Investigation of Per- and Polyfluoroalkyl Substances (PFAS) in the Grand River and Thornapple River Watersheds Surface Water Sampling Update August 2019

Perfluorinated and polyfluorinated alkyl substances (PFAS) are a very large class of man-made organic chemicals that have been used in numerous industrial processes and consumer products for over 60 years. Validated analytical methods are available for relatively few of the thousands of compounds. Much of the environmental monitoring of PFAS in Michigan has focused on measuring only perfluorinated chemicals.

Many PFAS are persistent, some bioaccumulate in the environment, and several are toxic to mammals and/or birds in laboratory tests. The toxicities of most PFAS have not been evaluated. Two perfluorinated compounds; perfluorooctanoic acid (PFOA) and perfluorooctane sulfonate (PFOS), have been the subject of the most toxicological work and environmental monitoring. Both compounds were manufactured intentionally, but they can also be generated as byproducts when other fluorinated compounds break down. In addition, several PFAS are key ingredients in fire-fighting foams. These foams have been used extensively in fire training exercises at military bases nation-wide; in recent years PFAS have been detected in surface and groundwater near many military facilities. Many products containing PFAS are used in numerous industrial processes including metal plating, textile production and treatment, and specialty paper production. Industrial and domestic waste containing these compounds can enter the environment through municipal or private waste treatment systems, stormwater runoff, venting groundwater, or as deposition after emissions into the atmosphere. Both PFOS and PFOA have been measured in surface waters across the state, and PFOS has been detected in most fish tissue samples from Michigan waters that have been analyzed for PFAS.

The Michigan Department of Environment, Great Lakes, and Energy (EGLE) has generated Rule 57 surface water quality values for the protection of human health and aquatic life for PFOS and PFOA. The Rule 57 Human Non-Cancer Value (HNV) for PFOS is 12 nanograms per liter (ng/L; parts per trillion) in surface waters not used as a source of drinking water, and 11 ng/L for those surface waters used as a drinking water source. The HNVs for PFOA are 420 ng/L and 12,000 ng/L for drinking and non-drinking water sources, respectively. The Aquatic Maximum Value (AMV) is the highest concentration of a substance to which an aquatic community can be exposed briefly without resulting in adverse effects, whereas, the Final Chronic Value (FCV) is the highest concentration of a substance to which an aquatic community can be exposed for a long period of time without experiencing adverse effects. The Rule 57 AMV and FCV for PFOS is 880,000 and 7,700 ng/L, respectively. The Rule 57 AMV and FCV for PFOA is 780,000 and 140,000 ng/L, respectively.

The Grand River watershed is the second largest watershed in Michigan and drains portions of 18 counties: Muskegon, Ottawa, Allegan, Newaygo, Kent, Mecosta, Montcalm, Ionia, Barry, Eaton, Gratiot, Clinton, Shiawassee, Ingham, Livingston, Jackson, Washtenaw, and Hillsdale. Approximately 53 % of the Grand River watershed is agricultural production, 27 % is urban, and 20 % is forested land (Grand Learning Network n.d.). The main tributaries of the Grand River are the Rogue River, Flat River, Maple River, Looking Glass River, Red Cedar River, and the Thornapple River.

EGLE Water Resources Division (WRD), Surface Water Assessment Section (SWAS) conducted surface water sampling in the Grand River and Thornapple River watersheds in August and September 2018 and in June 2019. This effort was initiated in part because there are 12 PFAS contamination investigations sites being conducted in these two watersheds. PFAS sites are where one or more groundwater sample exceeds the Part 201 cleanup criteria for groundwater used as drinking water,

which is 70 parts per trillion for PFOS + PFOA. EGLE WRD SWAS decided to monitor the rivers and select tributaries to evaluate the potential risk to human health caused by PFAS in area surface waters and to track potential sources of PFAS in the watershed. Initial ambient surface water samples were collected as a part of a 28-day caged fish study in the Rogue River and Thornapple River watersheds between August and September 2018. During this study, EGLE WRD SWAS collected grab samples of ambient surface water from 15 locations (Table 1). A larger, more broad sampling event across the entire Grand River watershed occurred in June 2019. During this event 141 samples at 129 locations were selected to bracket potential sources of PFAS contamination in the watershed and to repeat previous sampling locations. Over the course of the three sampling events, 169 surface water samples were collected at 140 locations. Samples were collected in accordance with the Michigan Per- and Polyfluoroalkyl Substances (PFAS) Sampling Guidance document (MDEQ 2018). QA/QC procedures followed the Michigan Surface Water PFAS Investigation 2019 QAPP (EGLE 2019).

Findings:

- PFOS was detected in 168 of the total 169 surface water samples (Table 1, Figure 1). Concentrations greater than the detection limit ranged from 0.5 ng/L in Hunton Creek (HC-0010) to 45.0 ng/L in the Reynold's Drain (RD-0010).
- 97 of the 169 total samples (57.3 %) were below the PFOS concentration reporting limit (2.0 ng/L).
- PFOS concentrations exceeded the Rule 57 HNV of 12.0 ng/L at five locations:
    - One location in the Upper Grand River watershed
        - The Reynold's Drain near Lansing (RD-0010; Figure 2): 45 ng/L
    - Four locations in the Lower Grand River watershed
        - An unnamed tributary to Indian Mill Creek (TI-0010; Figure 3): 13 ng/L
        - The Cogswell drain in Grand Rapids (CG-0010; Figure 3): 38 ng/L
        - The Rogue River (RR-0010 and RR-0020): up to 19 ng/L
    - No PFOS Rule 57 HNV exceedances were observed in the Thornapple River watershed
- Elevated PFOS concentrations (>5 ng/L) below the Rule 57 HNV were observed at 13 sampling locations throughout the watersheds.
    - One location in the Upper Grand River watershed
        - Husted Landenburg Drain (HD-0010): 8.6 ng/L
    - Two locations in the Thornapple River watershed
        - One airport drain (AP-0020): 5.3 to 6.2 ng/L
        - Schoolhouse Creek (UC-0010): 5.7 ng/L
    - 12 locations in the Lower Grand River watershed
        - Rogue River (RR-0050, RR-0100, RR-0200): 6.6 to 9.6 ng/L
        - Grand River (GR-0150): 9.0 ng/L
        - Coldbrook Creek (CO-0010): 6.3 ng/L
        - Three locations in Plaster Creek (PC-0010, PC-0030, PC-0100): 5.8 to 8.2 ng/L
        - Roy's Creek (RY-0010): 7.4 ng/L
        - Deer Creek (DC-0010): 8.8 to 9.8 ng/L
- PFOA was detected in 168 of 169 surface water samples. Concentrations were all below the Rule 57 HNV and ranged from non-detect in a Rogue River sample (RR-0600) to 26 ng/L in the Cogswell drain (CG-0010).
- Over the course of the three sampling events four trip blanks, three field blanks, and one equipment blank were collected. PFOS and PFOA were non-detect in each of these blanks except for the trip blank collected in June 2019 (PFOS: 0.47 ng/L).

- PFOS was non-detect in 13 of the 14 laboratory method blanks analyzed. The one detection was at 1.4 ng/L and below the laboratory reporting limit of 2.0 ng/L. PFOA was non-detect in all method blanks.
- Six replicate and six duplicate samples were collected over the three sampling events. Three of these samples exceeded the 30 % relative percent deviation (RPD) quality assurance/quality control objective (RR-0010 duplicate = 30.8 %; GR-0260 replicate = 39 %; LG-0150 replicate = 34.1 %).

As previously mentioned, several PFAS sites exist in the Grand River watershed. In 2018, groundwater samples near a former metal plating facility in Cascade Township (Lacks Industries) exceeded the Part 201 cleanup criteria for groundwater used as drinking water, which is 70 ng/L for PFOS + PFOA. A PFOS concentration of 240 ng/L was found in the discharge from a purge well prior to entering Walden Lake. The Walden Lake outlet had a PFOS concentration of 28 ng/L in a sample collected by Lacks Industries in October 2018. Schoolhouse Creek (sample location UC-0010) is a tributary to the Thornapple River that drains Walden and Wood lakes in Cascade.

The Gerald R. Ford International Airport (GFIA), located near Kentwood, performed federally required firefighting training activities using PFAS containing aqueous film forming foam (AFFF) on the northeast side of the property between the 1960s to the mid-1990s. In 2018, multiple locations on the site exceeded the criteria for PFOS for soil protective of the groundwater-surface water interface (GSI). The AP-0020 sampling location is a tributary to the Thornapple River that drains the airport property near the firefighting training activity location.

Operations at the former Wolverine World Wide tannery in Rockford resulted in PFAS contaminated groundwater and surface water near the Rogue River. The tannery is located on the east bank of the Rogue River upstream of sampling location RR-0050. Additionally, the Belmont – House Street area consists of a former licensed disposal facility owned and operated by Wolverine World Wide in Plainfield Township. In 2017, a concerned citizens group brought the former House Street disposal location to EGLE's attention. Levels of PFOS and PFOA in residential wells exceeded the U.S. Environmental Protection Agency's Lifetime Health Advisory of 70 ng/L for PFOA and PFOS individually or combined.

In 2019, groundwater PFOS concentrations exceeding the Part 201 groundwater cleanup criteria were found at the Electro Chemical Finishing Facility in Wyoming. In 2014, the facility discharged plating wastewater to Roys Creek, upstream of RY-0010, following a breach in the floor where plating water entered the ground and also discharged into the storm sewer system.

Overall, these results suggest that source(s) of PFAS exist in the Upper Grand River, the Thornapple River, and the Lower Grand River watersheds. EGLE WRD is planning to collect additional surface water samples near locations with elevated PFOS concentrations where the source(s) is still unknown.

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References

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Michigan Department of Environmental Quality. (2018). General Per- and Polyfluoroalkyl Substances (PFAS) Sampling Guide.

Michigan Department of Environment, Great Lakes, and Energy. (2019). Michigan Surface Water Perfluoroalkyl and Polyfluoroalkyl Compound (PFAS) Investigation: Quality Assurance Project Plan (QAPP).

Table 1. PFOS and PFOA concentrations measured above their detection limit in surface water samples collected from locations in the Upper and Lower Grand River and Thornapple watersheds between August 2018 and June 2019. N.D. indicates a sample that was below the detection limit for either PFOS or PFOA. Concentrations exceeding the Rule 57 HNV are in bold and italicized.

Site ID	Site Description	Lat	Long	Sampling Event	PFOS (ng/L)	PFOA (ng/L)
GR-0010	Grand River @ South Pier	43.05833	-86.24647	June 2019	2.9	1.8
GR-0015	Grand River off Dock @ Waterfront Stadium	43.06557	-86.23468	June 2019	3.1	2.2
GR-0020	Grand River @ N. 3rd St	43.07001	-86.22677	June 2019	2.6	2.0
GR-0025	Grand River off Dock at Coho Dr.	43.07686	-86.22608	June 2019	3.2	1.8
SL-0010	Spring Lake @ Marina	43.07761	-86.21274	June 2019	3.4	2.5
GR-0030	Grand River off Dock at Grand Isle Marina	43.07542	-86.22894	June 2019	3.6	1.9
GR-0035	Grand River @ Nature Preserve off Leonard	43.06017	-86.17955	June 2019	4.3	2.1
SB-0010	Stearns Bayou @ Green St	43.02599	-86.13712	June 2019	1.5	1.5
LR-0100	Little Robinson Creek @ Little Robinson	43.00462	-86.07504	June 2019	1.2	1.6
SK-0100	Stearns Creek @ Lincoln	43.00127	-86.08950	June 2019	N.D.	0.3
GR-0040	Grand River @ 231	43.04008	-86.09184	June 2019	2.2	1.6
GR-0040[D]	Grand River @ 231	43.04003	-86.09187	June 2019	2.3	1.6
CC-0010	Crockery Creek @ Leonard Rd	43.06292	-86.06649	June 2019	2.4	1.8
BR-0010	Bass River @ Bass Dr	42.99523	-86.01762	June 2019	3.6	6.6
BE-0010	Bear Creek @ 112th Ave	42.97525	-86.06340	June 2019	1.1	1.4
BE-0010[R]	Bear Creek @ 112th Ave	42.97526	-86.06339	June 2019	0.9	1.2
GR-0050	Grand River @ 68th Ave	43.01468	-85.95562	June 2019	2.8	1.8
DC-0100	Deer Creek @ Mill Rd	43.02901	-85.92185	June 2019	8.8	6.1
DC-0100[D]	Deer Creek @ Mill Rd	43.02899	-85.92183	June 2019	9.8	6.1
GR-0060	Grand River @ Lake Michigan Dr	42.97228	-85.87621	June 2019	2.7	1.7
CL-0010	Cedar Lake Drain @ Fillmore St	42.93442	-85.85294	June 2019	0.8	1.7
SC-0010	Sand Creek @ Luce St	42.94976	-85.84948	June 2019	1.4	1.6
GR-0070	Grand River Near Wallenwood Golf Course	42.91948	-85.79632	June 2019	3.3	2.0
RC-0010	Rush Creek @ Kenowa	42.90330	-85.78471	June 2019	3.2	4.4
BC-0010	Buck Creek @ Chicago Dr	42.90571	-85.77492	June 2019	4.4	2.7
GR-0080	Grand River @ 28th St SW	42.91543	-85.76755	June 2019	3.1	1.7
GR-0090	Grand River @ End of Riverbend Dr	42.93024	-85.75648	June 2019	3.2	2.0
RY-0010	Roys Creek @ Viaduct St	42.92108	-85.74224	June 2019	7.4	2.4

Site ID	Site Description	Lat	Long	Sampling Event	PFOS (ng/L)	PFOA (ng/L)
RY-0030	Roys Creek @ 28th St SW	42.91364	-85.73012	June 2019	3.4	2.5
GR-0100	Grand River @ I-196 (access via Market Ave)	42.94695	-85.71083	June 2019	4.9	3.0
PC-0010	Plaster Creek @ Market Ave	42.94857	-85.69841	June 2019	8.2	4.6
PC-0030	Plaster Creek @ Grandville Ave SW	42.93597	-85.68750	June 2019	5.8	2.6
PC-0100	Plaster Creek @ Shaffer Ave SE	42.90196	-85.58763	June 2019	6.0	4.0
PC-0100[R]	Plaster Creek @ Shaffer Ave SE	42.90197	-85.58763	June 2019	5.6	3.9
BL-0010	Unnamed Drain @ Butterworth Landfill	42.95096	-85.69728	June 2019	3.2	2.0
GR-0110	Grand River @ Oxford St Trail	42.95351	-85.68647	June 2019	2.3	1.6
GR-0115	Grand River @ Newberry St	42.97660	-85.67421	June 2019	1.6	1.2
CO-0110	Coldbrook Creek @ Highland Park	42.97421	-85.65663	June 2019	6.3	4.8
GR-0120	Grand River @ Leonard St	42.98485	-85.67284	June 2019	1.3	1.1
IM-0010	Indian Mill Creek @ Turner Ave	42.99462	-85.67804	June 2019	4.9	2.5
IM-0020	Indian Mill Creek @ Alpine	42.99574	-85.68196	June 2019	4.7	3.0
TI-0010	Trib to Indian Mill Creek near Bristol Ave	43.00007	-85.70322	June 2019	***13.0***	4.2
GR-0130	Grand River @ Ann St	42.99548	-85.67352	June 2019	3.1	1.5
CG-0010	Cogswell Drain @ US-131 offramp	43.00113	-85.67647	June 2019	***38.0***	26.0
GR-0140	Grand River near Rifle Range Rd	43.04594	-85.64708	June 2019	1.9	1.8
GR-0150	Grand River @ Jupiter Ave	43.06158	-85.60919	June 2019	2.0	1.3
GR-0150	Grand River @ Jupiter Ave	43.06164	-85.60958	August 2018	2.8	2.1
GR-0150	Grand River @ Jupiter Ave	43.06164	-85.60958	September 2018	9.0	3.9
RR-0010	Rogue River @ West River Dr	43.06429	-85.59220	June 2019	***16.0***	6.5
RR-0010	Rogue River @ West River Dr.	43.06381	-85.59122	August 2018	***19.0***	7.3
RR-0010	Rogue River @ West River Dr.	43.06381	-85.59122	September 2018	11.0	5.0
RR-0010[D]	Rogue River @ West River Dr	43.06430	-85.59220	June 2019	***15.0***	6.4
DNR-01	DNR Hatchery Rearing Middle Pond	43.08268	-85.60018	August 2018	1.3	3.0
RR-0020	Rogue River @ Packer Dr.	43.08237	-85.59058	August 2018	***18.0***	7.0
RR-0020	Rogue River @ Packer Dr.	43.08237	-85.59058	September 2018	11.0	5.4
RR-0050	Rogue River @ Bridge St.	43.11989	-85.56221	August 2018	7.8	3.3
RR-0050	Rogue River @ Bridge St.	43.11989	-85.56221	September 2018	9.6	3.6
RR-0100	Rogue River u/s Rockford Pond	43.13754	-85.55581	August 2018	6.7	2.4
RR-0100	Rogue River u/s Rockford Pond	43.13754	-85.55581	September 2018	6.6	2.7

Site ID	Site Description	Lat	Long	Sampling Event	PFOS (ng/L)	PFOA (ng/L)
RR-0200	Rogue River @ Algoma Ave.	43.13603	-85.61107	August 2018	7.0	2.0
RR-0200	Rogue River @ Algoma Ave.	43.13603	-85.61107	September 2018	5.0	2.7
RR-0300	Rogue River @ Pine Island Dr.	43.12406	-85.65093	August 2018	1.1	0.9
RR-0300	Rogue River @ Pine Island Dr.	43.12406	-85.65093	September 2018	1.4	1.8
RR-0600	Rogue River @ CH B72	43.16060	-85.68965	August 2018	0.7	N.D.
RR-0600	Rogue River @ CH B72	43.16060	-85.68965	September 2018	1.1	1.4
GR-0160	Grand River @ Northand Dr.	43.06351	-85.58002	June 2019	1.5	1.3
ST-0010	Stiles Creek @ Grand River Dr	43.03547	-85.55095	June 2019	1.1	1.0
GR-0175	Grand River d/s Thornapple	42.95942	-85.47928	August 2018	2.0	2.0
GR-0175	Grand River d/s Thornapple	42.95942	-85.47928	September 2018	1.8	1.4
GR-0180	Grand River @ Fulton St	42.95593	-85.47674	June 2019	1.0	1.3
TR-0010	Thornapple River @ Ada Covered Bridge	42.95335	-85.48580	June 2019	2.3	1.1
TR-0011	Thornapple River @ Ada Dr.	42.95345	-85.48608	August 2018	0.8	1.2
TR-0011	Thornapple River @ Ada Dr.	42.95345	-85.48608	September 2018	2.1	1.4
TR-0020	Thornapple River @ Thornapple River Dr	42.94004	-85.49105	June 2019	1.2	1.2
TR-0040	Thornapple River near Cascade Springs Dr	42.91871	-85.48982	June 2019	1.3	1.1
UC-0010	Schoolhouse Creek @ Thornapple River Dr.	42.91797	-85.49073	June 2019	5.7	2.5
TR-0050	Thornapple River @ Cascade Rd	42.91113	-85.49702	June 2019	1.1	1.3
AP-0010	Airport Drain @ 36th St & Kraft	42.89869	-85.52718	June 2019	1.5	0.9
AP-0010	Airport Drain @ 36th St & Kraft	42.89853	-85.52716	September 2018	3.2	1.6
AP-0020	Airport Drain @ 36th St	42.89672	-85.51541	June 2019	5.3	5.6
AP-0020	Airport Drain @ 36th St	42.89706	-85.51512	August 2018	5.6	7.5
AP-0020	Airport Drain @ 36th St	42.89706	-85.51512	September 2018	6.2	7.9
TR-0060	Thornapple River @ 48th St	42.87706	-85.47735	June 2019	1.3	1.1
AP-0030	Airport Drain @ Thornaple River Dr.	42.86077	-85.49832	June 2019	1.3	1.4
AP-0030	Airport Drain @ Thornaple River Dr.	42.86071	-85.49830	August 2018	0.8	1.1
AP-0030	Airport Drain @ Thornaple River Dr.	42.86071	-85.49830	September 2018	1.1	1.5
TR-0070	Thornapple River @ 84th St	42.81209	-85.48360	June 2019	1.1	1.2
TR-0070[R]	Thornapple River @ 84th St	42.81212	-85.48357	June 2019	0.9	1.2
TR-0080	Thornapple River @ 100th St	42.78303	-85.46963	June 2019	0.9	1.1
CR-0010	Coldwater River @ Whitneyville Ave	42.77538	-85.45672	June 2019	1.3	1.0

Site ID	Site Description	Lat	Long	Sampling Event	PFOS (ng/L)	PFOA (ng/L)
LT-0100	Little Thornapple River @ Brown Rd	42.75584	-85.14613	June 2019	1.1	1.0
TR-0090	Thornapple River @ Crane Rd	42.72544	-85.46863	June 2019	1.0	0.9
TR-0100	Thornapple River near N. Irving Rd	42.67522	-85.38129	June 2019	1.0	1.2
AL-0010	Algonquin Lake Drain Near end of Solomon Rd	42.66875	-85.35968	June 2019	0.8	1.0
TR-0110	Thornapple River @ N. Airport Rd Launch	42.66192	-85.35579	June 2019	0.8	1.0
TR-0120	Thornapple River Near W. State St	42.64856	-85.31423	June 2019	1.0	1.1
VD-0010	Drain near Viking Corporation	42.64864	-85.31288	June 2019	0.9	1.1
TR-0140	Thornapple River Near Cemetery	42.65556	-85.29970	June 2019	1.0	1.2
TR-0150	Thornapple River @ N. Michigan Ave	42.65278	-85.29237	June 2019	0.9	1.1
BT-0010	Butler Creek Near S East St	42.64908	-85.28171	June 2019	1.2	1.3
TR-0180	Thornapple River Near Dollar General	42.60054	-85.09637	June 2019	0.8	1.1
TR-0200	Thornapple River @ W Vermontville Hwy	42.62585	-84.77430	June 2019	1.1	0.9
BN-0010	Butternut Creek @ McConnell Hwy	42.61129	-84.78334	June 2019	1.6	1.6
TR-0210	Thornapple River @ N Stewart Rd	42.62054	-84.76838	June 2019	1.1	1.0
GR-0185	Grand River u/s Thornapple	42.94015	-85.45714	August 2018	2.0	1.9
GR-0185	Grand River u/s Thornapple	42.94015	-85.45714	September 2018	2.0	1.6
GR-0190	Grand River @ S. Hudson St	42.92505	-85.34296	June 2019	1.7	1.4
FR-0010	Flat River @ Fulton St	42.93409	-85.33910	June 2019	1.1	1.3
FR-0100	Flat River Near Button Rd	43.05868	-85.25486	June 2019	0.9	1.3
FR-0100[D]	Flat River Near Button Rd	43.05868	-85.25487	June 2019	0.8	1.4
FR-0110	Flat River @ East Riverside Park dock	43.09551	-85.21833	June 2019	1.0	1.4
FR-0150	Flat River Near Bracey Rd	43.16407	-85.24706	June 2019	1.0	1.3
GR-0200	Grand River @ N. Bridge St	42.93262	-85.21334	June 2019	1.6	1.5
GR-0210	Grand River Near Saranac Trail	42.93921	-85.20538	June 2019	1.7	1.7
CK-0010	Crooked Creek @ Fred Meijer River Trail	42.93666	-85.19383	June 2019	1.6	0.7
GR-0220	Grand River @ Fred Meijer River Trail	42.96711	-85.11095	June 2019	2.0	2.0
GR-0230	Grand River @ State Fairground Bridge	42.97442	-85.07527	June 2019	1.5	1.5
GR-0240	Grand River @ Cleveland St	42.97436	-85.04672	June 2019	1.5	1.6
GR-0250	Grand River @ Pedestrian Bridge?	42.97718	-85.03120	June 2019	1.7	1.9
PR-0010	Prairie Creek Near mouth	42.98428	-85.02714	June 2019	1.1	1.3
PR-0030	Prairie Creek @ Prairie Creek Rd	42.99306	-85.02721	June 2019	0.6	1.2

Site ID	Site Description	Lat	Long	Sampling Event	PFOS (ng/L)	PFOA (ng/L)
GR-0260	Grand River Near Fred Meijer River Trail	42.99527	-84.96012	June 2019	0.7	1.0
GR-0260[R]	Grand River Near Fred Meijer River Trail	42.99526	-84.96018	June 2019	1.1	1.3
MR-0010	Maple River @ Prairie St	42.99448	-84.94212	June 2019	0.8	1.0
GR-0270	Grand River @ Portland River Walk	42.87327	-84.90207	June 2019	1.4	1.5
GR-0270[R]	Grand River @ Portland River Walk	42.87333	-84.90222	June 2019	1.6	1.5
GR-0271	Outfall of Grand River @ Portland River Walk	42.87351	-84.90261	June 2019	0.6	0.5
LG-0010	Looking Glass River @ Divine Hwy	42.87035	-84.90019	June 2019	1.0	1.5
LG-0100	Looking Glass River Near Tallman Rd	42.82838	-84.75937	June 2019	1.0	1.5
HD-0010	Husted Landenburg Drain @ Wright Rd	42.78727	-84.73960	June 2019	8.6	3.4
LG-0110	Looking Glass River @ Bauer Rd	42.81920	-84.71976	June 2019	0.8	1.5
OD-0010	Openlander Drain @ Clark Rd	42.81331	-84.70040	June 2019	1.4	3.4
LG-0150	Looking Glass River @ Airport Rd	42.82411	-84.60273	June 2019	0.9	1.3
LG-0150[R]	Looking Glass River @ Airport Rd	42.82411	-84.60273	June 2019	1.2	1.4
LG-0200	Looking Glass River @ Schavey Rd	42.84269	-84.58863	June 2019	1.3	1.3
GR-0280	Grand River Near Riverwalk	42.76730	-84.76672	June 2019	1.6	1.7
SD-0010	Sandstone Creek Near Riverwalk	42.75876	-84.75773	June 2019	0.8	0.8
GR-0290	Grand River Near Old River Trail	42.76020	-84.65469	June 2019	2.5	2.1
CA-0010	Carrier Creek @ W. Willow Hwy	42.75530	-84.65274	June 2019	4.5	3.3
GR-0300	Grand River Near Tecumseh River Rd	42.75247	-84.59145	June 2019	2.8	3.1
GR-0305	Grand River @ Sunset Ave	42.75688	-84.57959	June 2019	1.8	1.6
RD-0010	Reynolds Drain @ Tecumseh River Rd.	42.75966	-84.57934	June 2019	***45.0***	9.9
GR-0310	Grand River @ N. MLK Jr Blvd	42.75569	-84.56765	June 2019	1.6	1.6
GR-0320	Grand River @ E. Kalamazoo St	42.72990	-84.54731	June 2019	1.8	1.6
RA-0010	Red Cedar River @ E. Elm St	42.72182	-84.54905	June 2019	1.6	1.7
SM-0010	Sycamore Creek @ E. Mt Hope Ave	42.71184	-84.52902	June 2019	2.5	1.8
SM-0010[D]	Sycamore Creek @ E. Mt Hope Ave	42.71184	-84.52902	June 2019	2.3	1.8
SM-0030	Sycamore Creek Near Lansing River Trail	42.70283	-84.53078	June 2019	1.9	1.5
HI-0010	Hawk Island Pond	42.69256	-84.53157	June 2019	2.0	2.3
SM-0100	Sycamore Creek @ E. Mt Hope Ave	42.58863	-84.44532	June 2019	1.9	1.2
RA-0030	Red Cedar River @ N. Aurelius Rd	42.71646	-84.52261	June 2019	1.7	1.5
CD-0010	Crego Pond Drain Near Lansing River Trail	42.71665	-84.52096	June 2019	1.9	2.2

Site ID	Site Description	Lat	Long	Sampling Event	PFOS (ng/L)	PFOA (ng/L)
CP-0010	Crego Pond	42.71650	-84.51248	June 2019	0.9	1.6
GR-0330	Grand River @ S MLK Jr Blvd	42.72004	-84.56723	June 2019	1.8	1.7
GR-0340	Grand River @ Waverly Rd	42.70930	-84.60296	June 2019	1.7	1.4
GR-0350	Grand River @ Waverly Rd	42.62216	-84.60265	June 2019	1.7	1.6
GR-0360	Grand River Near Raymerville Ct	42.51982	-84.64703	June 2019	2.6	1.6
GR-0400	Grand River @ Churchill Rd	42.40357	-84.44345	June 2019	1.8	1.8
HC-0010	Hunton Creek @ Mill St	42.44762	-84.43105	June 2019	0.5	0.6
GR-0450	Grand River @ W Parnall Rd	42.29121	-84.40551	June 2019	1.9	1.9
GR-0453	Grand River @ I-94 (access via service rd)	42.27169	-84.40882	June 2019	2.2	2.1
GR-0455	Grand River @ Monroe St	42.26497	-84.40901	June 2019	1.8	1.7
GR-0460	Grand River @ E. North St	42.25882	-84.40814	June 2019	1.8	1.7
GR-0470	Grand River @ E Ganson St	42.25483	-84.40743	June 2019	1.7	1.8
GR-0480	Grand River @ W. Trail St	42.25206	-84.40778	June 2019	1.9	1.8
GR-0485	Grand River @ Cooper St	42.24736	-84.40018	June 2019	2.5	1.9
GR-0500	Grand River @ E. High St	42.23334	-84.38839	June 2019	1.3	1.6
GR-0510	Grand River @ E. High St	42.22724	-84.36316	June 2019	0.7	1.9
GR-0510[D]	Grand River @ E. High St	42.22724	-84.36316	June 2019	0.9	1.9

[D] indicates a duplicate sample; [R] indicates a replicate sample

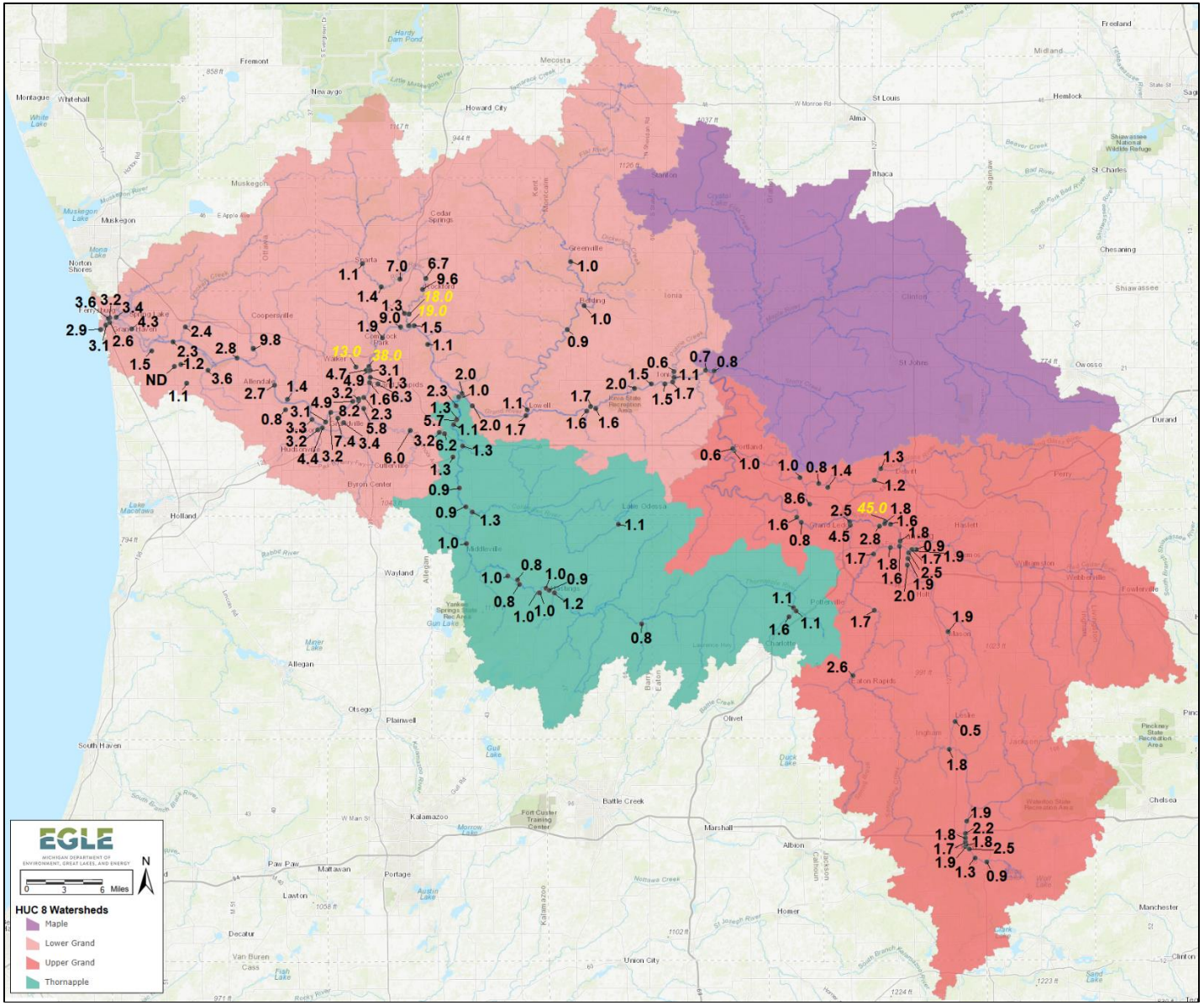

Figure 1: Overview map of the Grand River watershed with surface water PFOS concentrations (ng/L) at locations sampled in August and September 2018 and June 2019. The highest concentration is displayed at locations where more than one sample was collected. Concentrations exceeding the Rule 57 Human Health Value are displayed in italicized yellow font. ND indicates a non-detectable concentration of PFOS.

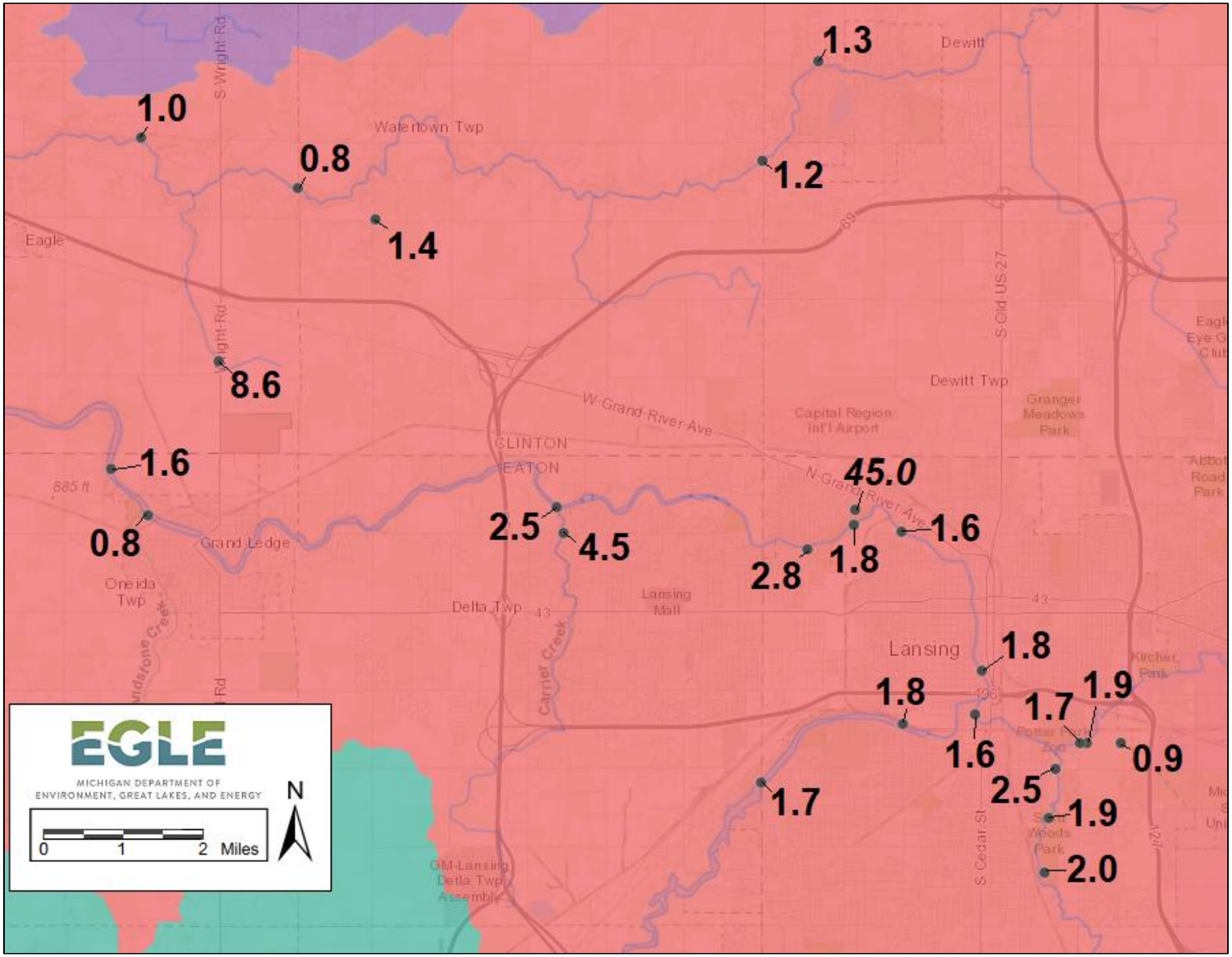

Figure 2: A closer view map of the Upper Grand River watershed near Lansing with surface water PFOS concentrations (ng/L) at locations sampled in June 2019. The highest concentration is displayed at locations where more than one sample was collected. Concentrations exceeding the Rule 57 Human Health Value are italicized.

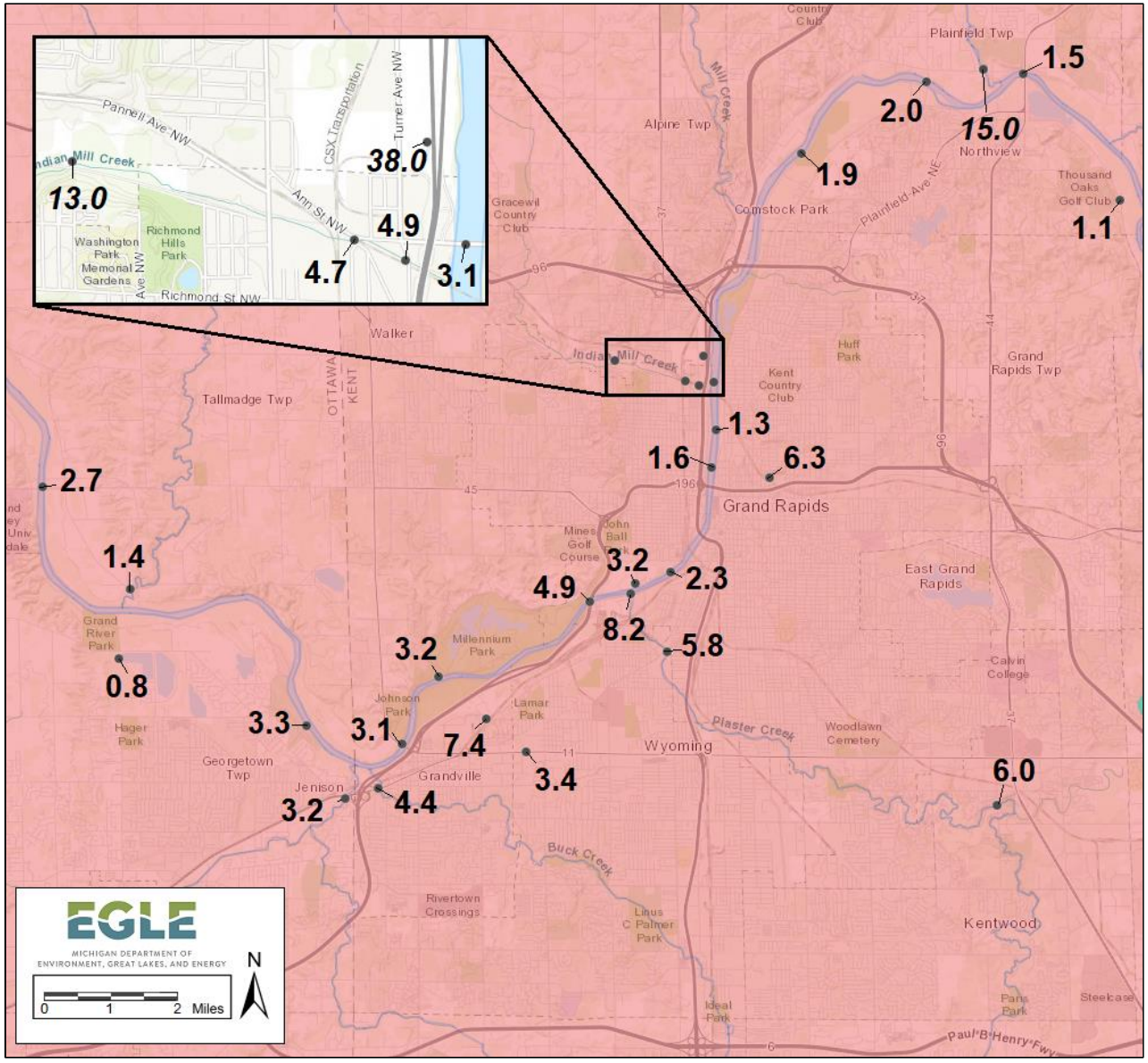

Figure 3: A closer view map of the Lower Grand River watershed near Grand Rapids with surface water PFOS concentrations (ng/L) at locations sampled in June 2019. Inset shows a more detailed view of the Indian Mill Creek. The highest concentration is displayed at locations where more than one sample was collected. Concentrations exceeding the Rule 57 Human Health Value are italicized.