIVER
DELTA LANDFORMS

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

P:\GIS_Data\GIS\Wurtsmith_AFB\Wurtsmith_GIS\MXDs\Reports\Hydrant_Report\Figure_2_WAFB_Relative_to_Paleo_Au_Sable_River_Delta_Landforms.mxd

Figure 3 -Delta: Facies Components



10/27/2017

Legend

- Approximate Groundwater Divide
- Groundwater Flow Direction
- Groundwater Contour
- Former Wurtsmith AFB Installation Boundary

FIGURE 4

GROUNDWATER FLOW

FORMER WURTSMITH AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 1,600 3,200
Feet

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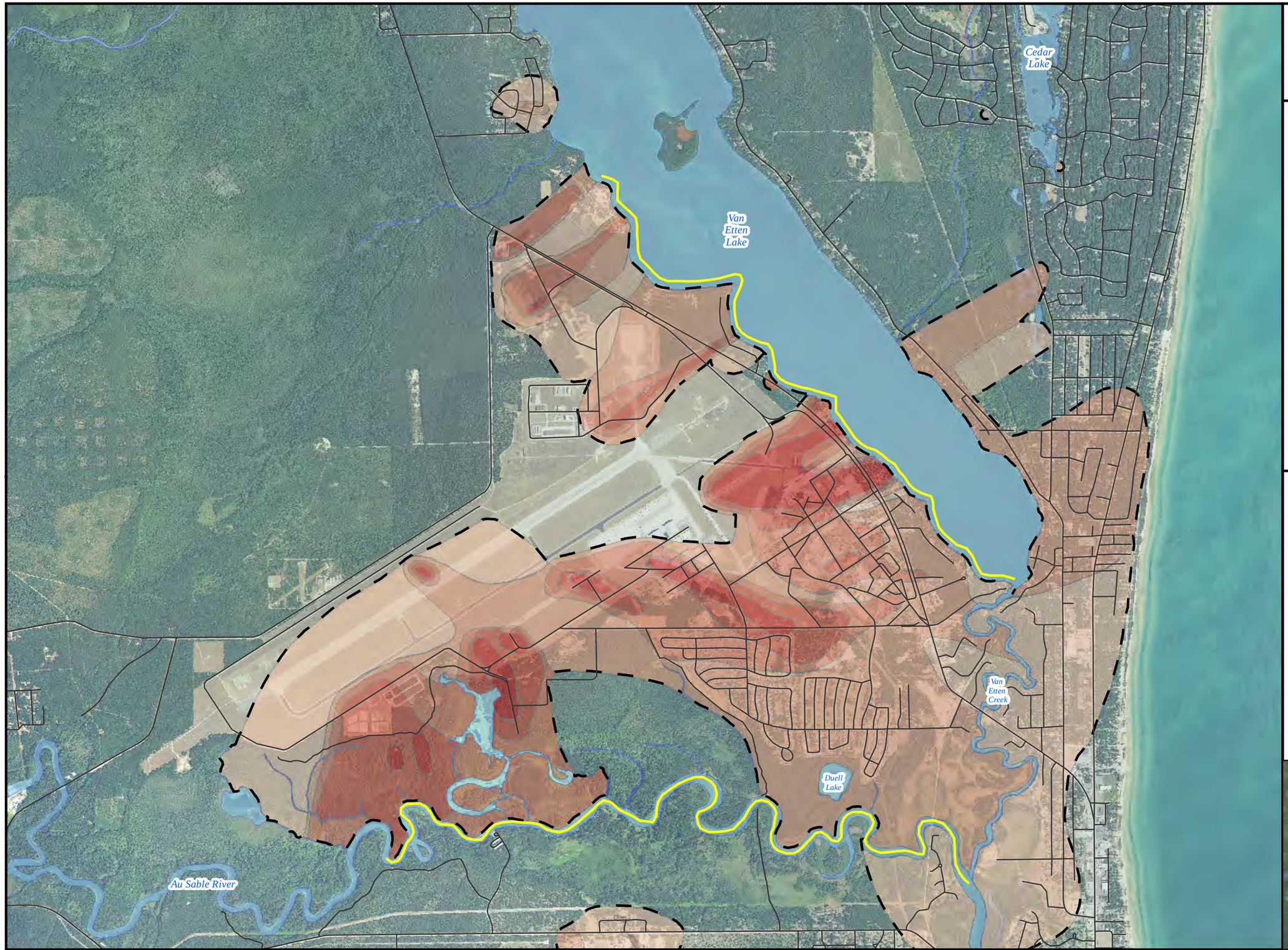

2/16/2018

Legend

- Temperature Survey Extent
- Road

Groundwater Impact

Total PFAS ppt

- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000
- Estimated Boundary
- Surface Water

FIGURE 5
TEMPERATURE
SURVEY LOCATION

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 2,500 5,000
Feet

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2/16/2018

Legend

Surface Water Sample

Groundwater Impact
Total PFAS ppt

- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000
- Estimated Boundary

Temperature Survey Results

- Deep - 1 Standard Deviation
- Deep - 2 Standard Deviation
- Shallow - 1 Standard Deviation
- Shallow - 2 Standard Deviation

2 & 3

4 & 5

6 & 7

FIGURE 6
TEMPERATURE
SURVEY RESULTS
Sheet 1 of 7

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 2,500 5,000
Feet

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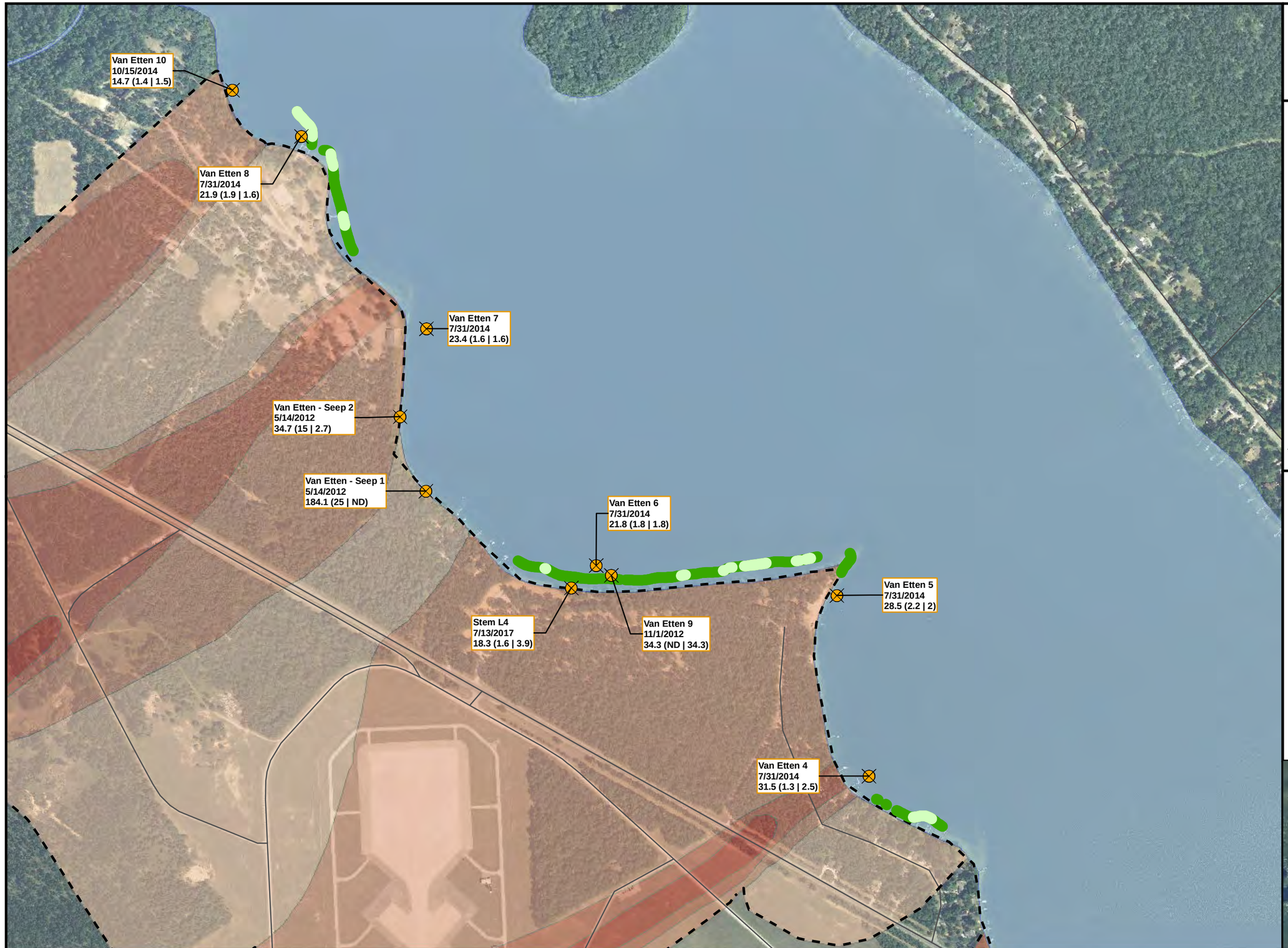

2/16/2018

Legend

- Surface Water Sample

Temperature Survey Results

- Deep - 1 Standard Deviation
- Deep - 2 Standard Deviation
- Shallow - 1 Standard Deviation
- Shallow - 2 Standard Deviation

Groundwater Impact

Total PFAS ppt

- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000
- Estimated Boundary

Location
Sample Date
Total PFAS (PFOA | PFOS)

*Measurements in units of PPT
ND = Non-Detect

FIGURE 6
TEMPERATURE
SURVEY RESULTS
Sheet 2 of 7

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 600 1,200
Feet

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2/16/2018

Legend

- Surface Water Sample

Temperature Survey Results

- Deep - 1 Standard Deviation
- Deep - 2 Standard Deviation
- Shallow - 1 Standard Deviation
- Shallow - 2 Standard Deviation

Groundwater Impact

Total PFAS ppt

- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000
- Estimated Boundary

Location
Sample Date
Total PFAS (PFOA | PFOS)

*Measurements in units of PPT
ND = Non-Detect

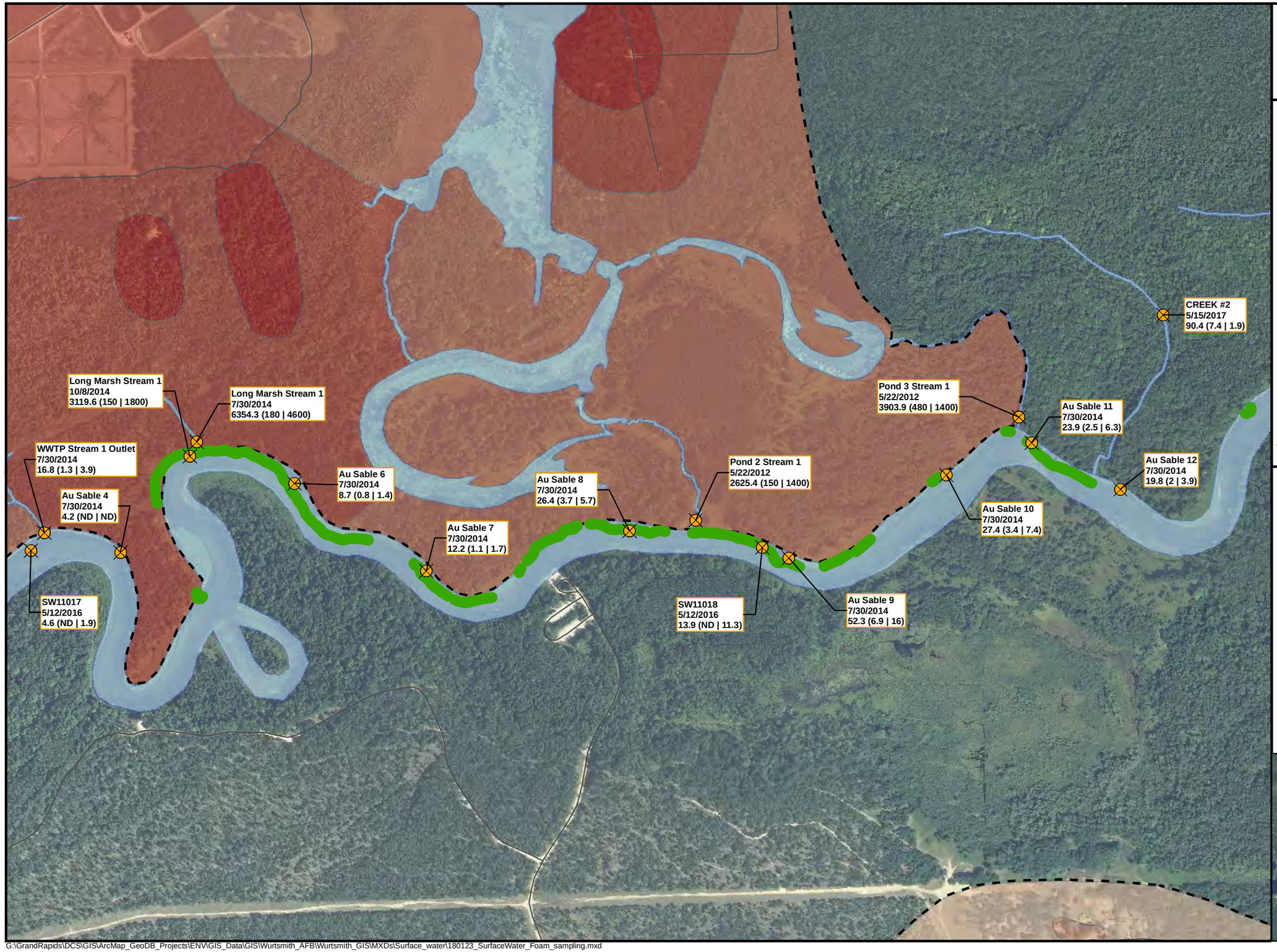
FIGURE 6
TEMPERATURE SURVEY RESULTS
Sheet 3 of 7

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 600 1,200
Feet

G:\GrandRapids\DCS\GIS\ArcMap_GeoDB_Projects\ENV\GIS_Data\GIS\Wurtsmith_AFB\Wurtsmith_GIS\MXDs\Surface_water\180123_SurfaceWater_Foam_sampling.mxd



2/16/2018

Legend

- Surface Water Sample

Temperature Survey Results

- Deep - 1 Standard Deviation
- Deep - 2 Standard Deviation
- Shallow - 1 Standard Deviation
- Shallow - 2 Standard Deviation

Groundwater Impact

Total PFAS ppt

- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000
- Estimated Boundary

Location
Sample Date
Total PFAS (PFOA | PFOS)

*Measurements in units of PPT
ND = Non-Detect

FIGURE 6
TEMPERATURE
SURVEY RESULTS
Sheet 4 of 7

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 600 1,200
Feet

G:\GrandRapids\DCS\GIS\ArcMap_GeoDB_Projects\ENV\GIS_Data\GIS\Wurtsmith_AFB\Wurtsmith_GIS\MXDs\Surface_water\180123_SurfaceWater_Foam_sampling.mxd

DEQ

2/16/2018

Legend

Surface Water Sample

Temperature Survey Results

- Deep - 1 Standard Deviation
- Deep - 2 Standard Deviation
- Shallow - 1 Standard Deviation
- Shallow - 2 Standard Deviation

Groundwater Impact

Total PFAS ppt

- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000
- Estimated Boundary

Location
Sample Date
Total PFAS (PFOA | PFOS)

*Measurements in units of PPT
ND = Non-Detect

Long Marsh Stream 1
10/8/2014
3119.6 (150 | 1800)

Long Marsh Stream 1
7/30/2014
6354.3 (180 | 4600)

WWTP Stream 1 Outlet
7/30/2014
16.8 (1.3 | 3.9)

Au Sable 4
7/30/2014
4.2 (ND | ND)

SW11017
5/12/2016
4.6 (ND | 1.9)

Au Sable 6
7/30/2014
8.7 (0.8 | 1.4)

Au Sable 7
7/30/2014
12.2 (1.1 | 1.7)

Au Sable 8
7/30/2014
26.4 (3.7 | 5.7)

Pond 2 Stream 1
5/22/2012
2625.4 (150 | 1400)

SW11018
5/12/2016
13.9 (ND | 11.3)

Au Sable 9
7/30/2014
52.3 (6.9 | 16)

Au Sable 10
7/30/2014
27.4 (3.4 | 7.4)

Pond 3 Stream 1
5/22/2012
3903.9 (480 | 1400)

Au Sable 11
7/30/2014
23.9 (2.5 | 6.3)

CREEK #2
5/15/2017
90.4 (7.4 | 1.9)

Au Sable 12
7/30/2014
19.8 (2 | 3.9)

FIGURE 6
TEMPERATURE SURVEY RESULTS
Sheet 5 of 7

FORMER WURTSMITH AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 600 1,200
Feet

G:\GrandRapids\DCS\GIS\ArcMap_GeoDB_Projects\ENV\GIS_Data\GIS\Wurtsmith_AFB\Wurtsmith_GIS\MXDs\Surface_water\180123_SurfaceWater_Foam_sampling.mxd

2/16/2018

Legend

Surface Water Sample

Temperature Survey Results

- Deep - 1 Standard Deviation
- Deep - 2 Standard Deviation
- Shallow - 1 Standard Deviation
- Shallow - 2 Standard Deviation

Groundwater Impact

Total PFAS ppt

- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000
- Estimated Boundary

Location
Sample Date
Total PFAS (PFOA | PFOS)

*Measurements in units of PPT
ND = Non-Detect

FIGURE 6
TEMPERATURE SURVEY RESULTS
Sheet 6 of 7

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 600 1,200
Feet

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Au Sable 13
7/30/2014
11.9 (1.4 | 2.3)

Au Sable 14
7/30/2014
16.2 (1.7 | 2.9)

3 Pipes Outfall
4/12/2012
829.6 (55 | 180)

Au Sable 15
7/30/2014
15.3 (1.6 | 2.8)

Au Sable 16
7/30/2014
53.4 (3.7 | 11)

SW14007
5/5/2016
36.4 (1.8 | 27.1)

Consumers Ditch Outlet 1
5/22/2012
2256 (80 | 3)

Au Sable 18
7/30/2014
15.4 (1.7 | 2.9)

Au Sable 20
7/30/2014
15.5 (1.5 | 3)

Au Sable 19
7/30/2014
149.8 (7.1 | 3.6)

Au Sable 17
7/30/2014
15.8 (1.3 | 2.8)

Van Etten Creek 3
10/9/2012
39.9 (5 | 3.5)

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DEQ

2/16/2018

Legend

Surface Water Sample

Temperature Survey Results

- Deep - 1 Standard Deviation
- Deep - 2 Standard Deviation
- Shallow - 1 Standard Deviation
- Shallow - 2 Standard Deviation

Groundwater Impact

Total PFAS ppt

- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000

Estimated Boundary

Location
Sample Date
Total PFAS (PFOA | PFOS)

*Measurements in units of PPT
ND = Non-Detect

FIGURE 6
TEMPERATURE SURVEY RESULTS
Sheet 7 of 7

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 600 1,200
Feet

2/16/2018

Legend

- Photo Location
- Temperature Survey Extent
- Road

Groundwater Impact

Total PFAS ppt

- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000
- Estimated Boundary
- Surface Water

FIGURE 7
AU SABLE RIVER
TEMPERATURE
SURVEY RESULTS
SHEET 1 of 8

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 2,000 4,000
Feet

Van Etten Lake

Van Etten Creek

Au Sable River

2 3 4 5 6 7 8

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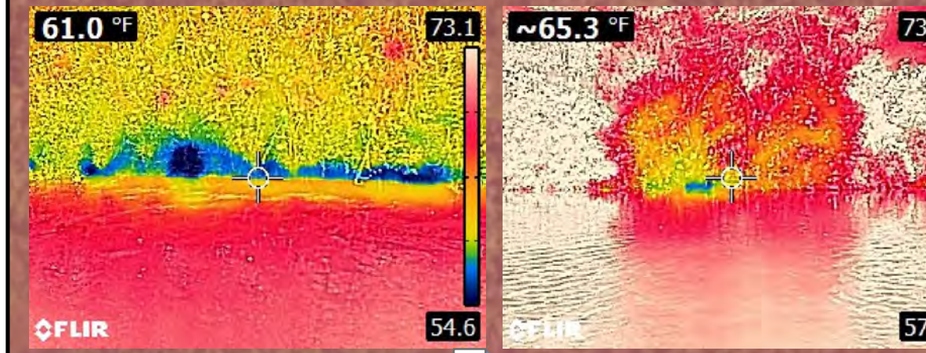

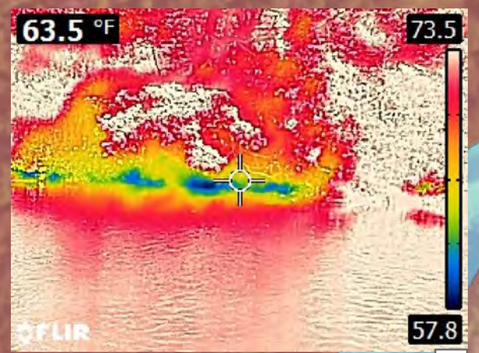

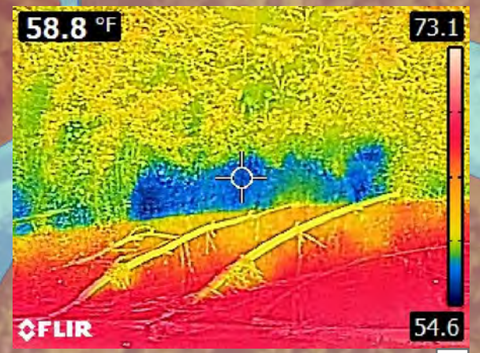

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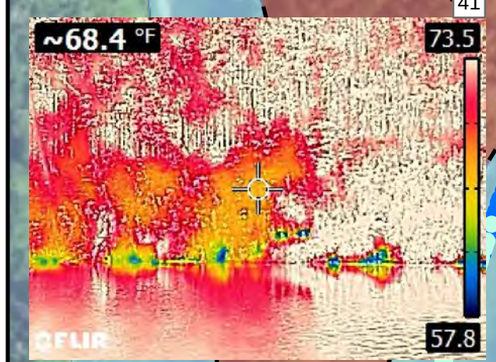
43

26



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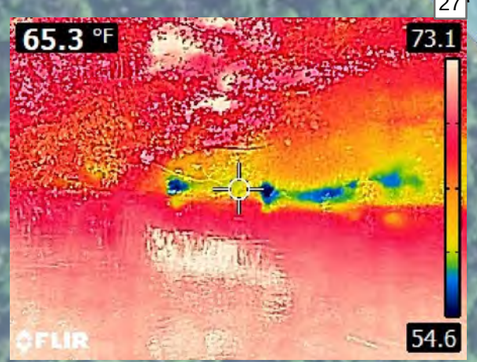

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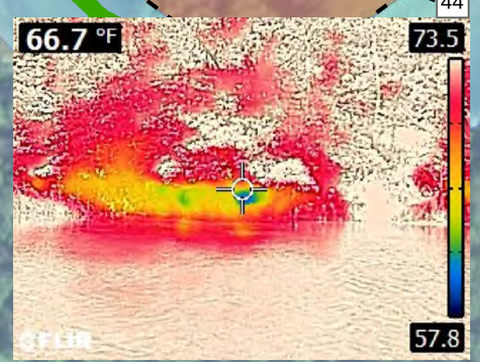

44

DEQ

2/16/2018

Legend

Photo Location

Temperature Survey Results
depth, dev

- Deep - 1 Standard Deviation
- Deep - 2 Standard Deviation
- Shallow - 1 Standard Deviation
- Shallow - 2 Standard Deviation
- Road

Groundwater Impact
Total PFAS ppt

- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000
- Estimated Boundary
- Surface Water

FIGURE 7
AU SABLE RIVER
TEMPERATURE
SURVEY RESULTS
Sheet 2 of 8

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 210 420
Feet

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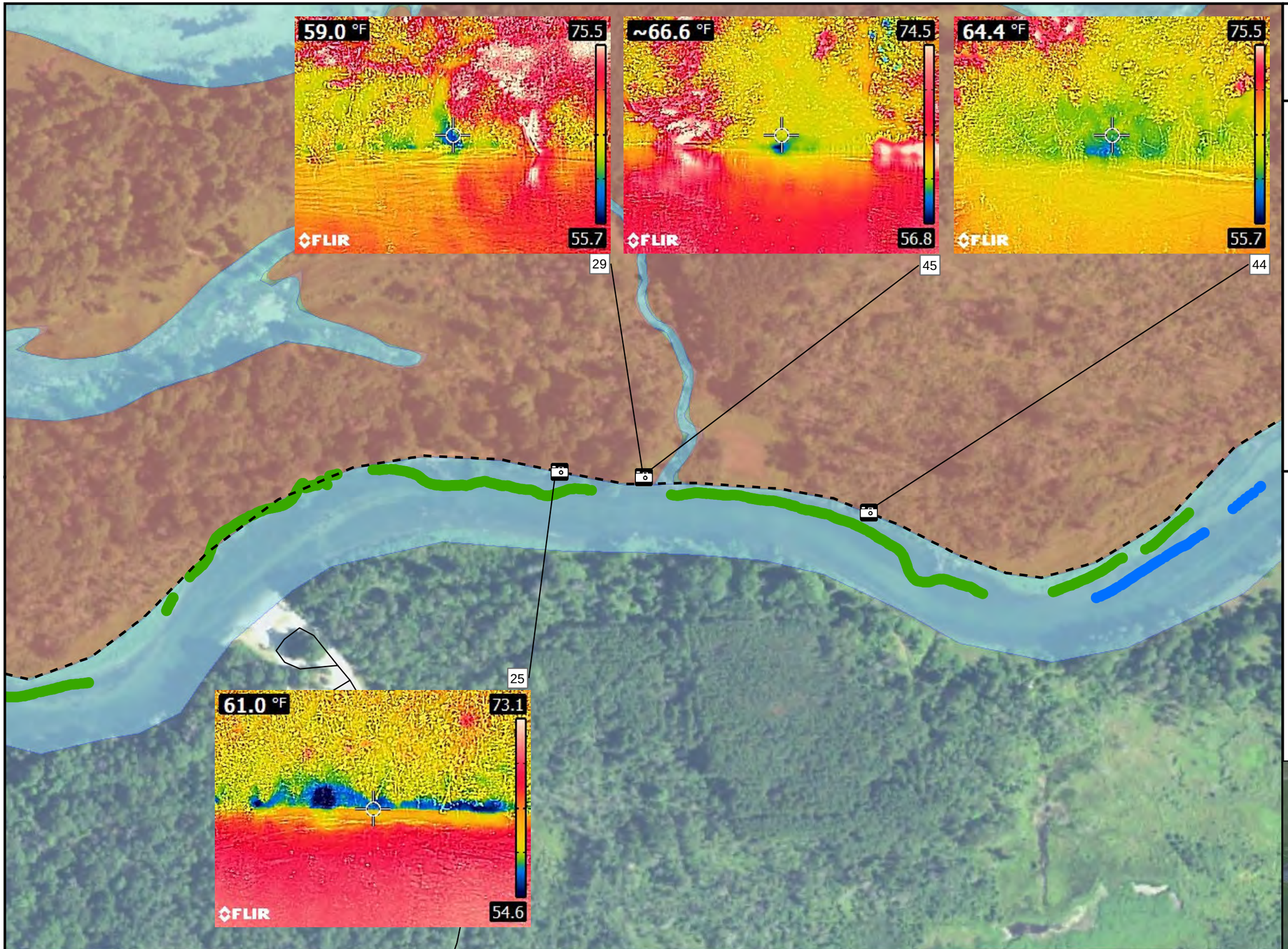

DEQ

2/16/2018

Legend

Photo Location

Temperature Survey Results

depth, dev

- Deep - 1 Standard Deviation
- Deep - 2 Standard Deviation
- Shallow - 1 Standard Deviation
- Shallow - 2 Standard Deviation
- Road

Groundwater Impact

Total PFAS ppt

- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000
- Estimated Boundary
- Surface Water

FIGURE 7
AU SABLE RIVER
TEMPERATURE
SURVEY RESULTS
Sheet 3 of 8

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 210 420
Feet

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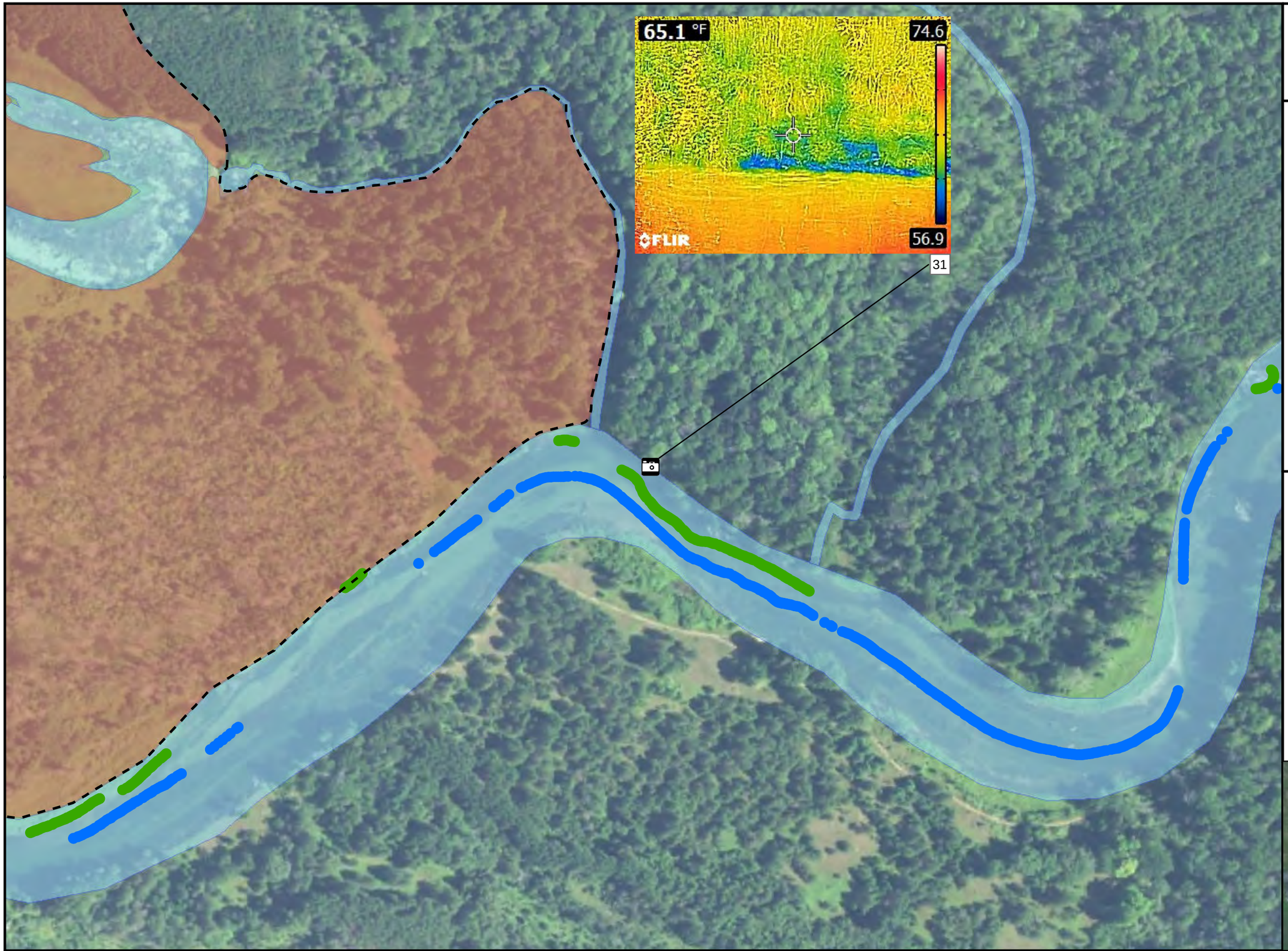

2/16/2018

Legend

Photo Location

Temperature Survey Results
depth, dev

- Deep - 1 Standard Deviation
- Deep - 2 Standard Deviation
- Shallow - 1 Standard Deviation
- Shallow - 2 Standard Deviation
- Road

Groundwater Impact
Total PFAS ppt

- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000
- Estimated Boundary
- Surface Water

FIGURE 7
AU SABLE RIVER
TEMPERATURE
SURVEY RESULTS
Sheet4 of 8

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 210 420
Feet

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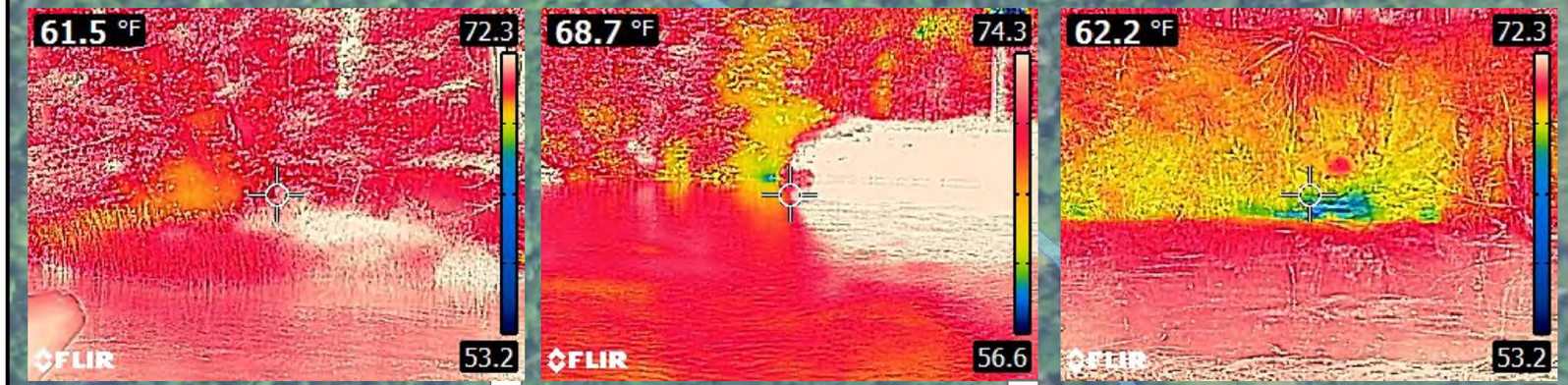

DEQ

2/16/2018

Legend

Photo Location

Temperature Survey Results
depth, dev

- Deep - 1 Standard Deviation
- Deep - 2 Standard Deviation
- Shallow - 1 Standard Deviation
- Shallow - 2 Standard Deviation
- Road

Groundwater Impact
Total PFAS ppt

- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000
- Estimated Boundary
- Surface Water

FIGURE 7
AU SABLE RIVER
TEMPERATURE
SURVEY RESULTS
Sheet 5 of 8

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 210 420
Feet

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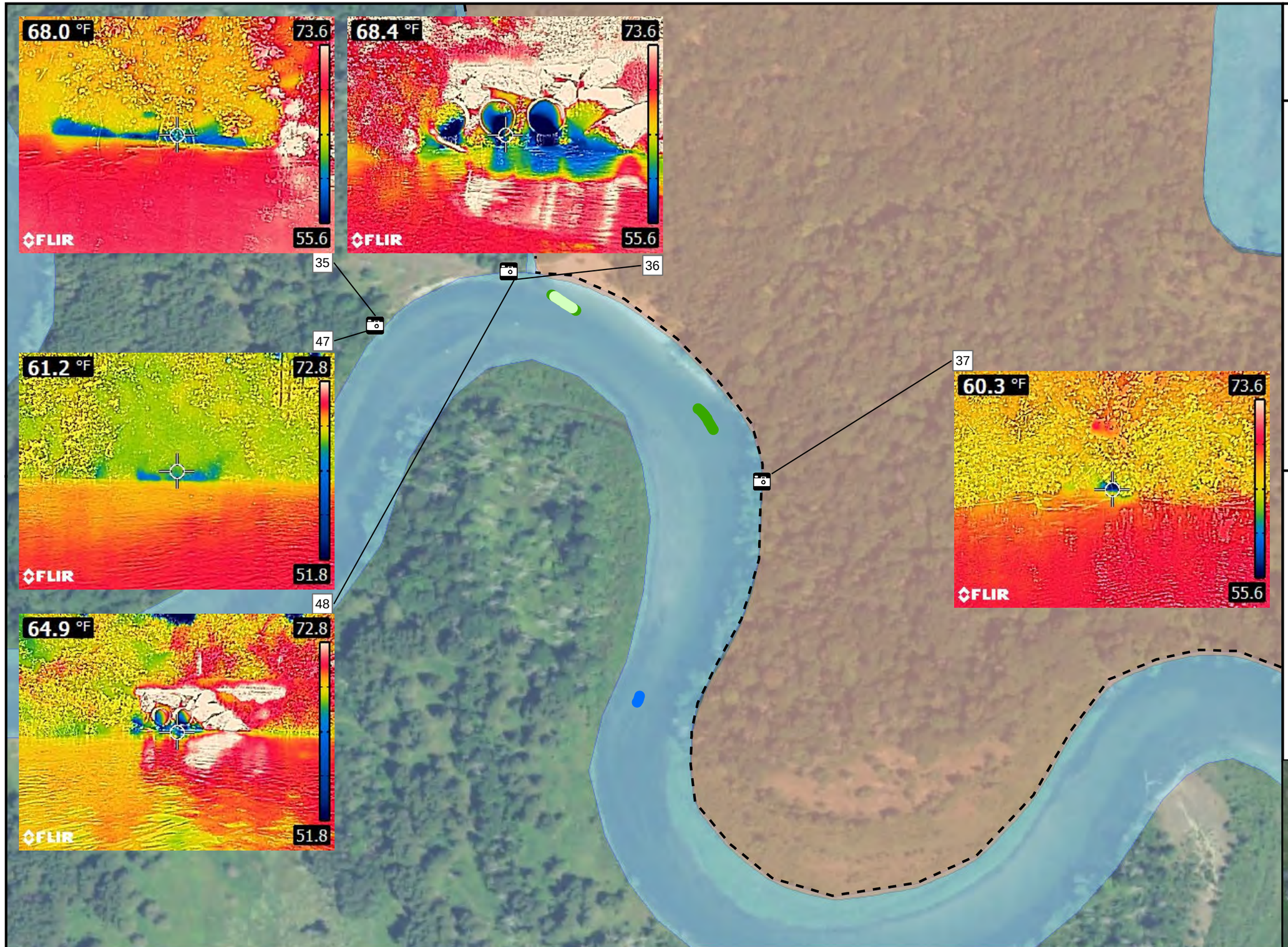


DEQ

2/16/2018

Legend

Photo Location

Temperature Survey Results
depth, dev

- Deep - 1 Standard Deviation
- Deep - 2 Standard Deviation
- Shallow - 1 Standard Deviation
- Shallow - 2 Standard Deviation
- Road

Groundwater Impact
Total PFAS ppt

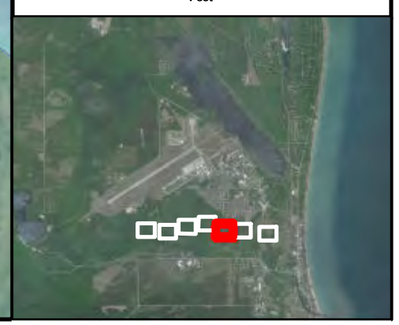
- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000
- Estimated Boundary
- Surface Water

FIGURE 7
AU SABLE RIVER
TEMPERATURE
SURVEY RESULTS
Sheet 6 of 8

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 210 420
Feet



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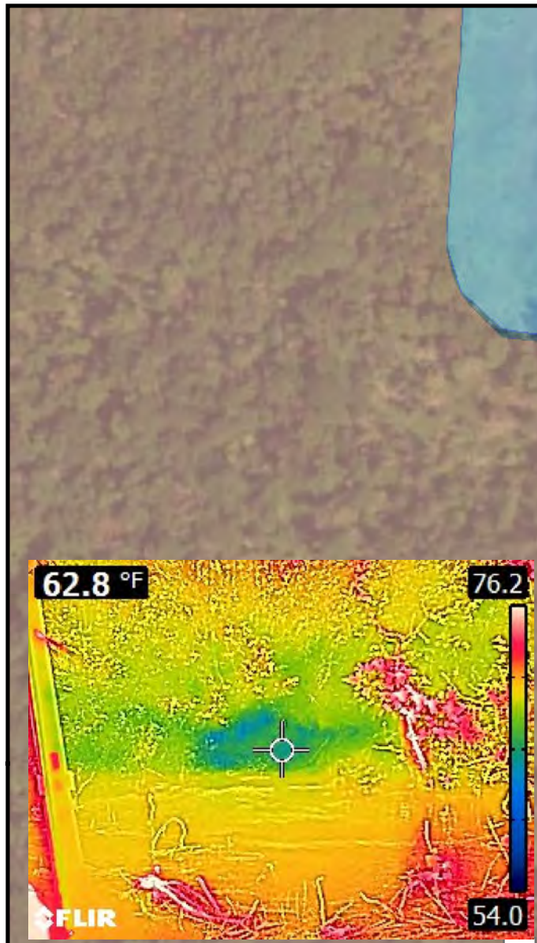
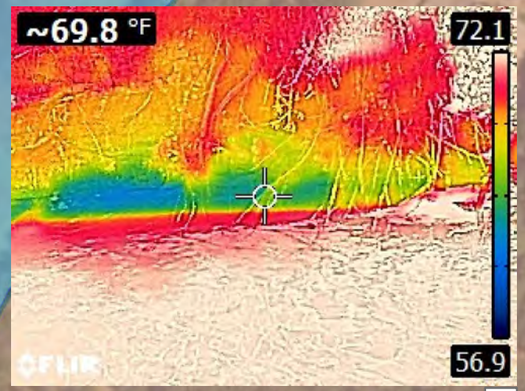




39

38

2/16/2018

Legend

Photo Location

Temperature Survey Results
depth, dev

- Deep - 1 Standard Deviation
- Deep - 2 Standard Deviation
- Shallow - 1 Standard Deviation
- Shallow - 2 Standard Deviation
- Road

Groundwater Impact
Total PFAS ppt

- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000
- Estimated Boundary
- Surface Water

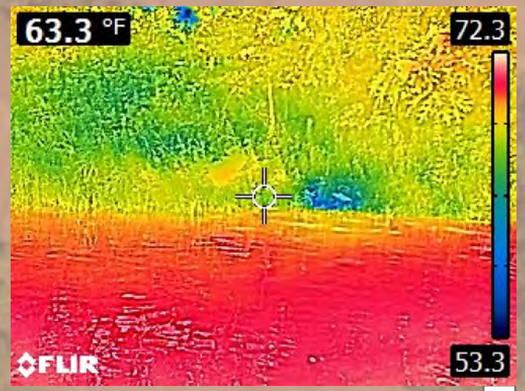
FIGURE 7
AU SABLE RIVER
TEMPERATURE
SURVEY RESULTS
Sheet 7 of 8

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 210 420
Feet

G:\GrandRapids\DCS\GIS\ArcMap_GeoDB_Projects\ENV\GIS_Data\GIS\Wurtsmith_AFB\Wurtsmith_GIS\MXDs\Reports\temp_study\Figure_7_photo_locations_page7.mxd



40

2/16/2018

Legend

Photo Location

Temperature Survey Results
depth, dev

- Deep - 1 Standard Deviation
- Deep - 2 Standard Deviation
- Shallow - 1 Standard Deviation
- Shallow - 2 Standard Deviation
- Road

Groundwater Impact
Total PFAS ppt

- 1 - 50
- 51 - 300
- 301 - 1,000
- 1,000 - 5,000
- > 5,000
- Estimated Boundary
- Surface Water

FIGURE 7
AU SABLE RIVER
TEMPERATURE
SURVEY RESULTS
Sheet 8 of 8

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY, MICHIGAN

N

0 210 420
Feet

G:\GrandRapids\DCS\GIS\ArcMap_GeoDB_Projects\ENV\GIS_Data\GIS\Wurtsmith_AFB\Wurtsmith_GIS\MXDs\Reports\temp_study\Figure_7_photo_locations_page8.mxd

3950 Sparks Drive SE
Grand Rapids, Michigan 49546
aecom.com

Attachment 11 – December 2018 Memo Van Etten Lake Surface Water Sampling by AECOM on behalf of the EGLE (formerly known as MDEQ)

AECOM
3950 Sparks Drive Southeast
Grand Rapids, MI 49546
aecom.com

Project name:
Wurtsmith Air Force Base

Project ref:
60518528

From:
Jeremiah Morse, AECOM

Date:
February 6, 2019

To:
Michael Jury
Michigan Department of Environmental Quality – Remediation and Redevelopment Division
401 Ketchum St.
Bay City, Michigan 48708

CC:
Susan Leeming, MDEQ
Robert Delaney, MDEQ
Beth Place, MDEQ
John Bradley, MDEQ
John Cuthbertson, AECOM
Dorin Bogdan, AECOM
Michael Wolf, AECOM

Memo

Subject: December 2018 Van Etten Lake Surface Water Sampling

1. Introduction

This Technical Memorandum (TM) is being submitted to the Michigan Department of Environmental Quality (MDEQ) presenting surface water and pore water sample analytical findings from Van Etten Lake near the former Wurtsmith Air Force Base (WAFB) located in Oscoda Township, Michigan. AECOM understands that the MDEQ is the regulatory authority in charge of protection of human health and the environment with regard to contamination present at and migrating from the former WAFB. Since 2010, per- and polyfluoroalkyl substances (PFAS) have been identified in groundwater, surface water, soil, sediments and biota at WAFB.

During low winter water levels on Van Etten Lake, MDEQ personnel observed areas where ice was not forming along the shoreline. It was believed this may be occurring due to potential groundwater discharge areas along the eastern boundary of the former Air Force base and Van Etten Lake. MDEQ requested AECOM to collect pore water and surface water samples from these potential groundwater discharge areas. This technical memorandum summarizes the findings of this sampling effort on Van Etten Lake completed December, 2018.

2. Investigation

AECOM mobilized to the site on 27 December 2018. Four (4) locations were identified as potential groundwater discharge areas (**Figure 1**). These locations were identified by observing areas with the absence of near-shore ice and/or had visible water discharging from on-shore sediments. During the winter months it is expected that groundwater discharging into surface water and/or from surface sediments would be relatively warmer than adjacent surface water and/or surface sediments. A Forward Looking Infrared (FLIR) camera was utilized to further verify potential warmer groundwater discharge areas at each of the four sampling locations (**Photo Log Appendix A**).

Two samples were collected from each of the four locations. The first was a pore water sample collected with a Henry sampler installed onshore to intercept where groundwater may be discharging. The Henry sampler consisted of a narrow gauge stainless steel tube with a series of interlaced machined slots on the sampling end of the tube that was inserted into the sediment. New, flexible tubing was then connected to the other end of the sampler and a peristaltic pump was used to extract the sample. The second sample at each location was collected from the lake directly off-shore from the Henry sample location, close to the lake bottom at or near the same elevation in which the Henry sample was taken.

Due to the prevalence of PFAS in articles of commerce, cross contamination may occur between sampling equipment and the water samples. To ensure no cross-contamination occurred, AECOM decontaminated all non-dedicated equipment with a Liquinox-deionized water mixture. Field personnel performing the collection procedures donned a new pair of sampling gloves prior to handling any sampling equipment, between sampling and decontamination procedures, and between sampling locations.

Samples were collected in appropriate certified PFA-free sample containers (provided by the laboratory), labeled, transferred to a cooler on ice, and submitted to the laboratory, under chain-of-custody documentation, for analysis. Detailed sampling and handling procedures are provided in MDEQ PFAS Sampling Guidance documents.

2.1 Methodology

All surface water samples were analyzed for PFAS. Vista Analytical Laboratory (Vista) in El Dorado Hills, California conducted the PFAS analysis using Modified Environmental Protection Agency's (EPA) Method 537 Rev. 1.1 with isotope dilution. Currently, a published USEPA reference method is not available for the analysis of PFAS in surface water. In 2009, USEPA published reference Method 537 Rev. 1.1 for finished drinking water, but this method is not appropriate for more complex solid and aqueous matrices. The Method 537 Rev. 1.1 is an internal standard method. Internal standardization is a determinative technique where a chemical substance similar to the analytes of interest is added to sample extracts to quantify the target analytes.

The Michigan Department of Environmental Quality (MDEQ) is using an isotope dilution method for analysis of 24 PFAS for many of their ongoing investigations. The isotope dilution method is widely accepted as a better technique for quantification where matrix interference may be present and/or analyte loss may occur during the sample preparation process. The Department of Defense's accreditation program using DoD QSM Version 5.1 recognizes that isotope dilution is a better technique for quantifying PFAS at low concentrations especially in complex environmental matrices due to these matrix effects and requires isotope dilution quantification where the isotopically labeled analytes of interest are available, and the target compound concentration is not so high that serial dilution or direct injection is appropriate.

3. Results

Analytical results from this event are summarized in the **Table 1**. The laboratory analytical summary report is included for reference (**Appendix B**). All samples analyzed detected Perfluorooctanesulfonic acid (PFOS) at concentrations greater than the Michigan GSI Criteria of 12 ng/L. **Figure 2** depicts detected concentrations of specific PFAS compounds (Total PFAS|PFOA|PFOS|PFHxS) at each sample location.

Figures

DEQ

1/30/2019

Surface Water Samples

●

Pore Water Samples

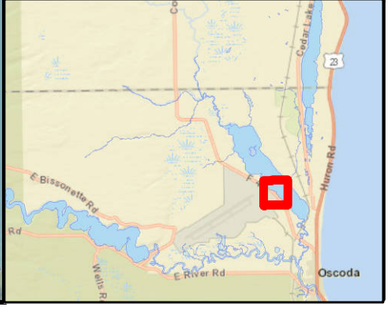
▲

FIGURE 1
DECEMBER 2018 VAN ETTEN LAKE SURFACE WATER & PORE WATER SAMPLE LOCATIONS

FORMER WURTSMITH AIR FORCE BASE IOSCO COUNTY, MICHIGAN

N

0 440 880
Feet



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Total PFAS Plume
Concentration (ppt)
- 10 - <70
- 70 - <1,000
- 1,000 - <5,000
- >5,000

Sample Location - Sample Date
Total PFAS (PFOA | PFOS | PFHxS) ppt

Van Etten Lake

SW-4 - 12/27/2018
553 (47 | 50 | 212)

SW-3 - 12/27/2018
314 (28 | 59 | 96)

PW-4 - 12/27/2018
159 (11 | 61 | 55)

PW-3 - 12/27/2018
2,232 (108 | 55 | 591)

SW-2 - 12/27/2018
574 (46 | 102 | 176)

PW-2 - 12/27/2018
356 (19 | 195 | 54)

SW-1 - 12/27/2018
1,855 (131 | 497 | 531)

PW-1 - 12/27/2018
1,064 (84 | 566 | 282)

DEQ

1/30/2019

Total PFAS (ppt)
Surface Water Samples
- Non-Detect
- <12
- 12 - <50
- 50 - <100
- 100 - <1,000
- 1,000 - <2,500
- >2,500

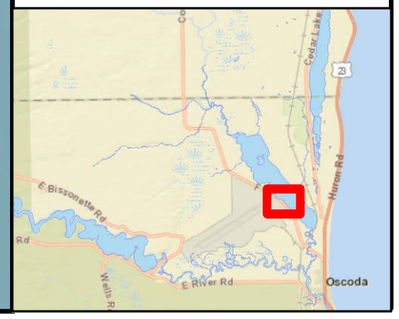
Pore Water Samples
- Non-Detect
- <12
- 12 - <50
- 50 - <100
- 100 - <1,000
- 1,000 - <2,500
- >2,500

FIGURE 2
DECEMBER 2018 VAN ETTEN LAKE
SURFACE WATER &
PORE WATER
TOTAL PFAS
SAMPLING RESULTS

FORMER WURTSMITH
AIR FORCE BASE
IOSCO COUNTY,
MICHIGAN

N

0 440 880
Feet



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Tables

Van Etten Lake Suface Water Sampling
December 2018
Former Wurtsmith Air Force Base
Iosco County, Michigan
60518528

PFAS Compound	PW-01	SW-01	PW-02	SW-02	PW-03	SW-03	PW-04	SW-04
	12/27/2018	12/27/2018	12/27/2018	12/27/2018	12/27/2018	12/27/2018	12/27/2018	12/27/2018
	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l	ng/l
PFBA	2	24	7	10	143	10	5	22
PFPeA	2	83	6	30	592	32	6	79
PFHxA	11	77	8	30	467	27	7	61
PFHpA	3	49	9	16	205	17	6	32
PFOA	84	131	19	46	108	28	11	47
PFNA	3	3	4	< 4.19	< 4.09	< 4.23	2	< 4.10
PFDA	< 4.09	< 4.19	< 4.05	< 4.19	< 4.09	< 4.23	< 4.06	< 4.10
PFUnDA	< 4.09	< 4.19	< 4.05	< 4.19	< 4.09	< 4.23	< 4.06	< 4.10
PFDoDA	< 4.09	< 4.19	< 4.05	< 4.19	< 4.09	< 4.23	< 4.06	< 4.10
PFTrDA	< 4.09	< 4.19	< 4.05	< 4.19	< 4.09	< 4.23	< 4.06	< 4.10
PFTeDA	< 4.09	< 4.19	< 4.05	< 4.19	< 4.09	< 4.23	< 4.06	< 4.10
PFBS	3	6	3	3	17	2	2	4
PFPeS	< 4.09	13	1	4	35	4	1	9
PFHxS	282	531	54	176	591	96	55	212
PFHpS	14	33	8	10	15	5	3	5
PFOS	566	497	195	102	55	59	61	50
PFNS	< 4.09	< 4.19	< 4.05	< 4.19	< 4.09	< 4.23	< 4.06	< 4.10
PFDS	< 4.09	< 4.19	< 4.05	< 4.19	< 4.09	< 4.23	< 4.06	< 4.10
PFOSA	< 4.09	< 4.19	< 4.05	< 4.19	< 4.09	< 4.23	< 4.06	< 4.10
4:2 FTSA	< 4.09	< 4.19	< 4.05	< 4.19	< 4.09	< 4.23	< 4.06	< 4.10
6:2 FTSA	89	407	42	146	5	34	< 4.06	32
8:2 FTSA	6	2	< 4.05	< 4.19	< 4.09	< 4.23	< 4.06	< 4.10
EtFOSAA	< 4.09	< 4.19	< 4.05	< 4.19	< 4.09	< 4.23	< 4.06	< 4.10
MeFOSAA	< 4.09	< 4.19	< 4.05	< 4.19	< 4.09	< 4.23	< 4.06	< 4.10
Total PFAS	**1,064**	**1,855**	**356**	**574**	**2,232**	**314**	**159**	**553**

Perfluoroalkyl Carboxylic Acids (**PFCAs**)
Perfluoroalkane Sulfonic Acids (**PFSAs**)
Perfluoroalkane Sulfonamides (**FASAs**)
Fluorotelomer Sulfonic Acids (**FTSAs**)
N-Ethyl Perfluoroalkane Sulfonamidoacetic Acids (**EtFASAAs**)
N-Methyl Perfluoroalkane Sulfonamidoacetic Acids (**MeFASAAs**)

Appendix A – Photograph Log

AECOM

PHOTOGRAPH LOG

Project Name:	Site Location:	Sample Location ID:	Project No.
Former Wurtsmith Air Force Base	Oscoda Township, MI	PW/SW-1	60518528

Photo No. 1	Date: 12/27/18

Direction Photo Taken:

North

Description:

Infrared picture of PW/SW-1 sampling location

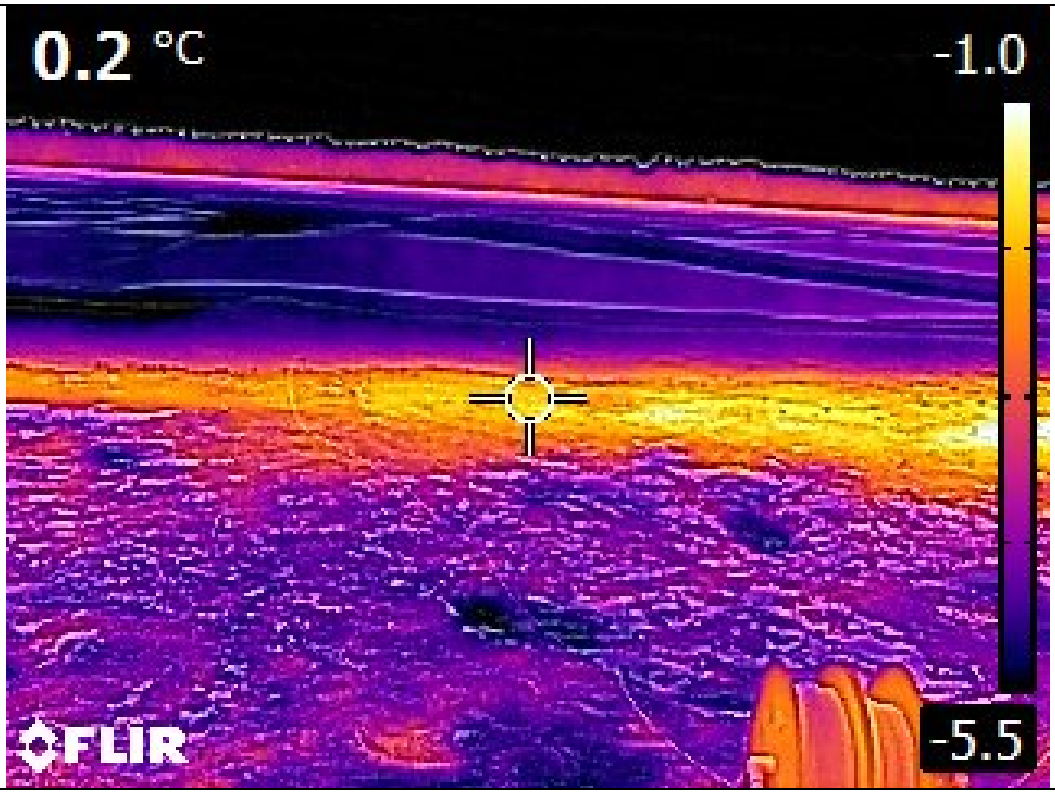


Photo No. 2	Date: 12/27/18

Direction Photo Taken:

North

Description:

Color picture of PW/SW-1 sampling location

AECOM

PHOTOGRAPH LOG

Project Name:	Site Location:	Sample Location ID:	Project No.
Former Wurtsmith Air Force Base	Oscoda Township, MI	PW/SW-2	60518528

Photo No. 1	Date: 12/27/18

Direction Photo Taken:

North

Description:

Infrared picture of PW/SW-2 sampling location

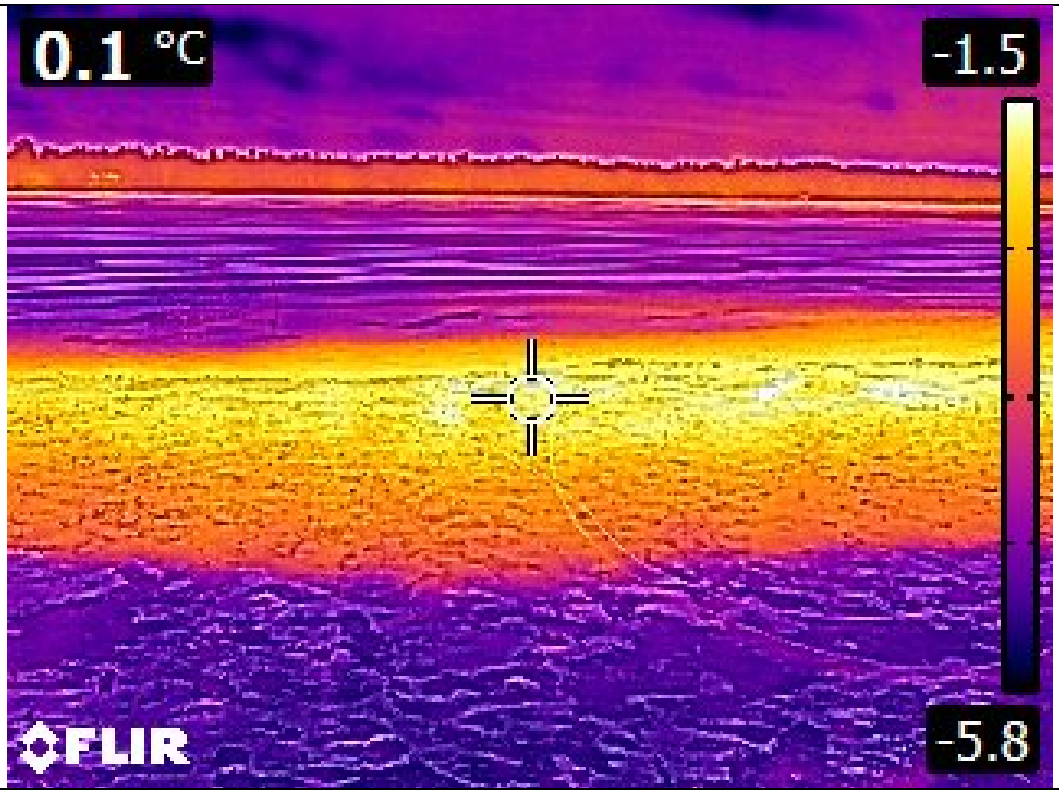


Photo No. 2	Date: 12/27/18

Direction Photo Taken:

North

Description:

Color picture of PW/SW-2 sampling location

AECOM

PHOTOGRAPH LOG

Project Name:	Site Location:	Sample Location ID:	Project No.
Former Wurtsmith Air Force Base	Oscoda Township, MI	PW/SW-3	60518528

Photo No.	Date:
1	12/27/18

Direction Photo Taken:

North

Description:

Infrared picture of PW/SW-3 sampling location

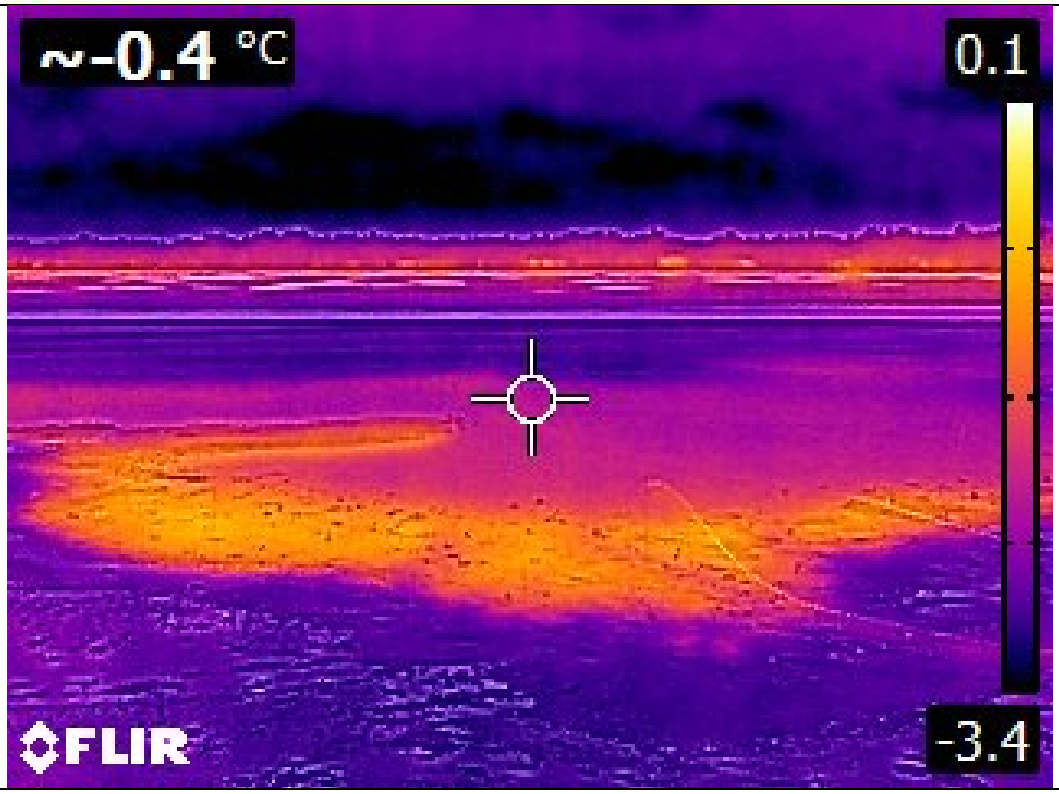


Photo No.	Date:
2	12/27/18

Direction Photo Taken:

North

Description:

Color picture of PW/SW-3 sampling location

AECOM

PHOTOGRAPH LOG

Project Name:	Site Location:	Sample Location ID:	Project No.
Former Wurtsmith Air Force Base	Oscoda Township, MI	PW/SW-4	60518528

Photo No.	Date:
1	12/27/18

Direction Photo Taken:

North

Description:

Infrared picture of PW/SW-4 sampling location

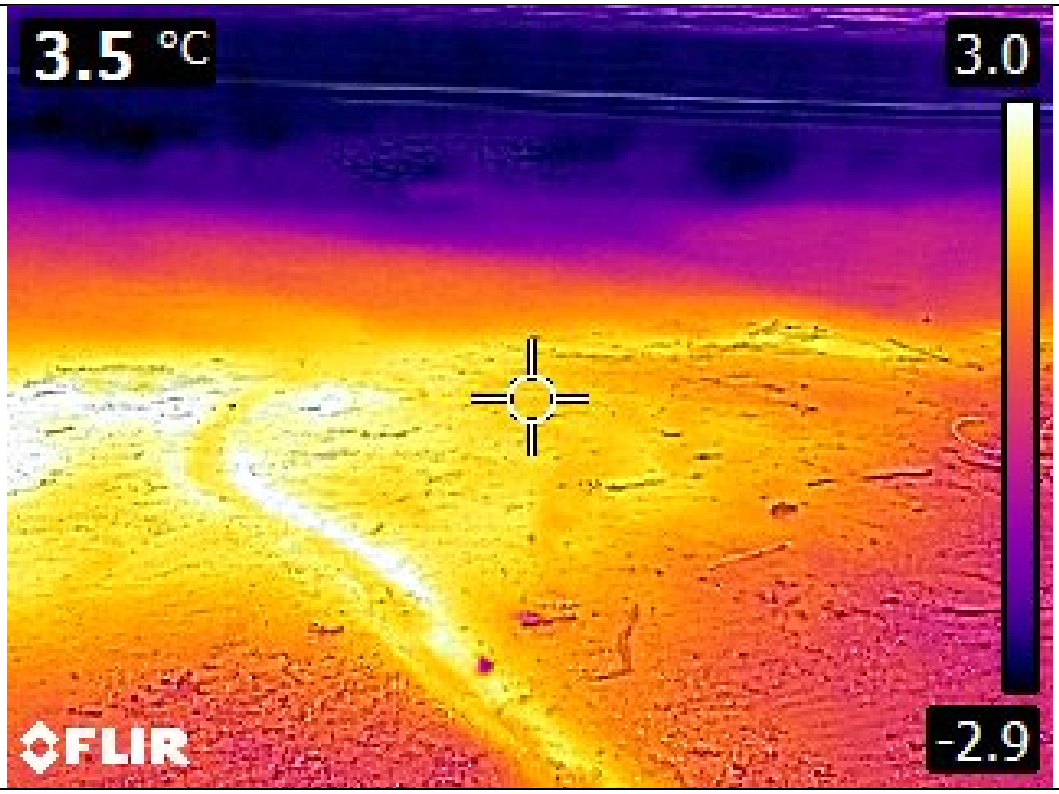


Photo No.	Date:
2	12/27/18

Direction Photo Taken:

North

Description:

Color picture of PW/SW-4 sampling location

Appendix B – Analytical Report

January 14, 2019

Vista Work Order No. 1900023

Ms. Maya Murshak
Merit Laboratories, Inc.
2680 East Lansing Drive
East Lansing, MI 48823

Dear Ms. Murshak,

Enclosed are the results for the sample set received at Vista Analytical Laboratory on January 03, 2019 under your Project Name 'Wurtsmith'.

Vista Analytical Laboratory is committed to serving you effectively. If you require additional information, please contact me at 916-673-1520 or by email at mmaier@vista-analytical.com.

Thank you for choosing Vista as part of your analytical support team.

Sincerely,

Martha Maier
Laboratory Director

Vista Analytical Laboratory certifies that the report herein meets all the requirements set forth by NELAP for those applicable test methods. Results relate only to the samples as received by the laboratory. This report should not be reproduced except in full without the written approval of Vista.

Vista Work Order No. 1900023
Case Narrative

Sample Condition on Receipt:

Eight aqueous samples were received in good condition and within the method temperature requirements. The samples were received and stored securely in accordance with Vista standard operating procedures and EPA methodology.

Analytical Notes:

PFAS Isotope Dilution Method

The samples were extracted and analyzed for a selected list of PFAS using the PFAS Isotope Dilution Method (Modified EPA Method 537). The results for PFHxS, PFOA, PFOS, MeFOSAA and EtFOSAA include both linear and branched isomers. Results for all other analytes include the linear isomers only.

Holding Times

The samples were extracted and analyzed within the method hold times.

Quality Control

The Initial Calibration and Continuing Calibration Verifications met the method acceptance criteria.

A Method Blank and Ongoing Precision and Recovery (OPR) sample were extracted and analyzed with the preparation batch. No analytes were detected in the Method Blank above 1/2 the LOQ. The OPR recoveries were within the method acceptance criteria.

The labeled standard recoveries for all QC and field samples were within the acceptance criteria.

TABLE OF CONTENTS

Sample Inventory Report

Vista Sample ID	Client Sample ID	Sampled	Received	Components/Containers
1900023-01	PW1812271330GSC	27-Dec-18 13:30	03-Jan-19 09:42	HDPE Bottle, 250 mL
				HDPE Bottle, 250 mL
1900023-02	SW1812271410GSC	27-Dec-18 14:10	03-Jan-19 09:42	HDPE Bottle, 250 mL
				HDPE Bottle, 250 mL
1900023-03	PW1812271435GSC	27-Dec-18 14:35	03-Jan-19 09:42	HDPE Bottle, 250 mL
				HDPE Bottle, 250 mL
1900023-04	SW1812271450GSC	27-Dec-18 14:50	03-Jan-19 09:42	HDPE Bottle, 250 mL
				HDPE Bottle, 250 mL
1900023-05	PW1812271510GSC	27-Dec-18 15:10	03-Jan-19 09:42	HDPE Bottle, 250 mL
				HDPE Bottle, 250 mL
1900023-06	SW1812271530GSC	27-Dec-18 15:30	03-Jan-19 09:42	HDPE Bottle, 250 mL
				HDPE Bottle, 250 mL
1900023-07	PW1812271555GSC	27-Dec-18 15:55	03-Jan-19 09:42	HDPE Bottle, 250 mL
				HDPE Bottle, 250 mL
1900023-08	SW1812271610GSC	27-Dec-18 16:10	03-Jan-19 09:42	HDPE Bottle, 250 mL
				HDPE Bottle, 250 mL

ANALYTICAL RESULTS

Sample ID: Method Blank

PFAS Isotope Dilution Method

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Matrix: Aqueous

Laboratory Data

Lab Sample: B9A0023-BLK1
Column: BEH C18

Analyte	Conc. (ng/L)	DL	LOD	LOQ	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
L-PFBA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFPeA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFBS	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-4:2 FTS	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFHxA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFPeS	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFHpA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFHxS	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
Br-PFHxS	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
Total PFHxS	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-6:2 FTS	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFOA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
Br-PFOA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
Total PFOA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFHpS	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFNA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFOSA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFOS	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
Br-PFOS	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
Total PFOS	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFDA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-8:2FTS	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFNS	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-MeFOSAA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
Br-MeFOSAA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
Total MeFOSAA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-EtFOSAA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
Br-EtFOSAA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
Total EtFOSAA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFUnA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFDS	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFDoA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFTrDA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
L-PFTeDA	ND	1.37	2.00	4.00		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C3-PFBA	IS	94.1	60 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
13C3-PFPeA	IS	92.4	60 - 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
13C3-PFBS	IS	98.2	60 - 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1

Sample ID: Method Blank **PFAS Isotope Dilution Method**

Client Data

Name: Merit Laboratories, Inc. Matrix: Aqueous

Project: Wurtsmith

Laboratory Data

Lab Sample: B9A0023-BLK1 Column: BEH C18

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C2-4:2 FTS	IS	82.2	40 - 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
13C2-PFHxA	IS	94.5	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
13C4-PFHpA	IS	96.2	60 - 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
18O2-PFHxS	IS	98.0	60 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
13C2-6:2 FTS	IS	104	40 - 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
13C2-PFOA	IS	94.0	60 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
13C5-PFNA	IS	89.4	50 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
13C8-PFOSA	IS	45.0	20 - 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
13C8-PFOS	IS	90.5	60 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
13C2-PFDA	IS	73.4	60 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
13C2-8:2 FTS	IS	90.2	40 - 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
d3-MeFOSAA	IS	71.3	50 - 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
d5-EtFOSAA	IS	71.5	50 - 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
13C2-PFUnA	IS	74.9	60 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
13C2-PFDoA	IS	63.7	30 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1
13C2-PFTeDA	IS	79.3	20 - 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:29	1

DL - Detection Limit LOD - Limit of Detection Results reported to the DL.
LOQ - Limit of quantitation

Sample ID: OPR **PFAS Isotope Dilution Method**

Client Data

Name: Merit Laboratories, Inc. Matrix: Aqueous
Project: Wurtsmith

Laboratory Data

Lab Sample: B9A0023-BS1 Column: BEH C18

Analyte	Amt Found (ng/L)	Spike Amt	% Rec	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
L-PFBA	44.1	40.0	110	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-PFPeA	43.8	40.0	110	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-PFBS	45.7	40.0	114	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-4:2 FTS	45.9	40.0	115	60 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-PFHxA	43.4	40.0	109	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-PFPeS	48.3	40.0	121	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-PFHpA	43.4	40.0	109	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
Total PFHxS	41.0	40.0	103	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-6:2 FTS	48.8	40.0	122	60 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
Total PFOA	40.9	40.0	102	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-PFHpS	45.1	40.0	113	60 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-PFNA	44.3	40.0	111	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-PFOSA	42.7	40.0	107	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
Total PFOS	45.6	40.0	114	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-PFDA	44.4	40.0	111	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-8:2FTS	47.1	40.0	118	60 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-PFNS	44.6	40.0	111	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
Total MeFOSAA	39.1	40.0	97.7	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
Total EtFOSAA	47.8	40.0	119	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-PFUnA	44.8	40.0	112	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-PFDS	38.6	40.0	96.6	60 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-PFDoA	40.0	40.0	99.9	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-PFTrDA	45.0	40.0	113	60 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
L-PFTeDA	44.7	40.0	112	70 - 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1

Labeled Standards	Type	% Rec	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C3-PFBA	IS	101	60- 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
13C3-PFPeA	IS	97.7	60- 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
13C3-PFBS	IS	94.5	60- 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
13C2-4:2 FTS	IS	86.4	40- 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
13C2-PFHxA	IS	101	70- 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
13C4-PFHpA	IS	104	60- 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
18O2-PFHxS	IS	107	60- 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
13C2-6:2 FTS	IS	103	40- 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
13C2-PFOA	IS	95.9	60- 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
13C5-PFNA	IS	85.2	50- 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1

Sample ID: OPR **PFAS Isotope Dilution Method**

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Matrix: Aqueous

Laboratory Data

Lab Sample: B9A0023-BS1
Column: BEH C18

Labeled Standards	Type	% Rec	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C8-PFOSA	IS	44.1	20- 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
13C8-PFOS	IS	108	60- 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
13C2-PFDA	IS	76.7	60- 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
13C2-8:2 FTS	IS	97.3	40- 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
d3-MeFOSAA	IS	77.7	50- 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
d5-EtFOSAA	IS	70.0	50- 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
13C2-PFUnA	IS	76.8	60- 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
13C2-PFDoA	IS	72.4	30- 130		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1
13C2-PFTeDA	IS	87.6	20- 150		B9A0023	04-Jan-19	0.250 L	07-Jan-19 17:19	1

Sample ID: PW1812271330GSC — **PFAS Isotope Dilution Method**

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: PW1
Matrix: Aqueous
Date Collected: 27-Dec-18 13:30

Laboratory Data

Lab Sample: 1900023-01
Date Received: 03-Jan-19 09:42
Column: BEH C18

Analyte	Conc. (ng/L)	DL	LOD	LOQ	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
L-PFBA	1.85	1.40	2.05	4.09	J	B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFPeA	2.37	1.40	2.05	4.09	J	B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFBS	2.72	1.40	2.05	4.09	J	B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-4:2 FTS	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFHxA	10.6	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFPeS	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFHpA	2.89	1.40	2.05	4.09	J	B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFHxS	251	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
Br-PFHxS	31.7	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
Total PFHxS	282	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-6:2 FTS	88.5	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFOA	81.1	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
Br-PFOA	2.90	1.40	2.05	4.09	J	B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
Total PFOA	84.0	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFHpS	14.4	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFNA	2.84	1.40	2.05	4.09	J	B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFOSA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFOS	347	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
Br-PFOS	219	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
Total PFOS	566	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFDA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-8:2FTS	6.27	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFNS	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-MeFOSAA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
Br-MeFOSAA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
Total MeFOSAA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-EtFOSAA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
Br-EtFOSAA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
Total EtFOSAA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFUnA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFDS	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFDoA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFTrDA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
L-PFTeDA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C3-PFBA	IS	97.8	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
13C3-PFPeA	IS	101	60 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
13C3-PFBS	IS	103	60 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1

Sample ID: PW1812271330GSC

PFAS Isotope Dilution Method

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: PW1
Matrix: Aqueous
Date Collected: 27-Dec-18 13:30

Laboratory Data

Lab Sample: 1900023-01
Date Received: 03-Jan-19 09:42
Column: BEH C18

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C2-4:2 FTS	IS	82.6	40 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
13C2-PFHxA	IS	98.5	70 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
13C4-PFHpA	IS	99.3	60 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
18O2-PFHxS	IS	101	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
13C2-6:2 FTS	IS	96.3	40 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
13C2-PFOA	IS	96.3	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
13C5-PFNA	IS	91.2	50 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
13C8-PFOSA	IS	66.4	20 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
13C8-PFOS	IS	96.4	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
13C2-PFDA	IS	80.0	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
13C2-8:2 FTS	IS	95.1	40 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
d3-MeFOSAA	IS	79.0	50 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
d5-EtFOSAA	IS	82.7	50 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
13C2-PFUnA	IS	83.1	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
13C2-PFDoA	IS	73.0	30 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1
13C2-PFTeDA	IS	85.1	20 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:15	1

DL - Detection Limit
LOD - Limit of Detection
LOQ - Limit of quantitation
Results reported to the DL.

Sample ID: SW1812271410GSC **PFAS Isotope Dilution Method**

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: SW1
Matrix: Aqueous
Date Collected: 27-Dec-18 14:10

Laboratory Data

Lab Sample: 1900023-02
Date Received: 03-Jan-19 09:42
Column: BEH C18

Analyte	Conc. (ng/L)	DL	LOD	LOQ	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
L-PFBA	24.4	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFPeA	82.7	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFBS	5.88	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-4:2 FTS	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFHxA	76.5	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFPeS	12.7	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFHpA	48.8	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFHxS	455	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
Br-PFHxS	76.4	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
Total PFHxS	531	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-6:2 FTS	407	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFOA	123	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
Br-PFOA	7.51	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
Total PFOA	131	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFHpS	32.6	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFNA	3.09	1.43	2.09	4.19	J	B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFOSA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFOS	229	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
Br-PFOS	268	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
Total PFOS	497	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFDA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-8:2FTS	2.01	1.43	2.09	4.19	J	B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFNS	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-MeFOSAA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
Br-MeFOSAA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
Total MeFOSAA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-EtFOSAA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
Br-EtFOSAA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
Total EtFOSAA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFUnA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFDS	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFDoA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFTrDA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
L-PFTeDA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C3-PFBA	IS	94.3	60 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
13C3-PFPeA	IS	93.5	60 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
13C3-PFBS	IS	99.2	60 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1

Sample ID: SW1812271410GSC

PFAS Isotope Dilution Method

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: SW1
Matrix: Aqueous
Date Collected: 27-Dec-18 14:10

Laboratory Data

Lab Sample: 1900023-02
Date Received: 03-Jan-19 09:42
Column: BEH C18

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C2-4:2 FTS	IS	85.9	40 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
13C2-PFHxA	IS	94.0	70 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
13C4-PFHpA	IS	96.2	60 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
18O2-PFHxS	IS	96.1	60 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
13C2-6:2 FTS	IS	96.4	40 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
13C2-PFOA	IS	86.6	60 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
13C5-PFNA	IS	89.1	50 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
13C8-PFOSA	IS	72.6	20 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
13C8-PFOS	IS	93.6	60 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
13C2-PFDA	IS	81.2	60 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
13C2-8:2 FTS	IS	86.9	40 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
d3-MeFOSAA	IS	84.7	50 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
d5-EtFOSAA	IS	92.3	50 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
13C2-PFUnA	IS	77.6	60 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
13C2-PFDoA	IS	72.4	30 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1
13C2-PFTeDA	IS	92.0	20 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:26	1

DL - Detection Limit
LOD - Limit of Detection
LOQ - Limit of quantitation
Results reported to the DL.

Sample ID: PW1812271435GSC **PFAS Isotope Dilution Method**

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: PW2
Matrix: Aqueous
Date Collected: 27-Dec-18 14:35

Laboratory Data

Lab Sample: 1900023-03
Date Received: 03-Jan-19 09:42
Column: BEH C18

Analyte	Conc. (ng/L)	DL	LOD	LOQ	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
L-PFBA	7.18	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFPeA	6.33	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFBS	2.53	1.39	2.02	4.05	J	B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-4:2 FTS	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFHxA	7.76	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFPeS	1.45	1.39	2.02	4.05	J	B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFHpA	9.25	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFHxS	48.5	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
Br-PFHxS	5.30	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
Total PFHxS	53.8	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-6:2 FTS	41.5	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFOA	19.4	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
Br-PFOA	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
Total PFOA	19.4	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFHpS	8.15	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFNA	3.53	1.39	2.02	4.05	J	B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFOSA	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFOS	94.4	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
Br-PFOS	101	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
Total PFOS	195	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFDA	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-8:2FTS	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFNS	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-MeFOSAA	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
Br-MeFOSAA	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
Total MeFOSAA	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-EtFOSAA	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
Br-EtFOSAA	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
Total EtFOSAA	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFUnA	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFDS	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFDoA	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFTrDA	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
L-PFTeDA	ND	1.39	2.02	4.05		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C3-PFBA	IS	95.5	60 - 130		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
13C3-PFPeA	IS	92.5	60 - 150		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
13C3-PFBS	IS	90.3	60 - 150		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1

Sample ID: PW1812271435GSC

PFAS Isotope Dilution Method

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: PW2
Matrix: Aqueous
Date Collected: 27-Dec-18 14:35

Laboratory Data

Lab Sample: 1900023-03
Date Received: 03-Jan-19 09:42
Column: BEH C18

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C2-4:2 FTS	IS	78.5	40 - 150		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
13C2-PFHxA	IS	92.2	70 - 130		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
13C4-PFHpA	IS	88.7	60 - 150		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
18O2-PFHxS	IS	97.1	60 - 130		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
13C2-6:2 FTS	IS	92.8	40 - 150		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
13C2-PFOA	IS	86.8	60 - 130		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
13C5-PFNA	IS	92.6	50 - 130		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
13C8-PFOSA	IS	55.6	20 - 150		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
13C8-PFOS	IS	94.5	60 - 130		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
13C2-PFDA	IS	76.5	60 - 130		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
13C2-8:2 FTS	IS	83.4	40 - 150		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
d3-MeFOSAA	IS	81.5	50 - 150		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
d5-EtFOSAA	IS	85.9	50 - 150		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
13C2-PFUnA	IS	74.6	60 - 130		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
13C2-PFDoA	IS	74.1	30 - 130		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1
13C2-PFTeDA	IS	86.6	20 - 150		B9A0023	04-Jan-19	0.247 L	07-Jan-19 19:36	1

DL - Detection Limit
LOD - Limit of Detection
LOQ - Limit of quantitation
Results reported to the DL.

Sample ID: SW1812271450GSC

PFAS Isotope Dilution Method

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: SW2
Matrix: Aqueous
Date Collected: 27-Dec-18 14:50

Laboratory Data

Lab Sample: 1900023-04
Date Received: 03-Jan-19 09:42
Column: BEH C18

Analyte	Conc. (ng/L)	DL	LOD	LOQ	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
L-PFBA	10.4	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFPeA	30.3	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFBS	3.07	1.43	2.09	4.19	J	B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-4:2 FTS	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFHxA	29.7	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFPeS	4.48	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFHpA	15.9	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFHxS	153	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
Br-PFHxS	23.0	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
Total PFHxS	176	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-6:2 FTS	146	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFOA	43.2	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
Br-PFOA	2.78	1.43	2.09	4.19	J	B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
Total PFOA	46.0	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFHpS	10.3	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFNA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFOSA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFOS	42.3	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
Br-PFOS	59.2	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
Total PFOS	102	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFDA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-8:2FTS	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFNS	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-MeFOSAA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
Br-MeFOSAA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
Total MeFOSAA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-EtFOSAA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
Br-EtFOSAA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
Total EtFOSAA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFUnA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFDS	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFDoA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFTrDA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
L-PFTeDA	ND	1.43	2.09	4.19		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C3-PFBA	IS	95.3	60 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
13C3-PFPeA	IS	95.6	60 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
13C3-PFBS	IS	94.2	60 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1

Sample ID: SW1812271450GSC

PFAS Isotope Dilution Method

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: SW2
Matrix: Aqueous
Date Collected: 27-Dec-18 14:50

Laboratory Data

Lab Sample: 1900023-04
Date Received: 03-Jan-19 09:42
Column: BEH C18

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C2-4:2 FTS	IS	78.1	40 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
13C2-PFHxA	IS	96.2	70 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
13C4-PFHpA	IS	99.2	60 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
18O2-PFHxS	IS	94.8	60 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
13C2-6:2 FTS	IS	87.9	40 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
13C2-PFOA	IS	92.8	60 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
13C5-PFNA	IS	86.1	50 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
13C8-PFOSA	IS	64.3	20 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
13C8-PFOS	IS	97.1	60 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
13C2-PFDA	IS	80.8	60 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
13C2-8:2 FTS	IS	93.0	40 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
d3-MeFOSAA	IS	77.6	50 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
d5-EtFOSAA	IS	84.9	50 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
13C2-PFUnA	IS	76.1	60 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
13C2-PFDoA	IS	74.6	30 - 130		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1
13C2-PFTeDA	IS	85.1	20 - 150		B9A0023	04-Jan-19	0.239 L	07-Jan-19 19:47	1

DL - Detection Limit
LOD - Limit of Detection
LOQ - Limit of quantitation
Results reported to the DL.

Sample ID: PW1812271510GSC

PFAS Isotope Dilution Method

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: PW3
Matrix: Aqueous
Date Collected: 27-Dec-18 15:10

Laboratory Data

Lab Sample: 1900023-05
Date Received: 03-Jan-19 09:42
Column: BEH C18

Analyte	Conc. (ng/L)	DL	LOD	LOQ	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
L-PFBA	143	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFPeA	592	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFBS	16.9	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-4:2 FTS	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFHxA	467	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFPeS	35.1	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFHpA	205	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFHxS	492	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
Br-PFHxS	99.6	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
Total PFHxS	591	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-6:2 FTS	5.11	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFOA	97.8	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
Br-PFOA	10.1	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
Total PFOA	108	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFHpS	14.7	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFNA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFOSA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFOS	4.51	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
Br-PFOS	50.0	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
Total PFOS	54.5	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFDA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-8:2FTS	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFNS	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-MeFOSAA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
Br-MeFOSAA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
Total MeFOSAA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-EtFOSAA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
Br-EtFOSAA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
Total EtFOSAA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFUnA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFDS	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFDoA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFTrDA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
L-PFTeDA	ND	1.40	2.05	4.09		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C3-PFBA	IS	94.3	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
13C3-PFPeA	IS	94.8	60 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
13C3-PFBS	IS	105	60 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1

Sample ID: PW1812271510GSC

PFAS Isotope Dilution Method

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: PW3
Matrix: Aqueous
Date Collected: 27-Dec-18 15:10

Laboratory Data

Lab Sample: 1900023-05
Date Received: 03-Jan-19 09:42
Column: BEH C18

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C2-4:2 FTS	IS	89.2	40 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
13C2-PFHxA	IS	96.3	70 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
13C4-PFHpA	IS	95.4	60 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
18O2-PFHxS	IS	102	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
13C2-6:2 FTS	IS	97.6	40 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
13C2-PFOA	IS	85.4	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
13C5-PFNA	IS	87.8	50 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
13C8-PFOSA	IS	57.3	20 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
13C8-PFOS	IS	92.2	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
13C2-PFDA	IS	74.3	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
13C2-8:2 FTS	IS	80.6	40 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
d3-MeFOSAA	IS	72.7	50 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
d5-EtFOSAA	IS	80.4	50 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
13C2-PFUnA	IS	70.3	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
13C2-PFDoA	IS	64.4	30 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1
13C2-PFTeDA	IS	79.8	20 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 19:57	1

DL - Detection Limit
LOD - Limit of Detection
LOQ - Limit of quantitation
Results reported to the DL.

Sample ID: SW1812271530GSC

PFAS Isotope Dilution Method

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: SW3
Matrix: Aqueous
Date Collected: 27-Dec-18 15:30

Laboratory Data

Lab Sample: 1900023-06
Date Received: 03-Jan-19 09:42
Column: BEH C18

Analyte	Conc. (ng/L)	DL	LOD	LOQ	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
L-PFBA	10.1	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFPeA	32.3	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFBS	2.47	1.45	2.12	4.23	J	B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-4:2 FTS	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFHxA	27.3	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFPeS	3.50	1.45	2.12	4.23	J	B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFHpA	17.1	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFHxS	82.0	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
Br-PFHxS	13.6	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
Total PFHxS	95.6	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-6:2 FTS	33.5	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFOA	26.5	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
Br-PFOA	1.83	1.45	2.12	4.23	J	B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
Total PFOA	28.4	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFHpS	4.92	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFNA	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFOSA	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFOS	20.0	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
Br-PFOS	39.2	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
Total PFOS	59.1	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFDA	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-8:2FTS	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFNS	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-MeFOSAA	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
Br-MeFOSAA	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
Total MeFOSAA	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-EtFOSAA	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
Br-EtFOSAA	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
Total EtFOSAA	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFUnA	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFDS	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFDoA	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFTrDA	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
L-PFTeDA	ND	1.45	2.12	4.23		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C3-PFBA	IS	99.2	60 - 130		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
13C3-PFPeA	IS	93.8	60 - 150		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
13C3-PFBS	IS	101	60 - 150		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1

Sample ID: SW1812271530GSC **PFAS Isotope Dilution Method**

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: SW3
Matrix: Aqueous
Date Collected: 27-Dec-18 15:30

Laboratory Data

Lab Sample: 1900023-06
Date Received: 03-Jan-19 09:42
Column: BEH C18

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C2-4:2 FTS	IS	87.5	40 - 150		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
13C2-PFHxA	IS	89.2	70 - 130		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
13C4-PFHpA	IS	91.2	60 - 150		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
18O2-PFHxS	IS	108	60 - 130		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
13C2-6:2 FTS	IS	88.1	40 - 150		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
13C2-PFOA	IS	89.4	60 - 130		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
13C5-PFNA	IS	89.2	50 - 130		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
13C8-PFOSA	IS	74.2	20 - 150		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
13C8-PFOS	IS	87.3	60 - 130		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
13C2-PFDA	IS	87.4	60 - 130		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
13C2-8:2 FTS	IS	65.3	40 - 150		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
d3-MeFOSAA	IS	93.1	50 - 150		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
d5-EtFOSAA	IS	97.8	50 - 150		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
13C2-PFUnA	IS	86.5	60 - 130		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
13C2-PFDoA	IS	81.4	30 - 130		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1
13C2-PFTeDA	IS	101	20 - 150		B9A0023	04-Jan-19	0.236 L	07-Jan-19 20:08	1

DL - Detection Limit
LOD - Limit of Detection
LOQ - Limit of quantitation
Results reported to the DL.

Sample ID: PW1812271555GSC **PFAS Isotope Dilution Method**

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: PW4
Matrix: Aqueous
Date Collected: 27-Dec-18 15:55

Laboratory Data

Lab Sample: 1900023-07
Date Received: 03-Jan-19 09:42
Column: BEH C18

Analyte	Conc. (ng/L)	DL	LOD	LOQ	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
L-PFBA	4.67	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFPeA	5.77	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFBS	1.80	1.39	2.03	4.06	J	B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-4:2 FTS	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFHxA	6.66	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFPeS	1.43	1.39	2.03	4.06	J	B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFHpA	6.20	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFHxS	49.9	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
Br-PFHxS	5.35	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
Total PFHxS	55.2	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-6:2 FTS	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFOA	11.0	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
Br-PFOA	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
Total PFOA	11.4	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFHpS	3.08	1.39	2.03	4.06	J	B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFNA	1.57	1.39	2.03	4.06	J	B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFOSA	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFOS	23.7	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
Br-PFOS	37.4	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
Total PFOS	61.1	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFDA	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-8:2FTS	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFNS	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-MeFOSAA	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
Br-MeFOSAA	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
Total MeFOSAA	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-EtFOSAA	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
Br-EtFOSAA	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
Total EtFOSAA	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFUnA	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFDS	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFDoA	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFTrDA	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
L-PFTeDA	ND	1.39	2.03	4.06		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C3-PFBA	IS	97.6	60 - 130		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
13C3-PFPeA	IS	96.2	60 - 150		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
13C3-PFBS	IS	93.6	60 - 150		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1

Sample ID: PW1812271555GSC

PFAS Isotope Dilution Method

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: PW4
Matrix: Aqueous
Date Collected: 27-Dec-18 15:55

Laboratory Data

Lab Sample: 1900023-07
Date Received: 03-Jan-19 09:42
Column: BEH C18

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C2-4:2 FTS	IS	81.0	40 - 150		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
13C2-PFHxA	IS	94.7	70 - 130		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
13C4-PFHpA	IS	95.1	60 - 150		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
18O2-PFHxS	IS	99.4	60 - 130		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
13C2-6:2 FTS	IS	96.4	40 - 150		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
13C2-PFOA	IS	93.8	60 - 130		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
13C5-PFNA	IS	94.9	50 - 130		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
13C8-PFOSA	IS	49.7	20 - 150		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
13C8-PFOS	IS	100	60 - 130		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
13C2-PFDA	IS	82.3	60 - 130		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
13C2-8:2 FTS	IS	99.7	40 - 150		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
d3-MeFOSAA	IS	92.0	50 - 150		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
d5-EtFOSAA	IS	95.0	50 - 150		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
13C2-PFUnA	IS	85.2	60 - 130		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
13C2-PFDoA	IS	76.1	30 - 130		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1
13C2-PFTeDA	IS	86.0	20 - 150		B9A0023	04-Jan-19	0.246 L	07-Jan-19 20:19	1

DL - Detection Limit
LOD - Limit of Detection
LOQ - Limit of quantitation
Results reported to the DL.

Sample ID: SW1812271610GSC

PFAS Isotope Dilution Method

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: SW4
Matrix: Aqueous
Date Collected: 27-Dec-18 16:10

Laboratory Data

Lab Sample: 1900023-08
Date Received: 03-Jan-19 09:42
Column: BEH C18

Analyte	Conc. (ng/L)	DL	LOD	LOQ	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
L-PFBA	21.9	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFPeA	79.4	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFBS	3.88	1.40	2.05	4.10	J	B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-4:2 FTS	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFHxA	61.1	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFPeS	8.59	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFHpA	32.4	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFHxS	180	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
Br-PFHxS	31.8	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
Total PFHxS	212	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-6:2 FTS	31.6	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFOA	44.1	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
Br-PFOA	3.03	1.40	2.05	4.10	J	B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
Total PFOA	47.1	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFHpS	5.10	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFNA	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFOSA	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFOS	14.4	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
Br-PFOS	36.0	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
Total PFOS	50.4	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFDA	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-8:2FTS	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFNS	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-MeFOSAA	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
Br-MeFOSAA	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
Total MeFOSAA	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-EtFOSAA	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
Br-EtFOSAA	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
Total EtFOSAA	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFUnA	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFDS	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFDoA	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFTrDA	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
L-PFTeDA	ND	1.40	2.05	4.10		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C3-PFBA	IS	97.3	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
13C3-PFPeA	IS	94.3	60 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
13C3-PFBS	IS	94.1	60 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1

Sample ID: SW1812271610GSC

PFAS Isotope Dilution Method

Client Data

Name: Merit Laboratories, Inc.
Project: Wurtsmith
Location: SW4
Matrix: Aqueous
Date Collected: 27-Dec-18 16:10

Laboratory Data

Lab Sample: 1900023-08
Date Received: 03-Jan-19 09:42
Column: BEH C18

Labeled Standards	Type	% Recovery	Limits	Qualifiers	Batch	Extracted	Samp Size	Analyzed	Dilution
13C2-4:2 FTS	IS	82.8	40 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
13C2-PFHxA	IS	97.1	70 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
13C4-PFHpA	IS	95.3	60 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
18O2-PFHxS	IS	97.0	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
13C2-6:2 FTS	IS	101	40 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
13C2-PFOA	IS	83.5	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
13C5-PFNA	IS	82.4	50 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
13C8-PFOSA	IS	61.2	20 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
13C8-PFOS	IS	104	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
13C2-PFDA	IS	86.6	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
13C2-8:2 FTS	IS	91.1	40 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
d3-MeFOSAA	IS	94.2	50 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
d5-EtFOSAA	IS	97.0	50 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
13C2-PFUnA	IS	85.2	60 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
13C2-PFDoA	IS	82.1	30 - 130		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1
13C2-PFTeDA	IS	97.9	20 - 150		B9A0023	04-Jan-19	0.244 L	07-Jan-19 20:29	1

DL - Detection Limit
LOD - Limit of Detection
LOQ - Limit of quantitation
Results reported to the DL.

DATA QUALIFIERS & ABBREVIATIONS

B	This compound was also detected in the method blank
Conc.	Concentration
D	Dilution
DL	Detection limit
E	The associated compound concentration exceeded the calibration range of the instrument
H	Recovery and/or RPD was outside laboratory acceptance limits
I	Chemical Interference
J	The amount detected is below the Reporting Limit/LOQ
LOD	Limits of Detection
LOQ	Limits of Quantitation
M	Estimated Maximum Possible Concentration (CA Region 2 projects only)
NA	Not applicable
ND	Not Detected
P	The reported concentration may include contribution from chlorinated diphenyl ether(s).
Q	Ion ratio outside of 70-130% of Standard Ratio. (DOD PFAS projects only)
TEQ	Toxic Equivalency
U	Not Detected (specific projects only)
*	See Cover Letter

Unless otherwise noted, solid sample results are reported in dry weight. Tissue samples are reported in wet weight.

Vista Analytical Laboratory Certifications

Accrediting Authority	Certificate Number
Alaska Department of Environmental Conservation	17-013
Arkansas Department of Environmental Quality	18-008-0
California Department of Health – ELAP	2892
DoD ELAP - A2LA Accredited - ISO/IEC 17025:2005	3091.01
Florida Department of Health	E87777
Hawaii Department of Health	N/A
Louisiana Department of Environmental Quality	01977
Maine Department of Health	2018017
Michigan Department of Environmental Quality	9932
Minnesota Department of Health	1322288
New Hampshire Environmental Accreditation Program	207718
New Jersey Department of Environmental Protection	CA003
New York Department of Health	11411
Oregon Laboratory Accreditation Program	4042-009
Pennsylvania Department of Environmental Protection	015
Texas Commission on Environmental Quality	T104704189-18-9
Virginia Department of General Services	9618
Washington Department of Ecology	C584-18
Wisconsin Department of Natural Resources	998036160

Current certificates and lists of licensed parameters are located in the Quality Assurance office and are available upon request.

NELAP Accredited Test Methods

MATRIX: Air	
Description of Test	**Method**
Determination of Polychlorinated p-Dioxins & Polychlorinated Dibenzofurans	EPA 23
Determination of Polychlorinated p-Dioxins & Polychlorinated Dibenzofurans	EPA TO-9A

MATRIX: Biological Tissue	
Description of Test	**Method**
Tetra- through Octa-Chlorinated Dioxins and Furans by Isotope Dilution GC/HRMS	EPA 1613B
Brominated Diphenyl Ethers by HRGC/HRMS	EPA 1614A
Chlorinated Biphenyl Congeners in Water, Soil, Sediment, and Tissue by GC/HRMS	EPA 1668A/C
Pesticides in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS	EPA 1699
Perfluorinated Alkyl Acids in Drinking Water by SPE and LC/MS/MS	EPA 537
Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans by GC/HRMS	EPA 8280A/B
Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by GC/HRMS	EPA 8290/8290A

MATRIX: Drinking Water	
Description of Test	**Method**
2,3,7,8-Tetrachlorodibenzo- p-dioxin (2,3,7,8-TCDD) GC/HRMS	EPA 1613/1613B
1,4-Dioxane (1,4-Diethyleneoxide) analysis by GC/HRMS	EPA 522
Perfluorinated Alkyl Acids in Drinking Water by SPE and LC/MS/MS	EPA 537
Perfluorinated Alkyl Acids in Drinking Water by SPE and LC/MS/MS	ISO 25101 2009

MATRIX: Non-Potable Water	
Description of Test	**Method**
Tetra- through Octa-Chlorinated Dioxins and Furans by Isotope Dilution GC/HRMS	EPA 1613B
Brominated Diphenyl Ethers by HRGC/HRMS	EPA 1614A
Chlorinated Biphenyl Congeners in Water, Soil, Sediment, and Tissue by GC/HRMS	EPA 1668A/C
Pesticides in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS	EPA 1699
Perfluorinated Alkyl Acids in Drinking Water by SPE and LC/MS/MS	EPA 537
Dioxin by GC/HRMS	EPA 613
Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans by GC/HRMS	EPA 8280A/B
Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by GC/HRMS	EPA 8290/8290A

MATRIX: Solids	
Description of Test	**Method**
Tetra-Octa Chlorinated Dioxins and Furans by Isotope Dilution GC/HRMS	EPA 1613
Tetra- through Octa-Chlorinated Dioxins and Furans by Isotope Dilution GC/HRMS	EPA 1613B
Brominated Diphenyl Ethers by HRGC/HRMS	EPA 1614A
Chlorinated Biphenyl Congeners in Water, Soil, Sediment, and Tissue by GC/HRMS	EPA 1668A/C
Pesticides in Water, Soil, Sediment, Biosolids, and Tissue by HRGC/HRMS	EPA 1699
Perfluorinated Alkyl Acids in Drinking Water by SPE and LC/MS/MS	EPA 537
Polychlorinated Dibenzo-p-Dioxins and Polychlorinated Dibenzofurans by GC/HRMS	EPA 8280A/B
Polychlorinated Dibenzodioxins (PCDDs) and Polychlorinated Dibenzofurans (PCDFs) by GC/HRMS	EPA 8290/8290A

Vista Analytical Laboratory

CHAIN OF CUSTODY

For Laboratory Use Only
Work Order #: 1900023 Temp: 0.2 °C
Storage ID: WK-2 Storage Secured: Yes ☑ No ☐

Project ID: **Wurtsmith** PO#: **60518528** Sampler: **Garth Cousineau** (name)

TAT (check one): Standard: x 21 days; Rush (surcharge may apply): ☐ 14 days ☐ 7 days Specify:

Invoice to: Name	Company	Address	City	State	Ph#	Fax#
Mike Jury	**MDEQ**	**4001 Ketchum St, Suite B**	**Bay City**	**MI**	**989-894-6255**	**989-891-9237**

Relinquished by (printed name and signature)	Date	Time	Received by (printed name and signature)	Date	Time
Garth Cousineau	1-2-18	1600	Marissa Sparks	01/03/19	0942
Relinquished by (printed name and signature)	Date	Time	Received by (printed name and signature)	Date	Time

SHIP TO: Vista Analytical Laboratory
1104 Windfield Way
El Dorado Hills, CA 95762
(916) 673-1520 * Fax (916) 673-0106

Method of Shipment:

ATTN: Jennifer Miller

Tracking No.:

Add Analysis(es) Requested

Sample ID	Date	Time	Location/Sample Description	Container(s): Quantity	Type	Matrix	Mod. EPA Method 537: PFOA/ PFOS	UCMR3 PFAS List:6	537 List: 14	Full List of 24	Other: Please List Below	Branch and Linear	EPA Method 537(DW only): PFOA/ PFOS	UCMR3 PFAS List:6	PFAS List: 14	Comments
PW1812271330GSC	12/27/18	1330	**PW1**	2	P	AQ						X				
SW1812271410GSC	12/27/18	1410	**SW1**	2	P	AQ						X				
PW1812271435GSC	12/27/18	1435	**PW2**	2	P	AQ						X				
SW1812271450GSC	12/27/18	1450	**SW2**	2	P	AQ						X				
PW1812271510GSC	12/27/18	1510	**PW3**	2	P	AQ						X				
SW1812271530GSC	12/27/18	1530	**SW3**	2	P	AQ						X				
PW1812271555GSC	12/27/18	1555	**PW4**	2	P	AQ						X				
SW1812271610GSC	12/27/18	1610	**SW4**	2	P	AQ						X				

Special Instructions/Comments: **Send Results and Acknowledgements to:**

Nic.Ropotos@aecom.com Dorin.Bogdan@aecom.com
Robert.Kennedy@aecom.com
Geoffrey.Groff@aecom.com
Jim.Carbone@aecom.com

SEND DOCUMENTATION AND RESULTS TO:

Name: **Mike Jury**
Company: **MDEQ**
Address: **4001 Ketchum St, Suite B**
City: **Bay City** State: **MI** Zip: **48708**
Phone: **989-894-6255** Fax: **989-891-9237**
Email: **MikeJ@michigan.gov**

Container Types: P= HDPE, PJ= HDPE Jar
O = Other:

Bottle Preservation Type: T = Thiosulfate,
TZ = Trizma: None

Matrix Types: AQ = Aqueous, DW = Drinking Water, EF = Effluent, PP = Pulp/Paper, SD = Sediment, SL = Sludge, SO = Soil, WW = Wastewater, B = Blood/Serum, O = Other:

Vista Analytical Laboratory

Sample Log-In Checklist

Page # 1 of 1

Vista Work Order #: 1900023 TAT Std

Samples Arrival:	**Date/Time** 01/03/19 0942	**Initials:** WDS	**Location:** WR-2 **Shelf/Rack:** N/a
Logged In:	**Date/Time** 01/03/19 1032	**Initials:** BLB	**Location:** WR-2 **Shelf/Rack:** A3 / B4

Delivered By:	(FedEx)	UPS	On Trac	GSO	DHL	Hand Delivered	Other
Preservation:		(Ice)	Blue Ice		Dry Ice		None

Temp °C: 0.3 (uncorrected)	**Probe used:** Y / (N)	**Thermometer ID:** IR-4
Temp °C: 0.2 (corrected)		

	YES	NO	NA
Adequate Sample Volume Received?	✓		
Holding Time Acceptable?	✓		
Shipping Container(s) Intact?	✓		
Shipping Custody Seals Intact?			✓
Shipping Documentation Present?	✓		
Airbill — Trk # 4377 0528 8209	✓		
Sample Container Intact?	✓		
Sample Custody Seals Intact?			✓
Chain of Custody / Sample Documentation Present?	✓		
COC Anomaly/Sample Acceptance Form completed?		✓	
If Chlorinated or Drinking Water Samples, Acceptable Preservation?			✓
Preservation Documented: $Na_2S_2O_3$ Trizma None Other	Yes	No	(NA)

Shipping Container	Vista	(Client)	Retain	(Return)	Dispose

Comments:

Attachment 12 – Figure of 2012-2018 Foam Sample Results by AECOM on behalf of the EGLE (formerly known as MDEQ)

DEQ

DRAFT 11/30/2018

Legend

- Surface Water Sample
- Seep / Surface Water Sample
- Foam Sample

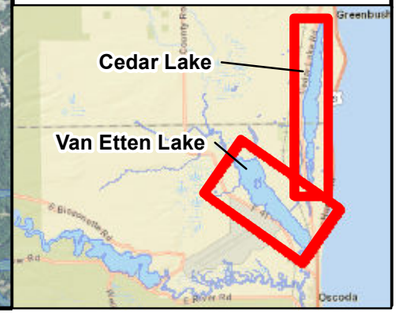
Sample Location: Sample Date
Total PFAS (PFOA | PFOS)

*Samples collected between 2012-2018,
Highest Total PFAS concentration shown for locations with multiple samples

CEDAR LAKE & VAN ETTEN LAKE SURFACE WATER & FOAM SAMPLING RESULTS

FORMER WURTSMITH AIR FORCE BASE IOSCO COUNTY, MICHIGAN

0 1,600 3,200
Feet



Cedar Lake

Lake Huron

Van Etten Lake

Cedar Lake Dis: 7/27/2017
16 (2 | 0)

Cedar Lake Foam: 12/17/2017
243 (8 | 158)

Cedar Lake SW 1: 5/15/2017
9 (2 | 0)

Cedar Lake SW 2: 5/15/2017
10 (2 | 1)

Cedar Lake SW 3: 5/15/2017
16 (3 | 4)

Sherman Cr: 7/27/2017
34 (6 | 1)

Huron Cr 2: 9/25/2018
2 (0 | 0)

Huron Cr: 9/25/2018
8,860 (57 | 7,480)

Cedar Pond 3: 8/10/2017
25 (2 | 2)

Cedar Pond 2: 8/10/2017
16 (2 | 2)

Cedar Pond 1: 8/10/2017
18 (2 | 2)

Cedar Pond 4: 8/10/2017
28 (3 | 2)

Lake Huron SW 1: 7/27/2017
8 (1 | 3)

Pine River: 8/27/2018
2 (0 | 0)

VEL SW 17: 10/3/2017
48 (5 | 24)

VEL Foam 1: 10/3/2017
11,574 (79 | 10,600)

Phelan Cr 1: 7/7/2017
7 (1 | 1)

Phelan Cr: 9/26/2018
7,915 (72 | 7,120)

Phelan Cr 2: 9/26/2018
9 (2 | 0)

YMCA Beach: 10/12/2017
24,572 (149 | 23,100)

VEL SW 3: 7/31/2014
22 (2 | 2)

VEL SW 4: 8/27/2018
16 (2 | 3)

VEL SW 5: 7/31/2014
23 (2 | 2)

Gray's Cr: 10/15/2014
4 (1 | 0)

VEL SW 1: 8/27/2018
14 (2 | 3)

VEL SW 2: 10/15/2014
15 (1 | 2)

VEL SW 8: 7/31/2014
29 (2 | 2)

VEL SW 9: 8/28/2018
33 (2 | 18)

Air Force Beach: 9/19/2017
117,625 (830 | 110,000)

VEL SW 10: 7/13/2017
55 (5 | 9)

VEL SW 16: 12/7/2017
33 (0 | 19)

Prv Boat Ramp: 9/26/2018
16,546 (102 | 14,900)

VEL SW 15: 3/23/2017
20 (2 | 3)

VEL - Seep 2: 5/14/2012
35 (15 | 3)

VEL SW 6: 8/28/2018
16 (2 | 3)

VEL - Seep 1: 5/14/2012
184 (25 | 0)

VEL SW 11: 7/31/2014
57 (5 | 4)

Ratliff Boat Launch: 10/1/2018
94,171 (830 | 86,500)

VEL SW 13: 8/28/2018
22 (3 | 4)

VEL SW 14: 7/31/2014
27 (2 | 2)

VEL SW 12: 7/27/2017
733 (50 | 254)

Ratliff Park South: 10/2/2018
149,962 (1,600 | 134,000)

VEL Dam: 3/9/2017
15 (1 | 2)

Ratliff Park North: 10/1/2018
293 (23 | 76)

Ratliff Park North: 10/2/2018
163,677 (1,640 | 148,000)

Van Etten Cr: 5/3/2016
338 (41 | 129)

State Camp Boat Launch: 10/2/2018
44,547 (443 | 40,800)

VEL SW 7: 11/1/2012
34 (0 | 34)

G:\GrandRapids\DCS\GIS\ArcMap_GeoDB_Projects\ENV\GIS_Data\GIS\Wurtsmith_AFB\Wurtsmith_GIS\MXDs\Surface_water\SW_Foam_Sampling_VanEtten_Results_ChemBox_11x17.mxd