Hydrogeologic Investigation Report

Parchment, Michigan

TETRA TECH

#117-4124071

May 30, 2019

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PRESENTED BY

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ACRONYMS/ABBREVIATIONS

Acronyms/Abbreviations	Definition
%R	Percent Recovery
Addendum	Hydrogeologic Investigation Work Plan Addendum, Tetra Tech, January 3, 2019
amsl	Above Mean Sea Level
bgs	Below Ground Surface
CORS	Continuously Operating Reference Station
COC	Constituents of Concern
CSM	Conceptual Site Model
DO	Dissolved Oxygen
EGLE	Michigan Department of Environment, Great Lakes and Energy
EPA	United States Environmental Protection Agency
FEP	Fluorinated Ethylene Propylene
GP	Georgia-Pacific LLC
gpd/ft	Gallons per Day per Foot
GDW	Groundwater to Drinking Water
GSI	Groundwater to Surface Water Interface
HDPE	High Density Polyethylene
IDW	Investigation Derived Waste
Investigation	Hydrogeological Investigation
KVG	Kalamazoo Valley Group
LCS	Laboratory Control Sample
LLC	Limited Liability Corporation
e.g.	Exempli Gratia (for example)
FEP	Fluorinated Ethylene Propylene
GPS	Global Positioning System
Landfills Area	Landfills associated with the former Crown Vantage operations
mg/L	Milligrams per Liter
MDOT	Michigan Department of Transportation
Mill 2	Former Crown Vantage Paper Mill
MS/MSD	Matrix Spike and Matrix Spike Duplicate
mV	Millivolt
NAD	North American Datum
NAVD	North American Vertical Datum
ng/L	Nanogram Per Liter

Acronyms/Abbreviations	Definition
ORP	Oxidation-Reduction Potential
Part 201	Part 201 of the Natural Resources and Environment Protection Act, PA 451, as amended
PCB	Polychlorinated Biphenyl
PFAS	Perfluoroalkyl and Polyfluoroalkyl Substances

EXECUTIVE SUMMARY

This report documents a Hydrogeologic Investigation (Investigation) in and near the City of Parchment, Michigan, where the presence of Perfluoroalkyl and Polyfluoroalkyl Substances (PFAS) in groundwater led to the shutdown of a municipal water supply well field in July 2018. The Investigation was completed in accordance with the Michigan Department of Environment, Great Lakes, and Energy (EGLE) approved *Hydrogeologic Investigation Work Plan* dated October 19, 2018 (Work Plan) and *Hydrogeological Investigation Work Plan Addendum* (Addendum), dated January 3, 2019. The Work Plan and Addendum were developed by Tetra Tech on behalf of Georgia-Pacific LLC (GP). The area of Investigation includes portions of Cooper Township, Kalamazoo Township, the City of Kalamazoo, and the City of Parchment (Study Area). The Study Area lies immediately east of the Kalamazoo River. A location map depicting the Study Area is presented as **Figure 1**.

PFAS were detected in groundwater samples collected from the City of Parchment municipal wells, select residential wells, and monitoring wells associated with a former Crown Vantage paper mill. These impacts were identified during sampling events that were completed by EGLE and their contractors from June 2018 through September 2018. The sampling was completed as part of the State of Michigan's proactive statewide testing of drinking water, groundwater, lakes and streams, soils, sediments, and wastewater.

In response to the sampling results, GP retained Tetra Tech to complete a Hydrogeological Investigation (Investigation) to characterize the groundwater flow system in the Study Area and to delineate the extent of PFAS, specifically Perfluorooctanoic Acid (PFOA) and Perfluorooctane Sulfonate (PFOS), impacts in groundwater above Groundwater Residential Generic Cleanup Criteria established in Part 201 of the Natural Resources and Environment Protection Act, PA 451, as amended (Part 201). The Investigation was completed between November 2018 and March 2019. The tasks completed of as part of the Investigation included:

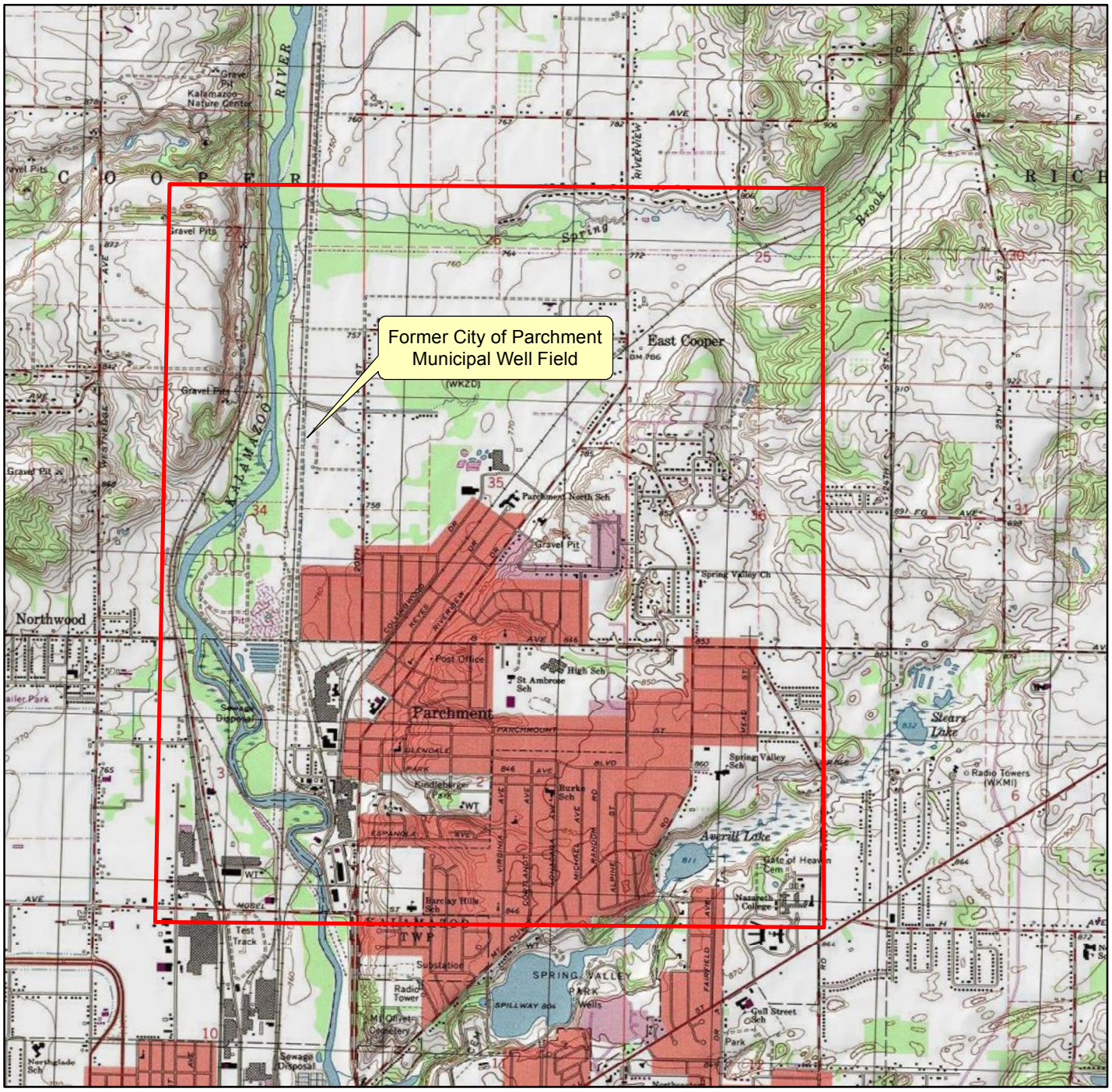
- Installation of twenty-nine monitoring wells at twenty-one locations.
- Minimal drawdown (low-flow) groundwater sampling of the new monitoring wells for PFAS.
- Surface water sampling at ten locations within the Study Area for PFAS.
- Collection of Quality Assurance/Quality Control (QA/QC) samples to monitor for sample integrity.

- Static water level gauging at the new monitoring wells in addition to wells previously installed at the former Crown Vantage Paper Mill (Mill 2) and at Landfills associated with the Former Crown Vantage operations (Landfills Area).
- Establishment of vertical and horizontal locations by survey of the monitoring wells installed as part of this Investigation, as well as, the Mill 2 and Landfills Area monitoring wells.

As a result of this work, PFOA and PFOS impacts in groundwater have been delineated to the Groundwater Residential Generic Cleanup Criteria for the Groundwater to Drinking Water Criteria (GDW Criteria) of 70 Nanograms per Liter (ng/L). The vertical extent of impact above Part 201 GDW Criteria is limited to the uppermost unconfined aquifer except at the former Parchment well field where impacts extend downward to a semi-confined aquifer that is beneath a clay layer (aquitard).

Facilities associated with the former Crown Vantage paper plant appear to be a source of PFAS compounds in groundwater. There appears to be other PFAS source(s) east of the former City of Parchment municipal well field.

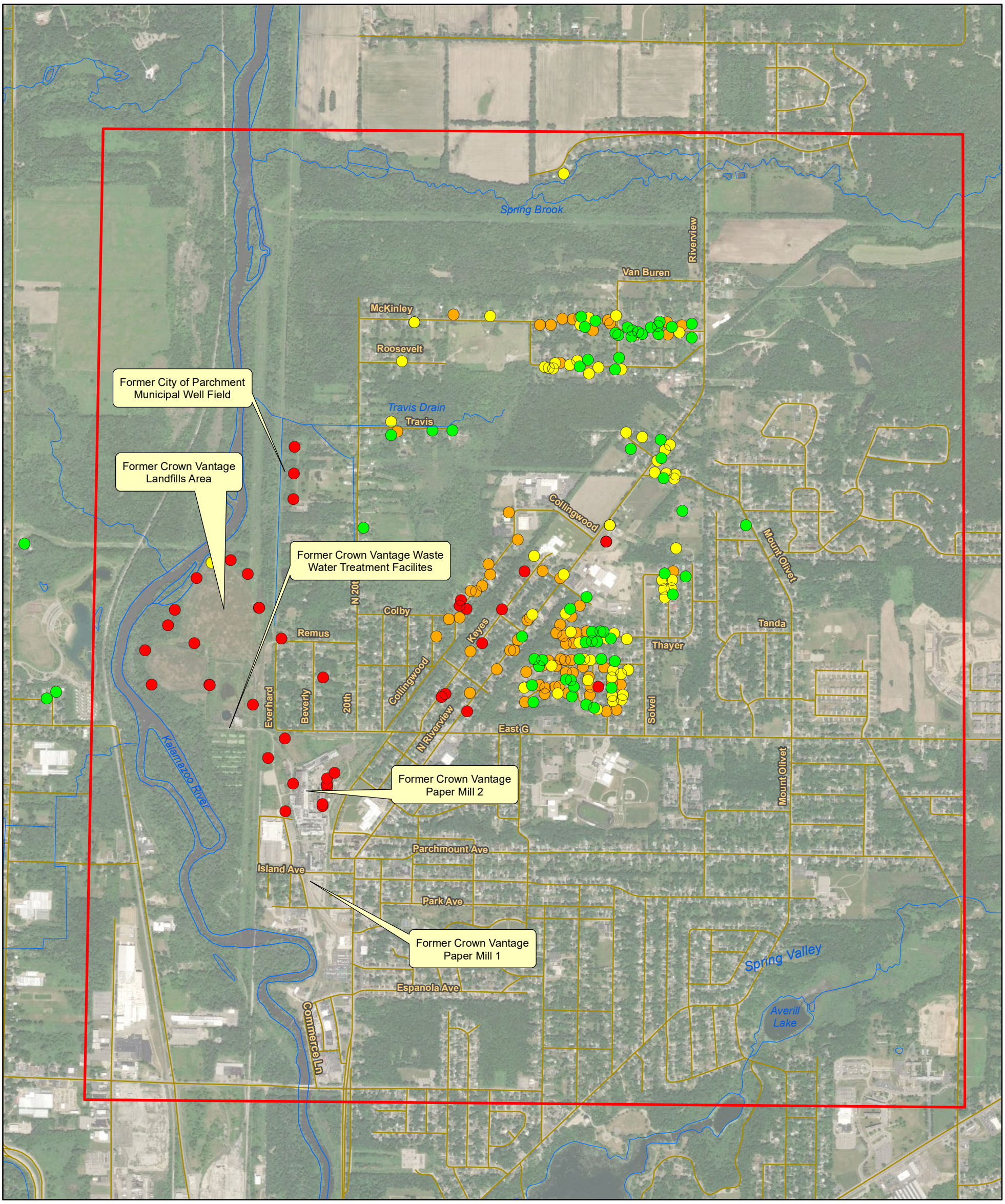
FIGURES



P:\Projects\Georgia-Pacific\Parchment, MI\GIS\Figures\Hydrogeologic Investigation\Figure 1 - Location Map_v1.mxd

BASE MAP: Copyright:© 2013 National Geographic Society, i-cubed

	ORIGINAL BY: JMM DATE: 10/12/2018 REVISED BY: JMM DATE: 4/25/2019	HYDROGEOLOGIC INVESTIGATION REPORT GEORGIA-PACIFIC PARCHMENT, MICHIGAN LOCATION MAP	FIGURE 1



Base MapSource: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Study Area

Surface Water

Sample Locations with PFOA plus PFOS Results

- ND above RL
- RL-10 ng/L
- >10 - 70 ng/L
- >70 ng/L

Abbreviations:
ng/L = nanograms per liter
ND - Not detected
RL = Reporting Limit
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctane sulfonate

N

0 625 1,250 2,500

Feet

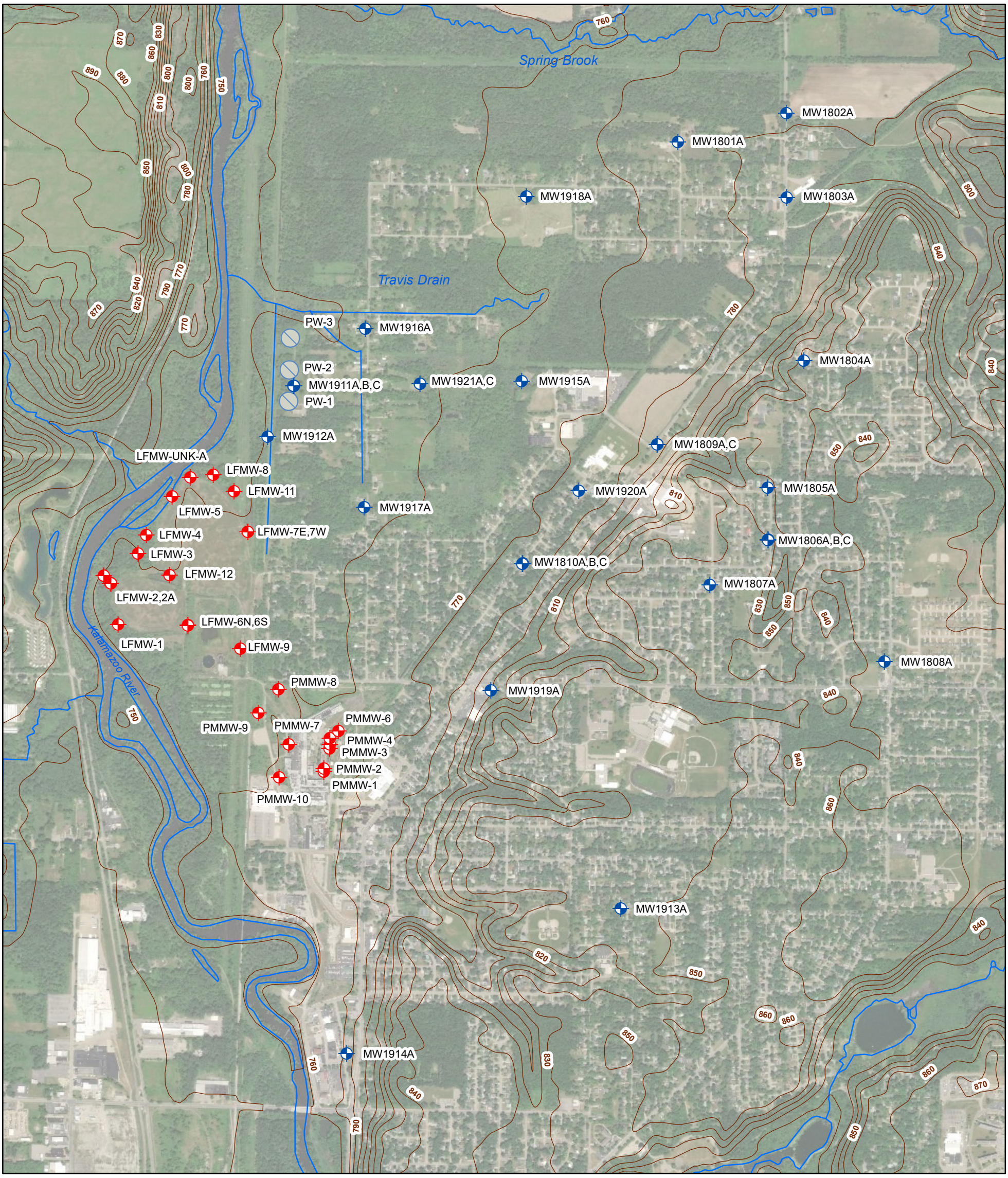
Notes

1. PFOA and PFOS results obtained by the Michigan Department of Environment, Great Lakes, and Energy (EGLE) July to August 2018. (Refer to Appendix A)
2. 70 nanograms per Liter (ng/L) for PFOA plus PFOS is the EGLE Drinking Water Criteria per Part 201, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the Part 201 Administrative Rules. Table 1(June 25, 2018).

ORIGINAL BY: MC	HYDROGEOLOGIC INVESTIGATION REPORT GEORGIA-PACIFIC PARCHMENT, MICHIGAN
DATE: 1/17/2019	
REVISED BY: LAS	**STUDY AREA AND EGLE SAMPLE RESULTS**
DATE: 6/4/2019	

FIGURE
2

P:\Projects\Georgia-Pacific\Parchment, MI\Documents\Investigation Report\3 - Draft Figures\executables\Figure 2 - Study Area and MDEQ SRes_rev3.mxd



Base Map Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

- Study Monitoring Well
- Landfill and Mill Monitoring Well
- Former City of Parchment Municipal Well
- Topopgraphic Contour (10 ft interval)
- Surface Water

Notes:
1. Refer to Table 1 for explanation of the naming convention for the Landfill and Mill Wells. These wells were renamed from previous reports by others, for the purpose of distinguishing the same numbered wells from each other.
2. Monitoring wells (names begin with MW) were installed as a part of the Hydrogeologic Investigation conducted by Tetra Tech. Monitoring well locations were established by survey (refer to Table 1).
3. Landfill and Mill monitoring wells were installed as a part of previous investigations conducted by others. Landfill and Mill monitoring well locations were established by survey (refer to Table 1).
4. Nested monitoring wells (example MW1809A,C) were installed in one or more soil borings and have well screens at different depths within the subsurface (refer to Appendix D). "A" denotes the shallowest, "B" the intermediate, and "C" the deepest well within the nest. An intermediate well was not installed at all well nests (refer to Table 2).

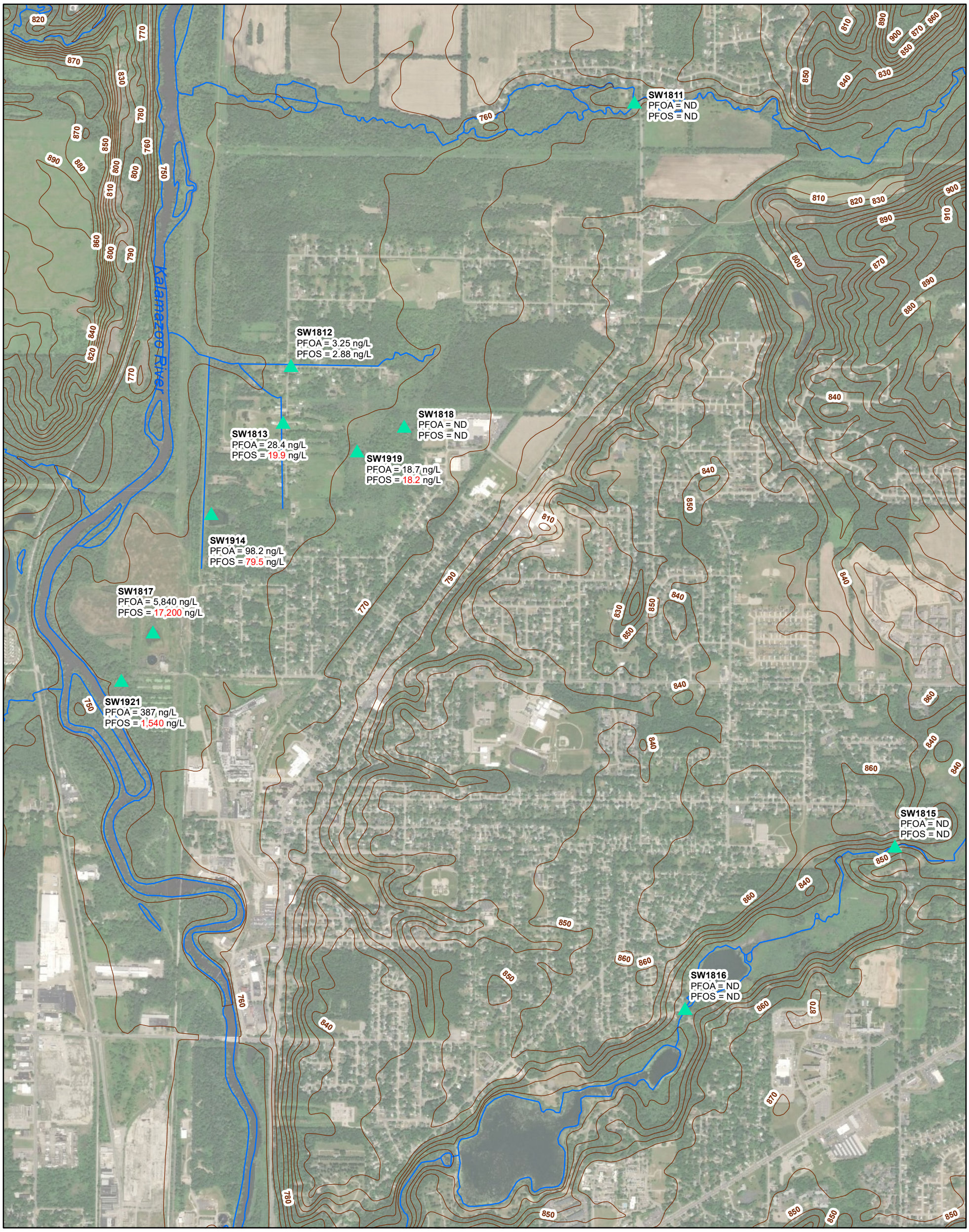
ORIGINAL BY:	MC
DATE:	1/17/2019
REVISED BY:	LAS
DATE:	6/3/2019

HYDROGEOLOGIC INVESTIGATION REPORT
GEORGIA-PACIFIC
PARCHMENT, MICHIGAN

MONITORING WELL LOCATION MAP

FIGURE
3

P:\Projects\Georgia-Pacific\Parchment, MI\Documents\Investigation Report\3 - Draft Figures\executables\Figure 3 - Monitoring Well Location.mxd



Base Map Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Surface Water Sample Location

Surface Water

Topopgraphic Contour (10 ft interval)

Notes:
1. 12 ng/L for PFOS and 12,000 ng/L for PFOA, are the Michigan Department of Environment, Great Lakes, and Energy, Rule 57 Nondrinking Water Human Health, Human Noncancer Valve. (HNV nondrinking)
2. Red text indicates the result is greater than the HNV Criteria.

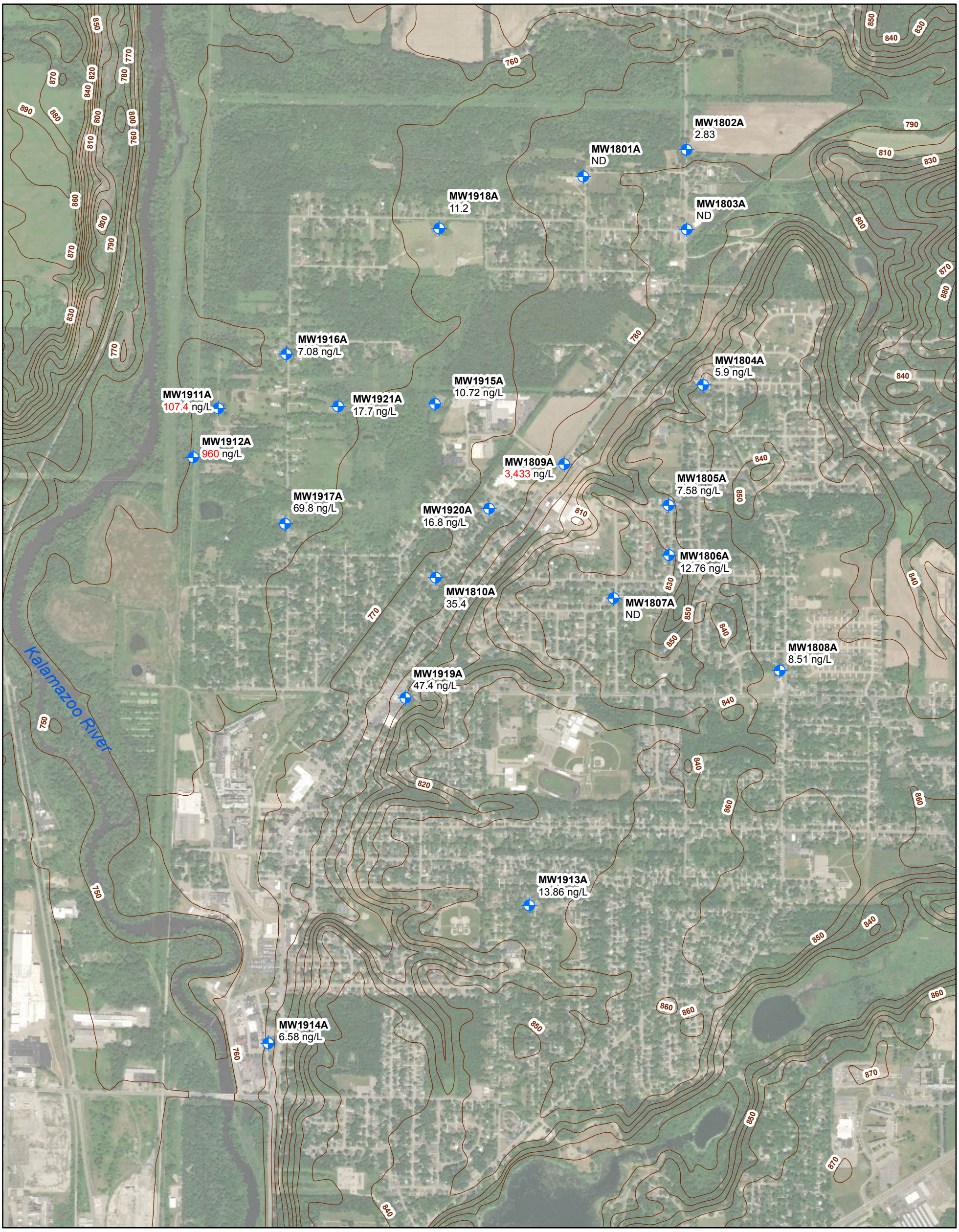
Abbreviations:
ng/L = nanograms per liter
ND = Not detected
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctane sulfonate

N

0 625 1,250 2,500
Feet

ORIGINAL BY: MC	HYDROGEOLOGIC INVESTIGATION REPORT GEORGIA-PACIFIC PARCHMENT, MICHIGAN
DATE: 1/17/2019	
REVISED BY: LAS	**PFOA AND PFOS ANALYTICAL RESULTS - SURFACE WATER**
DATE: 6/3/2019	FIGURE 4

P:\Projects\Georgia-Pacific\Parchment, MI\Documents\Investigation Report\3 - Draft Figures\executables\Figure 4 - PFOA + PFOS Surface Water Analytical Results_GSI.mxd



Base Map Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Study Monitoring Well - Unconfined Aquifer

Topopgraphic Contour (10 ft interval)

N

0 625 1,250 2,500

Feet

Notes:
1. Analytical results reflect the sum of PFOA and PFOS.
2. 70 nanograms per Liter (ng/L) for PFOA plus PFOS is the EGLE Drinking Water Criteria per Part 201, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the Part 201 Administrative Rules. Table 1 (June 25, 2018)
3. Red text indicates the result is greater than the Drinking Water Criteria.
4. Refer to notes on Figure 3 regarding monitoring well names and locations.

Abbreviations:
ng/L = nanograms per liter
ND = Not detected
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctane sulfonate

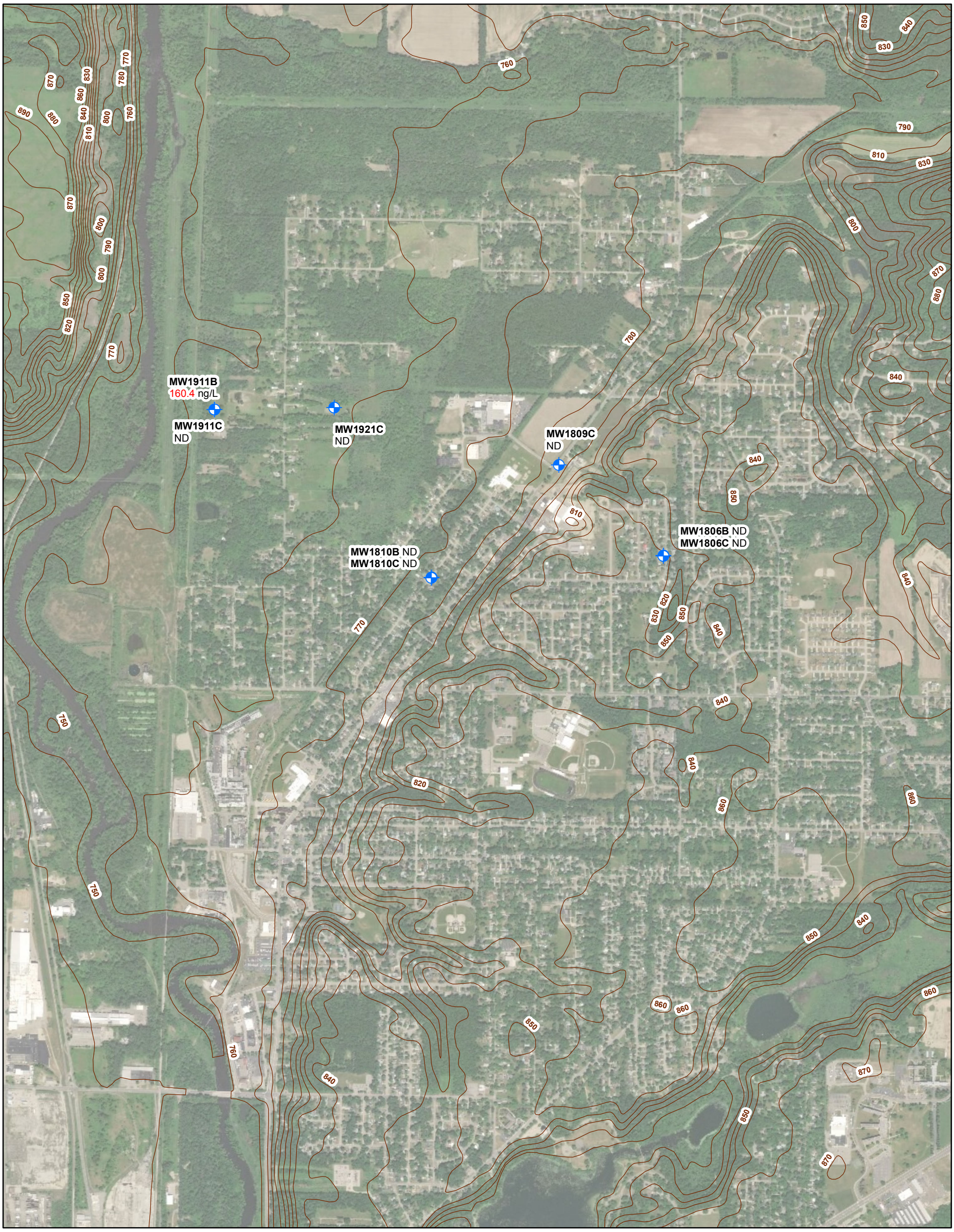
ORIGINAL BY:	MC
DATE:	1/17/2019
REVISED BY:	JMM
DATE:	5/31/2019

HYDROGEOLOGIC INVESTIGATION REPORT
GEORGIA-PACIFIC
PARCHMENT, MICHIGAN

PFOA PLUS PFOS ANALYTICAL RESULTS - UNCONFINED AQUIFER

FIGURE
5

P:\Projects\Georgia-Pacific\Parchment, MI\Documents\Investigation Report\3 - Draft Figures\executables\Figure 5 - PFOA + PFOS Analytical Results_WT_rev1.mxd



Base Map Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Study Monitoring Well - Semi-confined/Confined Aquifer

Topopgraphic Contour (10 ft interval)

N

0 625 1,250 2,500

Feet

Abbreviations:
ng/L = nanograms per liter
ND = Not detected
PFOA = Perfluorooctanoic acid
PFOS = Perfluorooctane sulfonate

Notes:
1. Analytical results reflect the combined total of PFOA and PFOS.
2. 70 nanograms per Liter (ng/L) for PFOA plus PFOS is the EGLE Drinking Water Criteria per Part 201, of the Natural Resources and Environmental Protection Act, 1994 PA 451, as amended, and the Part 201 Administrative Rules. Table 1 (June 25, 2018)
3. Red text indicates the result is greater than the Drinking Water Criteria.
4. Refer to notes on Figure 3 regarding monitoring well names and locations.

	ORIGINAL BY: MC	HYDROGEOLOGIC INVESTIGATION REPORT GEORGIA-PACIFIC PARCHMENT, MICHIGAN	FIGURE
	DATE: 1/17/2019		6
	REVISED BY: JMM	**PFOA PLUS PFOS ANALYTICAL RESULTS - SEMI-CONFINED/CONFINED AQUIFER**	
	DATE: 5/31/2019		

P:\Projects\Georgia-Pacific\Parchment, MI\Documents\Investigation Report\3 - Draft Figures\executables\Figure 6 - PFOA + PFOS Analytical Results_SC-C Aquifer.mxd