LAKESHORE ENVIRONMENTAL, INC.
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MAPLE LAKE IMPROVEMENT GUIDANCE REPORT

June, 2011

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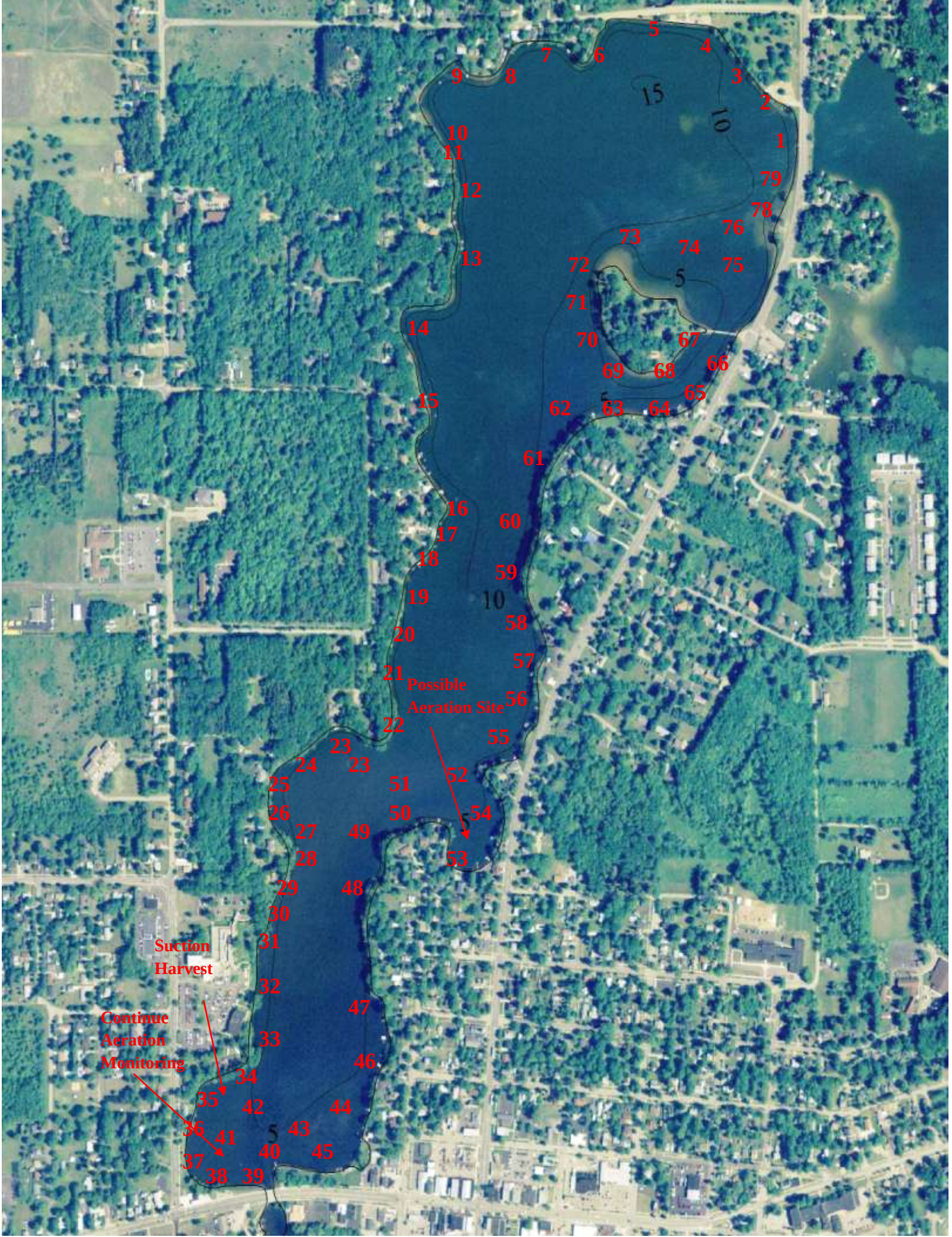
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Curly-Leaf Pondweed (CLP) in Maple Lake

Curly-Leaf Pondweed (up-close)

Eurasian Watermilfoil (EWM) canopy

Eurasian Watermilfoil (up-close)

Purple Loosestrife invading native shoreline plants

Purple Loosestrife

Sampling Location	Vegetation Found	Management Methods Recommended
1	CLP, Elodea, Chara	Suction harvest nearshore
2	CLP, Elodea	Suction harvest nearshore
3	CLP,Coontail,Elodea,Purple Loosestrife	Treat w/Diquat + CuSO4, hand-pull Loosestrife
4	CLP	NR
5	None	NR
6	CLP, Coontail	Treat w/Diquat + Aquathol K
7	Coontail	NR
8	Coontail	NR
9	None	NR
10	None	NR
11	Coontail,CLP	Diquat
12	Coontail	Diquat
13	EWM	Renovate OTF
14	EWM,Coontail,CLP	Renovate OTF/Diquat
15	Coontail	Diquat
16	None	NR
17	Coontail,Elodea,CLP	Diquat
18	Coontail,CLP,EWM	Renovate OTF/Diquat
19	EWM,Coontail,CLP	Renovate OTF/Diquat
20	Coontail,CLP	Diquat
21	Coontail,CLP	Diquat
22	Coontail, Purple Loosestrife	Diquat/Hand-pull Loosestrife
23	Coontail, EWM, Spirogyra	Renovate OTF/CuSO4
24	White waterlily,EWM,CLP,Coontail	Renovate OTF
25	White waterlily,Large-leaf Pondweed,Coontail,EWM EWM,Coontail	Renovate OTF
26	EWM,CLP,Large-leaf Pondweed,White waterlily,Spirogyra	Renovate OTF
27	White waterlily,Coontail,EWM,CLP,Spirogyra Flat-stem Pondweed,Coontail,CLP,Spirogyra	Renovate OTF/CuSO4
28	White waterlily	Renovate OTF/CuSO4
29	White waterlily,Coontail,Large-leaf	Diquat/CuSO4
30	Pondweed,EWM,Spirogyra White waterlily,EWM,Coontail,Spirogyra	NR Renovate OTF/CuSO4
31	Whitewaterlily,Duckweed,Cladophora,CLP,Coontail,	Renovate OTF/CuSO4
32	White waterlily,EWM,Coontail,CLP,Purple Loosestrife,Cattails	Renovate OTF/Hand-pull Loosestrife
33	White waterlily,Duckweed,Cladophora,Coontail,EWM,CLP	Renovate OTF/Diquat/CuSO4/Hand-pull Loosestrife
34	EWM,Coontail,Cladophora	Renovate OTF/CuSO4
35	Cladophora,Coontail,EWM,CLP,White waterlily,Purple Loosestrife	Renovate OTF/CuSO4/Hand-pull Loosestrife
36	CLP,EWM,Coontail,Large-leaf Pondweed,White waterlily	Renovate OTF/Diquat

Sampling Location	Vegetation Found	Management Methods Recommended
37	Spirogyra,CLP,Elodea,EWM,Coontail,Flat-stem Pondweed,Purple Loosestrife	Renovate OTF,Diquat,CuSO4,hand-pull Loosestrife
38	Spirogyra,CLP,Elodea,EWM,Coontail,Flat-stem Pondweed,Purple Loosestrife	Renovate OTF,Diquat,CuSO4,hand-pull Loosestrife
39	CLP,White waterlily,Coontail,Elodea,EWM,Flat-stem Pondweed, Scirpus subterminalis	Renovate OTF/Diquat
40	Scirpus subterminalis,CLP,Coontail,White waterlily,Spirogyra,Thin-leaf Pondweed	Diquat/CuSO4
41	CLP,Flat-stem Pondweed,Scirpus subterminalis,Coontail, EWM	Renovate OTF/Diquat
42	None	NR
43	Purple Loosestrife,Coontail	Diquat/Hand-pull Loosestrife
44	Purple Loosestrife,Bladderwort,CLP,White waterlily	Diquat/Hand-pull Loosestrife
45	CLP,EWM,Scirpus subterminalis	Renovate OTF/Diquat
46	Purple Loosestrife,White waterlily,Spirogyra,Cladophora,Bladderwort	Hand-pull Loosestrife/CuSO4
47	White waterlily,Cladophora,Spriogyra,Coontail,CLP	Diquat/CuSO4
48	Coontail	Diquat
49	EWM,Coontail,Flat-stem Pondweed,Spirogyra	Renovate OTF/CuSO4/Diquat
50	CLP,Coontail,Spirogyra	Diquat/CuSO4
51	Coontail,EWM,Spirogyra	Renovate OTF/CuSO4
52	CLP,Coontail	Diquat
53	CLP,Spirogyra,Thin-leaf Pondweed,Cattails	Diquat/CuSO4
54	CLP,Coontail,Thin-leaf Pondweed	Diquat
55	EWM,Coontail,Thin-leaf Pondweed	Renovate OTF/Diquat
56	Coontail,CLP,Spirogyra	Diquat/CuSO4
57	None	NR
58	Purple Loosestrife,Cattails,Coontail	Diquat/Hand-pull Loosestrife
59	CLP,Coontail	Diquat
60	Coontail,EWM	Renovate OTF/Diquat
61	Chara, Large-leaf Pondweed	NR
62	White waterlily,Coontail,EWM,CLP,Spirogyra	Renovate OTF/Diquat/CuSO4
63	Thin-leaf Pondweed,EWM	Diquat/CuSO4
64	CLP,Thin-leaf Pondweed,Coontail,Elodea,EWM	Renovate OTF/CuSO4/Diquat
65	Flat-stem Pondweed,Thin-leaf Pondweed,EWM	Diquat/Renovate OTF
66	CLP,Elodea,Flat-stem Pondweed	Diquat
67	White waterlily,EWM,Coontail,Thin-leaf Pondweed	Renovate OTF/CuSO4/Diquat Renovate OTF/CuSO4
68	CLP,EWM,Elodea,Thin-leaf Pondweed,Flat-stem Pondweed,Purple loosestrife	Renovate OTF/Hand-pull Loosestrife

Sampling Location	Aquatic Vegetation Found	Management Methods Recommended
69	Purple Loosestrife	Hand-pull Loosestrife
70	CLP,Purple Loosestrife	Diquat,hand-pull Loosestrife
71	CLP,EWM,Large-leaf Pondweed,Thin-leaf Pondweed	Renovate OTF/Diquat
72	CLP	Diquat
73	Thin-leaf Pondweed,Spirogyra,CLP	Diquat/CuSO4
74	CLP,EWM,White waterlily,Thin-leaf Pondweed,Purple Loosestrife	Diquat/Renovate OTF/Hand-pull Loosestrife
75	Coontail,EWM,CLP,Elodea	Diquat/Renovate OTF
76	CLP,EWM,Cattails,Spirogyra,Thin-leaf Pondweed	Diquat/Renovate OTF/CuSO4
77	Large-leaf Pondweed,CLP,Coontail	Diquat
78	EWM,CLP,Elodea,Coontail,Large-leaf Pondweed,Thin-leaf Pondweed,Flat-stem Pondweed	Diquat/Renovate OTF
79	Coontail,Iris	Diquat
80	Coontail,CLP,Thin-leaf Pondweed	Diquat

Summary of Recommended Management Methods

Laminar Flow Aeration

Although the technology itself is not new, the research being conducted on inland lakes in Michigan is quite recent. Laminar flow aeration systems have shown significant declines in blue-green algae, dense mats of green filamentous algae, sediment organic matter, and are being actively studied for possible roles in aquatic vegetation reduction. During the spring of 2011, aeration diffusers were placed at the south end and in Turtle Bay of Maple Lake and should be monitored for organic matter and sediment reduction and for the effects on the previously mentioned biotic parameters. The assessment of the aeration system on abiotic parameters such as dissolved oxygen, pH, total alkalinity, and nutrients is also recommended. At the present time, another aeration system is recommended for the south-central bay in Maple Lake. This technology would be useful for moving otherwise stagnant waters and in the control of filamentous algae that impair water quality and aesthetics.

Laminar flow aeration diffuser site

Benthic Barriers or Mats

Benthic Barriers are a practical and low-cost device for the prevention of aquatic plant germination in shallow swimming and beach areas. They come in many different sizes from 10X10' to a few thousand square feet. It is important to stake them into the lake bottom securely so that they do not pose a hazard to boaters or other water recreational activities. The mats may also serve to keep sediment re-suspension down, which reduces the turbidity of the water in nearshore areas. In Michigan, a minor permit from the Department of Environmental Quality (MDEQ) is required under Part 301 of Inland Lakes and Streams, and is simple to fill out.

Benthic barriers being installed on an inland lake.

Suction Dredging

Suction dredging removes sediment accumulations in small areas and can be costly. However, it can also be useful for the removal of thick sediment deposits that impair water quality in nearshore areas. The north-east end of Maple Lake contains thick sediments nearshore that allow the water in the region to become stagnant and accumulate filamentous algae, aquatic vegetation, and other debris. This area is too shallow for a laminar flow system and would best be improved by removing the excess sediments with the use of a suction dredge. This activity is also regulated by the MDEQ and requires a joint permit between the MDEQ and the U.S. Army Corps of Engineers (USACE).

A Suction Dredger for removal of sediment and nuisance vegetation

Purple Loosestrife Removal

Although liquid formulations of Triclopyr are highly effective on large stands of Purple Loosestrife, there are two other major removal methods including hand-removal and biological control with the beetle, Galerucella sp. Unfortunately, the beetle requires a fairly dense stand to maintain its population and the Purple Loosestrife population around the shoreline of Maple Lake is sparse. As a result, hand-pulling with the use of local volunteers is the most recommended option to reduce chemical herbicide costs onshore and utilize them best in submersed areas where they are most needed. During the hand-pulling process, it is important to utilize a shovel to assure that the entire root masses of the plants are removed. After the plant is unearthed, it should be disposed of entirely in a plastic waste bag to avoid wind dissemination of seeds that could be transported if the plants are not contained. Waste should then be transported to a proper yard waste facility.

Mechanical Harvesting

At this time, the use of a mechanical harvester is not recommended due to the large number of obstructions present in the impounded system. Repairs to a broken harvester are highly costly and may dramatically increase cost of the harvesting efforts.

Aquatic Herbicides and Algaecides

The use of aquatic chemical herbicides is regulated by the MDEQ under Part 33 (Aquatic Nuisance) of the Natural Resources and Environmental Protection Act, P.A. 451 of 1994, and requires a permit from the Michigan Department of Environmental Quality (MDEQ). The permit contains a list of approved herbicides for a particular body of water, as well as dosage rates, treatment areas, and water use restrictions. Furthermore, residents that reside within 100 feet of the proposed treatment area must be notified at least seven days, but not more than forty-five days prior to the initial treatment date. A certified aquatic herbicide applicator usually notices the residents in advance of the proposed treatment date, and during the day of treatment. Contact and systemic aquatic herbicides are the two primary herbicide types used in aquatic systems. Contact herbicides (such as diquat at 1.5 gallons per acre, and hydrothol at 1.5-2.5 gallons per acre) cause damage to leaf and stem structures; whereas systemic herbicides (such as 2,4-D and Triclopyr) are assimilated by the plant roots and are lethal to the entire plant. Wherever possible, it is preferred to use a systemic

herbicide for longer-lasting aquatic plant control. However, there are limitations for Maple Lake since there are high abundances of monocots (i.e. pondweeds) and there are currently no systemic herbicides for the treatment of monocots. As a result of this, the use of contact herbicides is recommended for pondweed control. There are often restrictions with usage of some systemic herbicides around shoreline areas that contain shallow drinking wells. Systemic herbicides such as 2, 4-D and Triclopyr could be used to successfully treat localized or widely dispersed beds of Eurasian Watermilfoil. Triclopyr (in liquid form) should be used with an adjuvant to increase its ability to adhere to the aquatic plants. Due to the flowing nature of Maple Lake, the use of the granular Triclopyr (OTF) at 120 lbs per acre is recommended. All herbicides should be applied during calm weather conditions to minimize drift of the chemical from the treatment site. Other systemic herbicide treatments may be needed throughout the growing season as new *M. spicatum* fragments may be introduced to the lake. Algae treatments with the use of algaecides (that contain chelated copper) should be limited to extremely dense filamentous algal blooms and efforts should be taken to reduce the nutrient loads that encourage algal blooms which may require treatments.

Lake Management Method	PROS	CONS
Herbicides	fast, targeting, whole cover	costly, chemical, restrictions
Harvesting	removes organic matter, fast	messy, re-growth of plants, costly
Biocontrol	chemical-free, reproducing	costly, unpredictable, little plant death
Laminar Flow Aeration	holistic, multiple benefits	costly, complex, new research area
Suction Dredging	remove sediment in small area	costly, disruptive to benthos