Restorative Lake Sciences™

Upper Long Lake 2019 Aquatic Vegetation, Water Quality & 2020 Management Recommendations Report

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Upper Long Lake 2019 Aquatic Vegetation, Water Quality & 2020 Management Recommendations Report

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Section 1

Upper Long Lake 2019 Aquatic Vegetation, Water Quality, and 2020 Management Recommendations Report

The following information is a summary of key lake findings collected during 2019.

The overall condition of Upper Long Lake in 2019 was good. The water clarity ranged between 8.0-8.5 feet during the August, 2019 sampling. Additionally, the lake has enough nutrients (phosphorus and nitrogen) to support abundant algae and submersed aquatic plant growth, but the nutrient levels are considered moderate and were higher at the lake bottom in 2019 due to increased runoff loads from storm events. The lake did experience depletion of dissolved oxygen with depth during mid-summer which is common for a small but deep inland lake. Conductivity was high and corresponds to increased urban runoff. A series of five drains including the Marie Circle Drain, the McClintock Road Drain, the Hammond Lake inlet, the Bayou Shores Drain, and the Middlebelt Road Drain entering the lake were sampled for total inorganic nitrogen, total suspended solids, and chlorides. The highest values for both TSS and chlorides were recorded from the Middlebelt Drain. However, all of the drains contained elevated TSS and chlorides overall. An August 7, 2019 whole-lake aquatic plant survey revealed the presence of 31 native aquatic plant species which included 22 submersed, 4 floating-leaved, and 5 emergent species. In addition, a total of four invasive species such as Eurasian Watermilfoil (EWM), Starry Stonewort, Purple Loosestrife, and Flowering Rush were found scattered within and around the lake. Management recommendations for the aquatic vegetation and the drains are offered in Section 4.0 of this report.

Section 2

Upper Long Lake Water Quality Data (2019)

Water Quality Parameters Measured

There are hundreds of water quality parameters that can measured on an inland lake, but several are the most critical indicators of lake health. The water quality parameters measured in the three deepest basins (Figure 1) of Upper Long Lake in 2019 included: water temperature (measured in °C), dissolved oxygen (measured in mg/L), pH (measured in standard units-SU), conductivity (measured in micro-Siemens per centimeter-µS/cm), total dissolved solids (mg/L), Secchi transparency (feet), total phosphorus and total inorganic nitrogen (both in mg/L), chlorophyll-*a* (in µg/L), and algal community composition. Physical water quality parameters were measured with a calibrated Eureka Manta II® multi-parameter sonde and chemical water quality parameters were analyzed in a NELAC-certified laboratory. Chlorophyll-a was measured with a calibrated *in situ* Turner Designs® fluorimeter. *E. coli* samples were collected at "B" beach and these numbers were above the 350 CFU/ml threshold for beach closings. The source(s) of these bacteria should be further explored.

Table 1 below demonstrates how lakes are classified based on key parameters. Upper Long Lake would be considered eutrophic (relatively productive) since it does contain ample phosphorus, nitrogen, algae, and aquatic vegetation growth. 2019 water quality data for Upper Long Lake is shown below in Tables 2-7. In addition to the deep basins, water quality parameters including total inorganic nitrogen (in mg/l), total suspended solids (in mg/l), and chlorides (in mg/l) were collected in key drains (Figure 2) entering Upper Long Lake such as the Marie Circle Drain, the McClintock Road Drain, the Hammond Lake inlet, the Bayou Shores Drain, and the Middlebelt Road Drain (Tables 8-12).

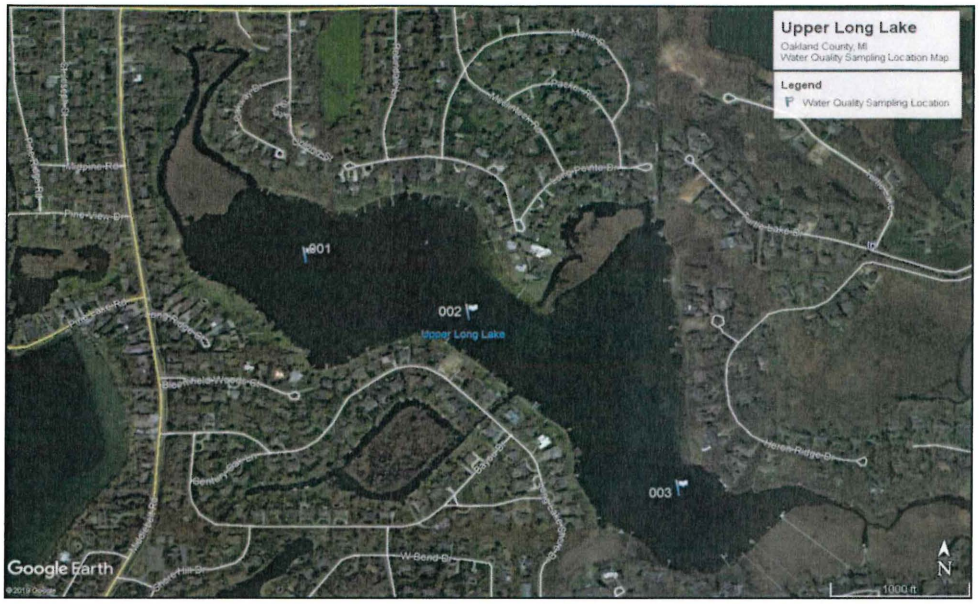

Figure 1. Deep basin water quality sampling sites in Upper Long Lake (2019).

Figure 2. Drain water quality sampling sites around Upper Long Lake (2019).

Table 1. Lake trophic classification (MDNR).

Lake Trophic Status	*Total Phosphorus ($\mu g\ L^{-1}$)*	*Chlorophyll-a ($\mu g\ L^{-1}$)*	*Secchi Transparency (feet)*
Oligotrophic	< 10.0	< 2.2	> 15.0
Mesotrophic	10.0 – 20.0	2.2 – 6.0	7.5 – 15.0
Eutrophic	> 20.0	> 6.0	< 7.5

Deep Basin Water Quality Data:

Table 2. Physical water quality data collected at Site #1 (North) on 7 Aug 19.

Depth (ft)	Temp (°C)	DO (mg/l)	pH (SU)	Cond (µS/cm)	TDS (mg/l)	Chl-a (µg/l)
0	27.29	9.26	8.84	639.8	410.6	7
10	26.44	6.72	8.84	642.2	413.4	
20	21.69	0.32	7.75	703.7	450.5	

Table 3. Chemical water quality data collected at Site #1 (North) on 7 Aug 19.

Depth	TP (mg/l)	TIN (mg/l)	NO_3 (mg/L)	NO_2 (mg/L)	NH_3(mg/L)
0	0.017	0.026	<0.10	<0.10	0.026
10	0.021	0.033	<0.10	<0.10	0.033
20	0.021	0.030	<0.10	<0.10	0.030

Table 4. Physical water quality data collected at Site #2 (Central) on 7 Aug 19.

Depth (ft)	Temp (°C)	DO (mg/l)	pH (SU)	Cond (µS/cm)	TDS (mg/l)	Chl-a (µg/l)
0	27.98	9.29	8.82	822.0	537.4	5
10	27.56	9.37	7.12	633.3	405.3	
20	23.88	6.47	7.45	700.2	418.4	

Table 5. Chemical water quality data collected at Site #2 (Central) on 7 Aug 19.

Depth	TP (mg/l)	TIN (mg/l)	NO_3 (mg/L)	NO_2 (mg/L)	NH_3(mg/L)
0	0.013	0.016	<0.10	<0.10	0.016
10	0.016	0.026	<0.10	<0.10	0.026
20	0.033	0.019	<0.10	<0.10	0.019

Table 6. Physical water quality data collected at Site #3 (South) on 7 Aug 19.

Depth	Temp (°C)	DO (mg/l)	pH (SU)	Cond (µS/cm)	TDS (mg/l)	Chl-a (µg/l)
0	28.02	9.73	8.85	762.2	476.2	4
7	27.45	9.92	8.91	696.3	468.4	
14	23.88	2.36	7.49	722.7	466.9	

Table 7. Chemical water quality data collected at Site #3 (South) on 7 Aug 19.

Depth	TP (mg/l)	TIN (mg/l)	NO_3 (mg/L)	NO_2 (mg/L)	NH_3(mg/L)
0	0.012	0.028	<0.10	<0.10	0.028
7	0.013	0.042	<0.10	<0.10	0.042
14	0.050	0.120	<0.10	<0.10	0.120

E-coli data for "B" Beach

Left: 548
Center: 687
Right: 411
Average (537)

Drain Water Quality Data:

Table 8. Marie Circle Drain water quality data by date.

Date	TIN (mg/l)	NO_3 (mg/L)	NO_2 (mg/L)	NH_3 (mg/L)	TSS (mg/L)	Chloride (mg/l)
12 March	4.20	3.70	<0.10	0.48	12	200
5 June	1.00	0.36	<0.10	0.69	64	-
19 June	1.10	0.36	<0.10	0.75	62	62
18 August	0.37	0.25	<0.10	0.12	22	-
11 Sept	0.60	0.47	<0.10	0.13	140	120

Table 9. McClintock Rd Drain water quality data by date.

Date	TIN (mg/l)	NO_3 (mg/L)	NO_2 (mg/L)	NH_3 (mg/L)	TSS (mg/L)	Chloride (mg/l)
14 March	0.23	0.21	<0.10	0.020	140	120
5 June	0.36	0.25	<0.10	0.11	50	-
19 June	0.44	0.31	<0.10	0.13	52	36
18 August	0.91	0.77	<0.10	0.15	28	-
11 Sept	-	-	-	0.25	-	-

Table 10. Hammond Lake Inlet water quality data by date.

Date	TIN (mg/l)	NO_3 (mg/L)	NO_2 (mg/L)	NH_3 (mg/L)	TSS (mg/L)	Chloride (mg/l)
12 March	0.15	0.11	<0.10	0.041	<10	130
19 June	0.029	<0.10	<0.10	0.029	42	120
18 August	0.16	<0.10	<0.10	0.160	56	-
11 Sept	0.16	0.11	<0.10	0.045	48	140

Table 11. Bayou Shores Drain water quality data by date.

Date	TIN (mg/l)	NO_3 (mg/L)	NO_2 (mg/L)	NH_3 (mg/L)	TSS (mg/L)	Chloride (mg/l)
12 March	0.54	0.53	<0.10	0.011	84	210
19 June	0.060	<0.10	<0.10	0.060	140	120
11 Sept	0.77	0.69	<0.10	0.082	24	<10

Table 12. Middlebelt Rd Drain water quality data by date.

Date	TIN (mg/l)	NO_3 (mg/L)	NO_2 (mg/L)	NH_3 (mg/L)	TSS (mg/L)	Chloride (mg/l)
14 March	0.34	0.22	<0.10	0.13	22	290
19 May	0.77	0.48	<0.10	0.30	260	-
22May	2.20	2.10	<0.10	0.16	170	-
5 June	1.70	0.52	<0.10	1.20	40	-
18 August	0.49	0.28	<0.10	0.21	16	<10
2 Sept	1.30	0.32	<0.10	1.00	28	<10
11 Sept @1850	0.65	0.31	<0.10	0.35	22	10
11 Sept @ 2200	0.79	0.42	<0.10	0.37	39	29

Results and Discussion:

Deep basins #1 and #3 both showed significant dissolved oxygen depletion with depth. This can result in phosphorus release from sediments under low oxygen conditions. The pH also decreased with depth which is normal. The values for pH were favorable. The specific conductivity remained high among the deep basin sites and ranged from 633-822 mS/cm and correspond to increased urban runoff. This also explains the elevated total dissolved solids that ranged from 405-537 mg/l. The chlorophyll-a concentrations also were elevated and ranged from 4-7 µg/l. This supports the lower water clarity observed on the date of sampling which ranged from 8.0-8.5 feet over the three deep basins. The total phosphorus was moderate and ranged from a low of 0.012 mg/l to a high of 0.050 mg/l. The higher concentrations were observed at the bottom of deep basins #2 and #3. The total inorganic nitrogen was moderate and ranged from a low of 0.016 mg/l to a high of 0.120 mg/l with the highest concentration recorded at deep basin #3. The nitrate and nitrite forms were below detection which means that all of the measured inorganic nitrogen was in the ammonia form. This form is what fuels the milfoil growth since ammonia is used in the sediment pore water by growing plant roots. The algal genera were determined from composite water samples collected over the deep basins of Upper Long Lake in 2019 and were analyzed

with a compound Zeiss® bright field microscope. The genera present included the Chlorophyta (green algae): *Scenedesmus* sp., *Rhizoclonium* sp., *Spirogyra* sp., *Mougeotia* sp., *Chlorella* sp., *Pandorina* sp., *Cladophora* sp., and *Chloromonas* sp. The Cyanophyta (blue-green algae): *Oscillatoria* sp.; the Bascillariophyta (diatoms)*: Fragilaria* sp., *Synedra* sp., *Navicula* sp., and *Cymbella* sp. The aforementioned species indicate a moderately diverse algal flora and represent a good diversity of algae.

The drains are major contributors to water quality degradation of Upper Long Lake. Total inorganic nitrogen concentrations were much higher than in the lake deep basins and ranged from 0.029-4.2 mg/l with the highest concentrations measured in the Marie Circle and Middlebelt Drains in March and May, respectively. Similar to the lake deep basins, the nitrite form was below the detection limit. However, nitrates and ammonia were elevated in most drains during most of the sampling periods. The total suspended solids were also very high overall and ranged from <10-260 mg/l with most values being well above the detection limit of 10 mg/l. Chlorides were also very high and are recommended to remain below 20 mg/l. The values for the drains ranged from <10-290 mg/l. The highest values for both TSS and chlorides were recorded from the Middlebelt Drain. However, all of the drains contained elevated TSS and chlorides overall.

Management recommendations for the drains are given in the management recommendations section (4.0) below.

Section

3

Aquatic Vegetation Data (2019)

Status of Native Aquatic Vegetation in Upper Long Lake

Native aquatic vegetation is essential for the overall health of the lake and the support of the lake fishery. The whole-lake aquatic vegetation survey (Figure 3) on August 7, 2019 utilized 206 geo-referenced GPS points and determined that there were a total of 31 native aquatic plant species. These include 22 submersed plant species, 4 floating-leaved plant species, and 5 emergent plant species. The most common native aquatic plant species in 2019 included the submersed macro alga *Chara vulgaris* (Figure 4) and Wild Celery (Figure 5).

This indicates a very high biodiversity of aquatic vegetation in Upper Long Lake. This means that there are a lot of different aquatic plants that serve varying functions in the ecology of Upper Long Lake. The overall percent cover of the lake by native aquatic plants is low relative to the lake size due to the great mean depth and thus these plants should be protected unless growing at nuisance levels. A list of all current native and invasive aquatic plant species is shown below in Table 13. The amount and distribution of all aquatic plants will vary annually based on climatic and seed bank conditions.

Figure 3. Aquatic vegetation sampling points in Upper Long Lake (Aug 7, 2019).

Figure 4. Chara

Figure 5. Wild Celery

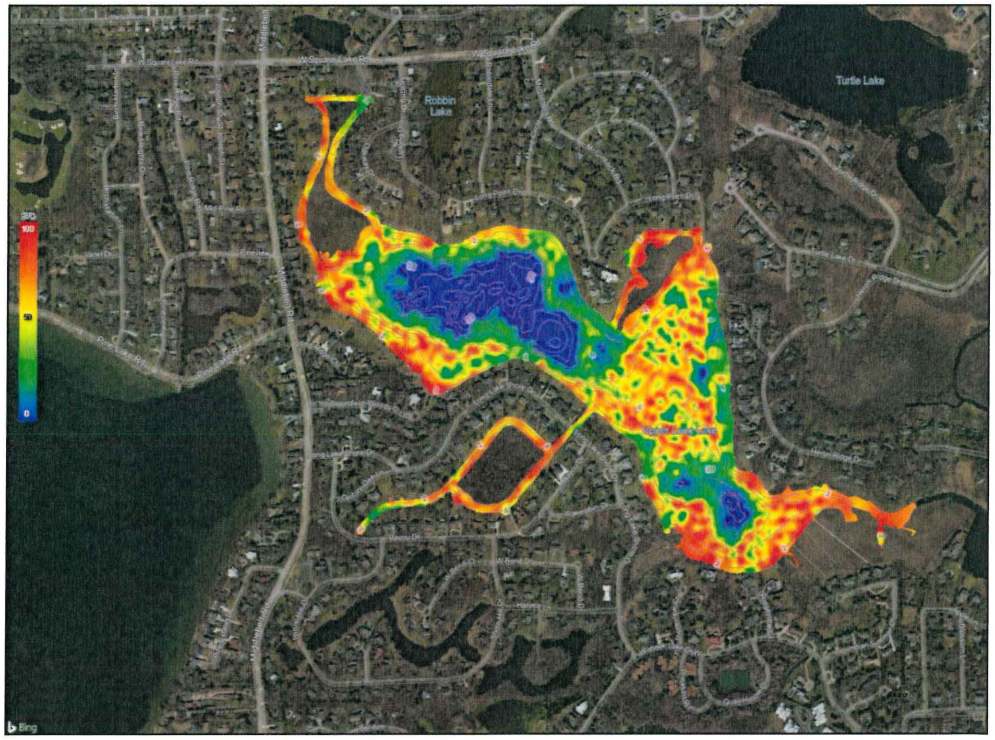

Figure 6. Aquatic vegetation biovolume of Upper Long Lake (August 7, 2019).

Table 13. All aquatic plant species found in Upper Long Lake (August 7, 2019).

LAKE NAME: **Upper Long Lake** SURVEY DATE: **7-Aug-2019**
COUNTY: **Oakland** SURVEY BY: **GJ/KJ**

Plant Code	Plant Name	Total number of AVAS's for each Density Category				Category Calculations				Sum of Previous Four Columns	Total Number of AVAS's	Quotient of Sum / # of AVAS sites	Overall CCV
		A	B	C	D	A x 1	B x10	C x 40	D x 80				
1	Eurasian watermilfoil	13	136	29	0	13	1360	1160	0	2533	206	**12.3**	B
2	Curly leaf pondweed	0	0	0	0	0	0	0	0	0	206	**0.0**	
3	Chara	11	63	4	0	11	630	160	0	801	206	**3.9**	
4	Thinleaf pondweed	1	2	1	0	1	20	40	0	61	206	**0.3**	
5	Flatstem pondweed	3	1	0	0	3	10	0	0	13	206	**0.1**	A
6	Robbins pondweed	1	1	0	0	1	10	0	0	11	206	**0.1**	
7	Variable pondweed	4	2	0	0	4	20	0	0	24	206	**0.1**	
8	Whitestem pondweed	2	1	0	0	2	10	0	0	12	206	**0.1**	B
9	Richardsons pondweed	0	2	1	0	0	20	40	0	60	206	**0.3**	
10	Illinois pondweed	22	26	1	0	22	260	40	0	322	206	**1.6**	
11	Large leaf pondweed	4	2	1	0	4	20	40	0	64	206	**0.3**	
12	American pondweed	15	36	1	0	15	360	40	0	415	206	**2.0**	
13	Floating leaf pondweed	1	14	1	0	1	140	40	0	181	206	**0.9**	
14	Water stargrass	1	2	1	0	1	20	40	0	61	206	**0.3**	B
15	Wild Celery	20	52	0	0	20	520	0	0	540	206	**2.6**	C
16													
17	Northern watermilfoil	1	1	0	0	1	10	0	0	11	206	**0.1**	B
18	Whorled watermilfoil	3	15	3	0	3	150	120	0	273	206	**1.3**	
19	Variable watermilfoil	0	0	0	0	0	0	0	0	0	206	**0.0**	
20	Coontail	11	8	0	0	11	80	0	0	91	206	**0.4**	C
21	Elodea	0	2	1	0	0	20	40	0	60	206	**0.3**	B
22	Bladderwort-large	4	2	1	0	4	20	40	0	64	206	**0.3**	B
23	Bladderwort-mini	0	0	0	0	0	0	0	0	0	206	**0.0**	
24	White water crowfoot	4	2	1	0	4	20	40	0	64	206	**0.3**	
25	Southern Naiad	0	5	1	0	0	50	40	0	90	206	**0.4**	A
26	Slender Naiad	3	1	0	0	3	10	0	0	13	206	**0.1**	
27	Sago pondweed	18	3	0	0	18	30	0	0	48	206	**0.2**	
28	Starry stonewort	3	28	16	4	3	280	640	320	1243	206	**6.0**	C
29	European Water Clover	0	0	0	0	0	0	0	0	0	206	**0.0**	
30	White waterlily	12	18	0	0	12	180	0	0	192	206	**0.9**	A
31	Yellow waterlily	7	2	0	0	7	20	0	0	27	206	**0.1**	A
32	Watershield	0	0	0	0	0	0	0	0	0	206	**0.0**	
33	Duckweed-lesser	2	2	0	0	2	20	0	0	22	206	**0.1**	A
34	Spirodella	0	0	0	0	0	0	0	0	0	206	**0.0**	
35	Watermeal	1	1	0	0	1	10	0	0	11	206	**0.1**	
36	Arrowhead	0	0	0	0	0	0	0	0	0	206	**0.0**	
37	Pickerelweed	4	6	1	0	4	60	40	0	104	206	**0.5**	
38	Arrow Arum	0	0	0	0	0	0	0	0	0	206	**0.0**	
39	Cattails	5	7	28	3	5	70	1120	240	1435	206	**7.0**	B
40	Bulrushes	17	3	2	0	17	30	80	0	127	206	**0.6**	A
41	Iris	1	1	0	0	1	10	0	0	11	206	**0.1**	A
42	Swamp Loosestrife	1	3	0	0	1	30	0	0	31	206	**0.2**	
43	Purple Loosestrife	20	3	0	0	20	30	0	0	50	206	**0.2**	
44	Nitella	0	0	0	0	0	0	0	0	0	206	**0.0**	A
45	Phragmites	0	0	0	0	0	0	0	0	0	206	**0.0**	A
46	Flowering Rush	5	3	1	0	5	30	40	0	75	206	**0.4**	
47	Wild Rice	0	0	0	0	0	0	0	0	0	206	**0.0**	
48	Button Bush	0	0	0	0	0	0	0	0	0	206	**0.0**	
49	Spike Rush	0	0	0	0	0	0	0	0	0	206	**0.0**	
50	Beak Rush	0	0	0	0	0	0	0	0	0	206	**0.0**	
51	Burr Reed	0	0	0	0	0	0	0	0	0	206	**0.0**	
52	Water Pennywort	0	0	0	0	0	0	0	0	0	206	**0.0**	
53	Twig Rush	0	0	0	0	0	0	0	0	0	206	**0.0**	
54		0	0	0	0	0	0	0	0	0	206	**0.0**	
55		0	0	0	0	0	0	0	0	0	206	**0.0**	
												44.4	

Status of Invasive (Exotic) Aquatic Vegetation in Upper Long Lake

The August 7, 2019 survey of aquatic plants in Upper Long Lake determined the presence of 4 invasive aquatic plant species, including, Eurasian Watermilfoil (EWM; Figure 7), Starry Stonewort (Figure 8), Purple Loosestrife (Figure 9) , and Flowering Rush (Figure 10). Based on this survey, approximately 49.3 acres of invasive watermilfoil were found throughout the lake. In addition, approximately 10.1 acres of invasive Starry Stonewort were found throughout the lake. Invasive emergents were also found scattered around the lake shoreline and wetlands. Figures 11-13 show the distribution of these invasive aquatic plant species.

Figure 7. Eurasian Watermilfoil

Figure 8. Starry Stonewort

Figure 9. Purple Loosestrife

Figure 10. Flowering Rush

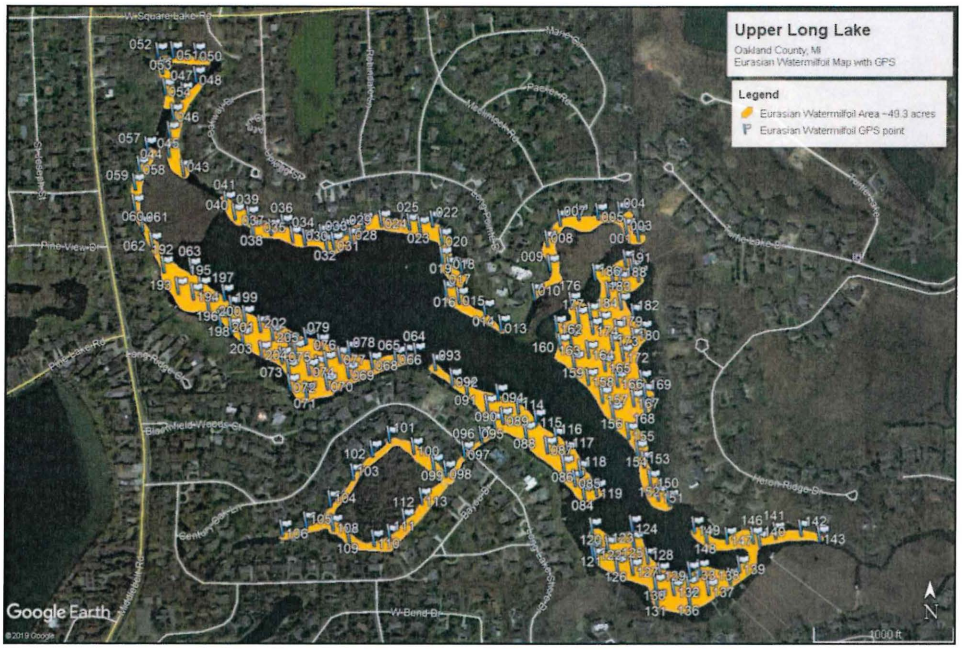

Figure 11. Invasive EWM found in Upper Long Lake (August 7, 2019).

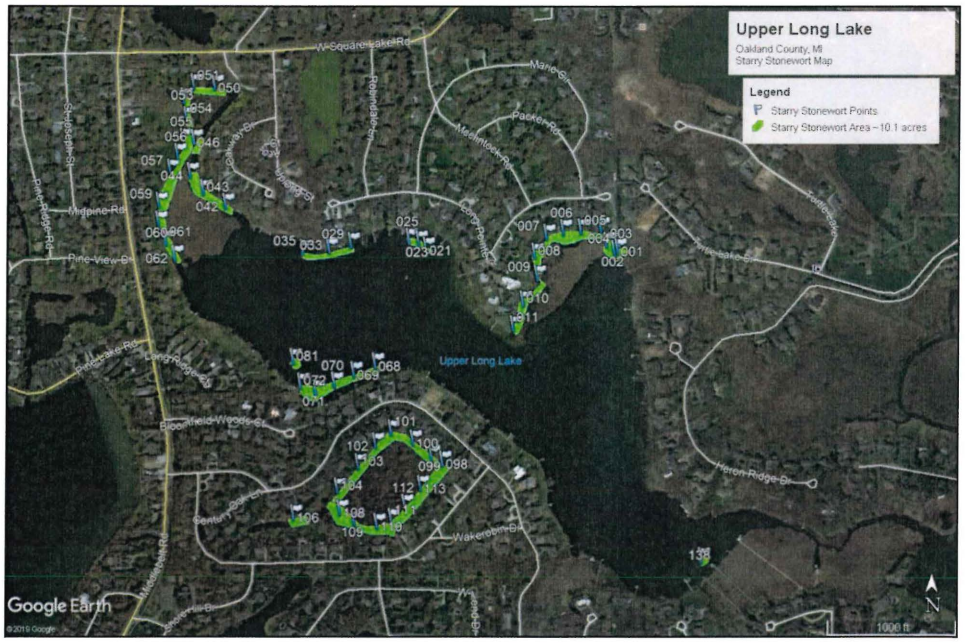

Figure 12. Invasive Starry Stonewort found in Upper Long Lake (August 7, 2019).

Figure 13. Invasive emergents found in Upper Long Lake (August 7, 2019).

Section 4

Management Recommendations for 2020

Continuous aquatic vegetation surveys are needed to determine the precise locations of EWM or other problematic invasives or dense nuisance native aquatic vegetation in and around Upper Long Lake. These surveys should occur in late-May to early-June and again post-harvest in 2020. The lake-wide aquatic vegetation scan and survey of Upper Long Lake by RLS in 2019 determined the presence of 31 native aquatic plant species. Efforts to preserve this biodiversity should be continued which includes the removal of nuisance milfoil biomass with mechanical harvesting as in previous years.

Water quality monitoring of the lake deep basins by RLS in 2019 showed the presence of ample nutrients such as phosphorus and nitrogen and elevated chlorophyll-a concentrations. In addition, the drains were found to have very high concentrations of total inorganic nitrogen, total suspended solids, and chlorides. These three substances contribute to water quality degradation over time and reductions in these parameters are recommended for long-term improvements to Upper Long Lake. Drain diversions may be possible but a receiving water body or watercourse would be needed, along with approval from the Oakland County Water Resources Commissioner. It may be possible to seek permit approval from EGLE to place charcoal filters in the drains to reduce suspends solids and nutrients. Such filters have been used with other lakes and are often considered on a "case by case" basis by EGLE. The filters must be used in a manner as to not induce localized flooding. Other drain improvements could be negotiated between the Township, County, and the County Road Commission. Reduction of solids entering the drains will lead to reduced associated nutrients loads as well. *E. coli* samples were collected at "B" beach and these numbers were above the 350 CFU/ml threshold for beach closings. The source(s) of these bacteria should be further explored.