INTRODUCTION

The Long Lake Preservation Association, Inc. (LLPA) contracted with Onterra in 2010 to conduct a three-year, aquatic invasive species (AIS) monitoring project for Long Lake, Fond du Lac County. Specifically, the goal of this project is to monitor and assess herbicide treatments for curly-leaf pondweed (CLP) and Eurasian water milfoil (EWM) from 2011-2013. This report discusses the first year of treatment monitoring under this WDNR grant-funded project.

Curly-leaf pondweed primarily reproduces annually via structures called turions (asexual reproductive shoots). The majority of the turions are produced along the stem in the leaf axils and fall to the bottom of the lake in late summer when the plants die back. Some turions are produced lower on the plant and along the underground rhizome. The turions lie dormant until autumn when they germinate to produce small winter foliage. While not really growing, the fact that these plants exist under the ice gives this plant a head start on outcompeting many of our native species in the spring. The intent of any CLP treatment is to kill the plants before they produce and release their turions. A single year of treatment effectively controls a single year of CLP without allowing it to produce subsequent generations. Still, the treatment areas will need to be focused on for 3-5 years until the turion base within that area is exhausted.

On April 25, 2011, Onterra ecologists visited Long Lake to conduct a meander survey of littoral areas to locate and map CLP in order to create treatment areas for 2011. Mapping of CLP in the early spring is not Onterra's standard protocol as it is difficult and sometimes impossible to accurately identify treatable areas as the plants are smaller at this time of year. Normally, CLP is mapped in mid- to late-June when these plants are at or near their peak growth. The LLPA understood that if weather or lake conditions would not permit an effective survey, no treatments would occur during the spring of 2011. During the late-April survey, despite very clear water, CLP was not able to be viewed from the surface. A submersible video camera was then lowered which revealed that the CLP was still very small and growing close to the bottom. It was determined that it was still too early to accurately assess and map CLP within the lake, and that the survey would have to be conducted a couple weeks later when the plants were higher in the water column and visible from the surface.

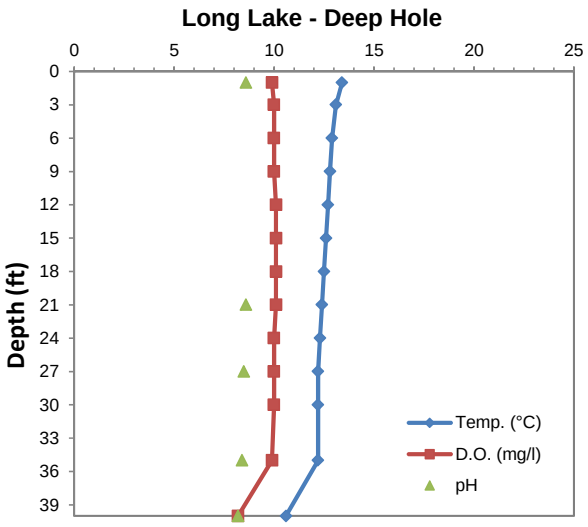


Figure 1. Temperature, dissolved oxygen, and pH profile for Long Lake – Deep Hole. May 16, 2011.

On May 4, 2011, after completing a survey on nearby Forest Lake, Onterra ecologists stopped at Long Lake to evaluate the growth stage of the CLP within the lake. At this time, water temperatures near the surface were around 48°F and it was believed the CLP needed at least one more week of growth for the crews to be able to complete the survey.

On May 16, 2011, Onterra ecologists visited Long Lake again to attempt the CLP pretreatment survey. Although not at its peak growth, the CLP had grown to sufficient levels to complete the

survey. During this survey, a temperature, dissolved oxygen, and pH profile was taken at Long Lake's deep hole site. Figure 1 shows that water surface temperatures were around 56°F. Following this survey, a treatment permit map was created with 34.5 acres of CLP treatment (Map 1).

During the herbicide application conducted by Aquatic Biologists Incorporated (ABI) on June 1, this acreage was slightly increased to 42.3 to encompass areas of CLP that were not visible during Onterra's survey. ABI reported that the treatment was conducted at approximately 1.2 gallons per acre foot or 0.9 ppm active ingredient (a.i.). The applicator reported surface water temperatures of 64°F and 10-30 mph winds out the southwest. Map 2 displays the applicator's track over the final 2011 treatment areas.

2011 TREATMENT MONITORING

The goal of any herbicide treatment is to maximize target species (normally CLP and/or EWM) mortality while minimizing impacts to valuable native aquatic plant species. Monitoring herbicide treatments and defining their success incorporates both quantitative and qualitative methods. As the name suggests, quantitative monitoring involves comparing number data (or quantities) such as plant frequency of occurrence before and after the control strategy is implemented. Qualitative monitoring is completed by comparing visual data such as EWM or CLP colony density ratings before and after the treatments.

Quantitative evaluation methodologies follow WDNR protocols in which point-intercept data is collected within treatment areas both the summer before and the summer immediately following the treatments take place. Evaluation of CLP treatments includes comparing data from a spring pretreatment survey (year of treatment) to a spring post-treatment survey (the year following treatment, but previous to that year's treatment). Because CLP naturally dies back in early summer, it is impossible to determine if the treatment was successful based upon a post-treatment survey completed during early summer. However, there was not enough time following the CLP mapping survey to collect quantitative data as the water was warming rapidly and the treatment could not be postponed. Quantitative data collection will begin in the spring of 2012.

Spatial data reflecting CLP locations were collected using a sub-meter Global Positioning System (GPS) before and after the 2011 treatment. Comparisons of the survey results are used to qualitatively evaluate the 2011 herbicide treatment on Long Lake.

2011 TREATMENT RESULTS

On June 20, 2011, Onterra ecologists visited Long Lake to complete the post-treatment assessment of the 2011 treatment areas and to conduct a lake-wide survey for CLP and EWM. Map 3 displays the results of the mid-June survey. CLP was found in many areas of Long Lake during this survey, some within treatment areas and some outside of treatment areas. Finding CLP within treatment areas can indicate the treatment was not completely effective. While it is not expected that every CLP plant be killed during a treatment, finding large numbers of plants certainly indicates failure.

It appears that the greatest treatment successes were in the very northern part of the lake from roughly the Chinatown boat landing north including the bay with the supper club (and out in front of the channel). The southernmost part of Site L-11 also seemed effective. CLP located outside of treatment areas indicates that these occurrences likely went undetected during the May pretreatment survey. A relatively large colony just north of the southern channelized area and southwest of the Town of Osceola boat landing appeared to have gone undetected during the pretreatment survey and was therefore not targeted for treatment in 2011 (Map 3). While this is unfortunate, it is a definite downfall of using an early spring survey to set up a treatment for that same spring.

2012 TREATMENT STRATEGY

Herbicides that target submersed plant species are directly applied to the water, either as a liquid or an encapsulated granular formulation. Factors such as water depth, water flow, treatment area size, and plant density work to dilute herbicide concentration within aquatic systems. Understanding concentration-exposure times are important considerations for aquatic herbicides. Successful control of the target plant is achieved when it is exposed to a lethal concentration of the herbicide for a specific duration of time. Much information has been gathered in recent years, largely as a result of a joint research project between the WDNR and US Army Corps of Engineers (USACE). Based on their preliminary findings, lake managers have adopted two main treatment strategies; 1) whole-lake treatments, and 2). spot treatments.

Whole-lake treatments are those where the herbicide is applied to specific sites, but when the herbicide reaches equilibrium within the entire volume of water (of the lake, lake basin, or within the epilimnion of the lake or lake basin); it is at a concentration that is sufficient to cause mortality to the target plant within that entire lake or basin. The application rate of whole-lake treatments is dictated by the volume of water in which the herbicide will reach equilibrium with. Because exposure time is so much greater, target herbicide levels for whole-lake treatments are 10 times less than for spot treatments.

Spot treatments are a type of control strategy where the herbicide is applied to a specific area (treatment site) such that when it dilutes from that area, its concentrations are insufficient to cause significant affects outside of that area. This is the strategy implemented on Long Lake. Spot treatments typically rely on a short exposure time (often hours) to cause mortality and therefore are applied at a much higher herbicide concentration than whole-lake treatments. For CLP, endothall is typically applied between 1.5 and 4.0 ppm a.i. in spot treatment scenarios. A newly adopted term, ‘micro-treatments’ is being used to describe very small spot treatments (working definition is less than 5 acres). Because of their small size, it is extremely difficult to predict treatment effectiveness due to rapid dilution of the herbicide. Larger treatment areas tend to be able to hold effective concentrations for a longer time.

Over half of the 2011 treatment acreage (22.8 acres) were comprised by four treatment sites (C-11, D-11, E-11, and L_1-11) that were approximately 5 acres or greater. All of these treatment sites were considered successful as evidenced by having few or no CLP occurrences within them following the treatment (Map 3). The remaining treatment areas fall into the micro-treatment subcategory. Emerging information suggests that in order for an application of 1.9 ppm a.i. endothall to be effective at controlling CLP, the concentration likely needs to be maintained for at least 8-12 hours (or longer). That length of exposure time is very difficult to achieve,

especially in micro-treatment situations. Some of the micro-treatments were shown to be effective (A-11, B-11, F-11, G-11), likely because they were all positioned in relatively sheltered areas where dilution of herbicide has been shown to be less rapid. Many of the narrow treatment sites along the western part of the lake were found to contain CLP following the treatment, likely indicating that the treatment was not completely effective in these areas.

Additional research by the USACE indicates that injured curly-leaf pondweed plants are still able to produce turions, and these stressed plants may produce even more turions in this condition (John Skogerboe, personal comm.). In these instances, the herbicide treatments may appear to be effective, but the injured plants are still able to produce turions particularly low on the plant and on the rhizome. This is always a concern when monitoring CLP treatments.

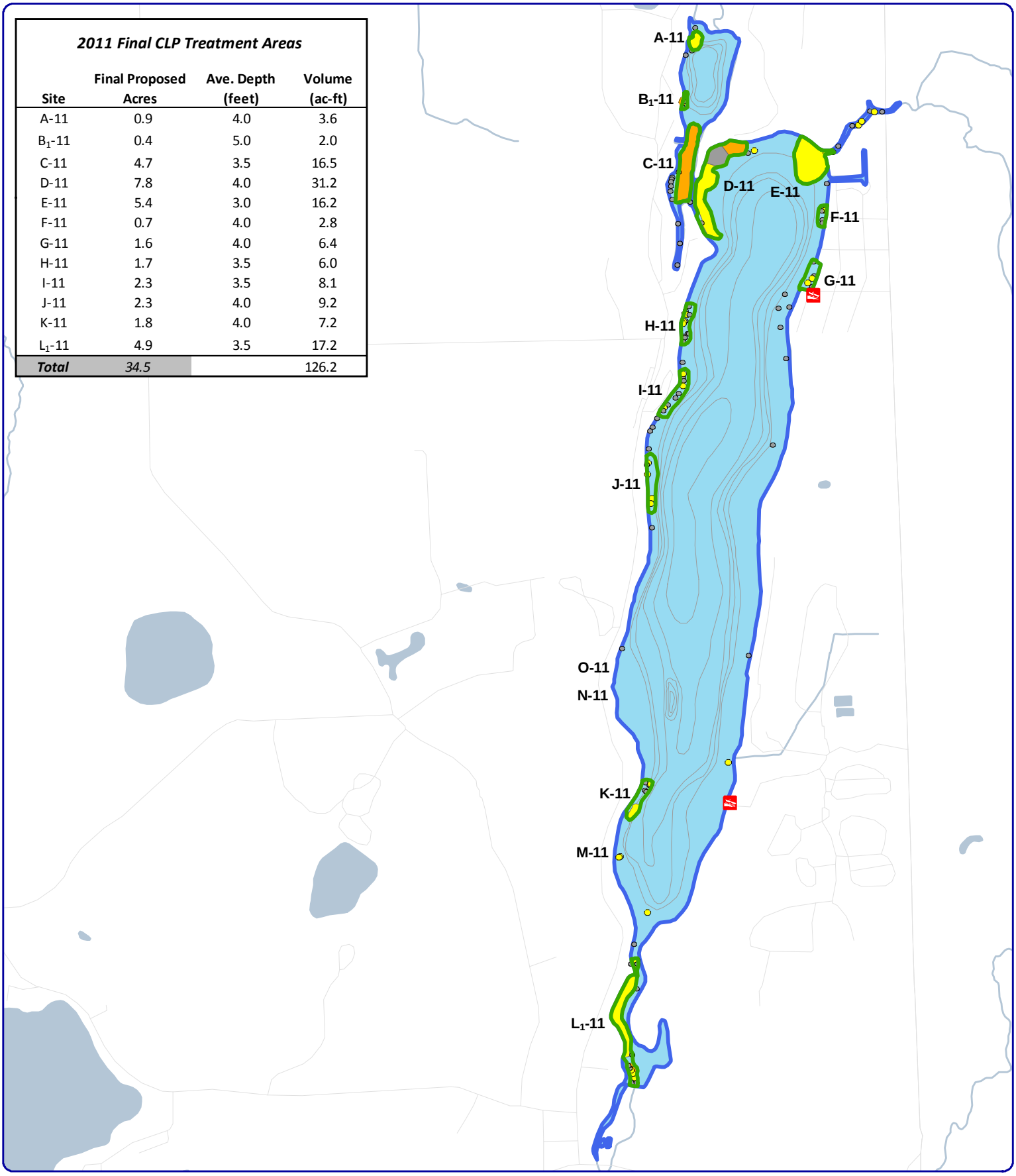
Comparisons of Map 1 and Map 3 show that many of the 2011 treatments were effective. While the 2011 treatment killed CLP that sprouted from turions in 2011, many viable turions produced in previous years are likely still present within the sediment in these areas. It is unknown exactly how long turions can remain viable in the sediment, but it is believed to be at least 3-5 years. For this reason, all of the areas that were treated in 2011 are proposed to be retreated in 2012 (Map 3). Multiple years of treatment over these same areas will need to occur to kill CLP sprouting from previously deposited turions. In total, 48.6 acres are initially proposed for treatment in 2012 (Map 3). These areas will be focused on during the spring pretreatment survey and potentially will be refined based on those survey results.

One of the major goals of this project is to monitor the treatment effectiveness and 'tune' or refine the treatment strategy in order for the most effective results to be achieved. In generally, treatment areas that are less than five acres are proposed to be treated with liquid endothall at a rate of 2.5 ppm a.i., while treatments greater than five acres will be treated at a rate of 2.0 ppm a.i. Due to its narrow width, treatment site J-12 (7.9 acres) is proposed to be treated at 2.5 ppm a.i. A few of the proposed treatment sites are approaching a point at which the herbicide application areas are too small to consistently predict if the endothall will cause CLP mortality, regardless of the dose rate. Therefore, potential treatment sites less than 0.5 acres were not proposed for treatment due to their extremely small size and unlikely nature of being successful.

Eurasian water milfoil (EWM) occurrences were also mapped during the summer of 2011. As Map 4 shows, no areas of colonized EWM were located. According the WDNR's database, EWM was first observed in Long Lake in 2002. Whole-lake point-intercept surveys were conducted by the WDNR in 2007 and 2010. EWM was not located at any of the sampling points during the 2007 survey and only located at 2 sampling locations during the 2010 survey. At this time, EWM does not appear to be rapidly spreading or colonizing large areas of Long Lake. Therefore, a EWM treatment is not proposed for 2012. However, continued monitoring will be important in shaping future management efforts.

2011 Final CLP Treatment Areas

Site	Final Proposed Acres	Ave. Depth (feet)	Volume (ac-ft)
A-11	0.9	4.0	3.6
B_1-11	0.4	5.0	2.0
C-11	4.7	3.5	16.5
D-11	7.8	4.0	31.2
E-11	5.4	3.0	16.2
F-11	0.7	4.0	2.8
G-11	1.6	4.0	6.4
H-11	1.7	3.5	6.0
I-11	2.3	3.5	8.1
J-11	2.3	4.0	9.2
K-11	1.8	4.0	7.2
L_1-11	4.9	3.5	17.2
Total	*34.5*		126.2



1,800
Feet

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Sources:
Roads and Hydro: WDNR
Aquatic Plants: Onterra, 2011
Map Date: January 18, 2012
Filename: *Map1_LongFDL_CLPMay11_T2011.mxd*

Project Location in Wisconsin

Legend

- Highly Scattered *(None)*
- Scattered
- Dominant
- Highly Dominant
- Surface Matting *(None)*
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony
- 2011 Final Proposed Treatment Area

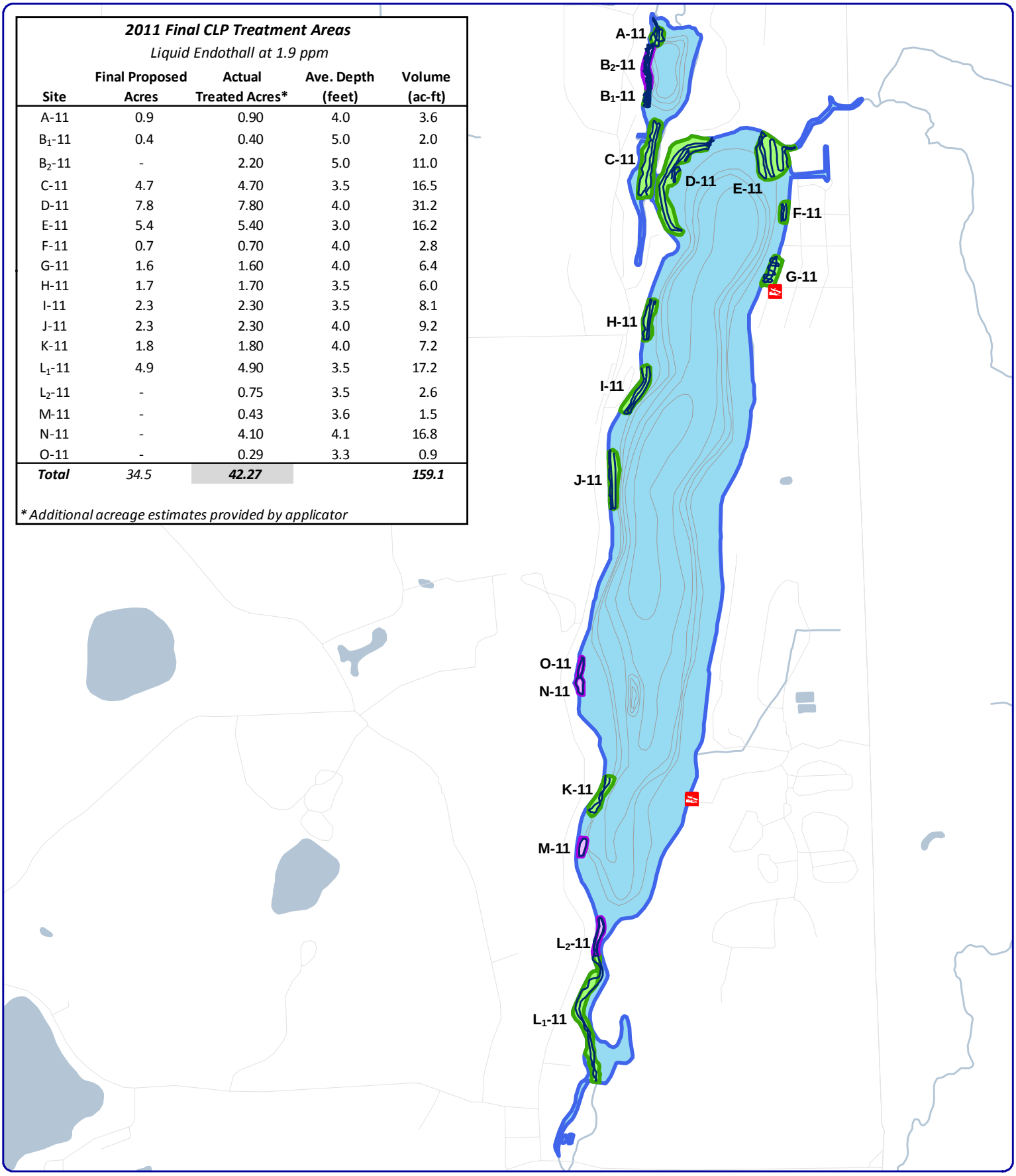
Map 1
Long Lake
Fond du Lac County, Wisconsin
May 2011
CLP Locations & Treatment Areas

2011 Final CLP Treatment Areas

Liquid Endothall at 1.9 ppm

Site	Final Proposed Acres	Actual Treated Acres*	Ave. Depth (feet)	Volume (ac-ft)
A-11	0.9	0.90	4.0	3.6
B_1-11	0.4	0.40	5.0	2.0
B_2-11	-	2.20	5.0	11.0
C-11	4.7	4.70	3.5	16.5
D-11	7.8	7.80	4.0	31.2
E-11	5.4	5.40	3.0	16.2
F-11	0.7	0.70	4.0	2.8
G-11	1.6	1.60	4.0	6.4
H-11	1.7	1.70	3.5	6.0
I-11	2.3	2.30	3.5	8.1
J-11	2.3	2.30	4.0	9.2
K-11	1.8	1.80	4.0	7.2
L_1-11	4.9	4.90	3.5	17.2
L_2-11	-	0.75	3.5	2.6
M-11	-	0.43	3.6	1.5
N-11	-	4.10	4.1	16.8
O-11	-	0.29	3.3	0.9
Total	*34.5*	***42.27***		***159.1***

** Additional acreage estimates provided by applicator*



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Feet

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Sources:
Roads and Hydro: WDNR
Aquatic Plants: Onterra, 2011
Map Date: January 18, 2012
Filename: *Map2_LongFDL_ABI_TrackLog.mxd*

Project Location in Wisconsin

Legend

- 2011 Final Proposed Treatment Area
- Treatment Area Added by ABI in the Field
- Applicator Treatment Track

Map 2

Long Lake

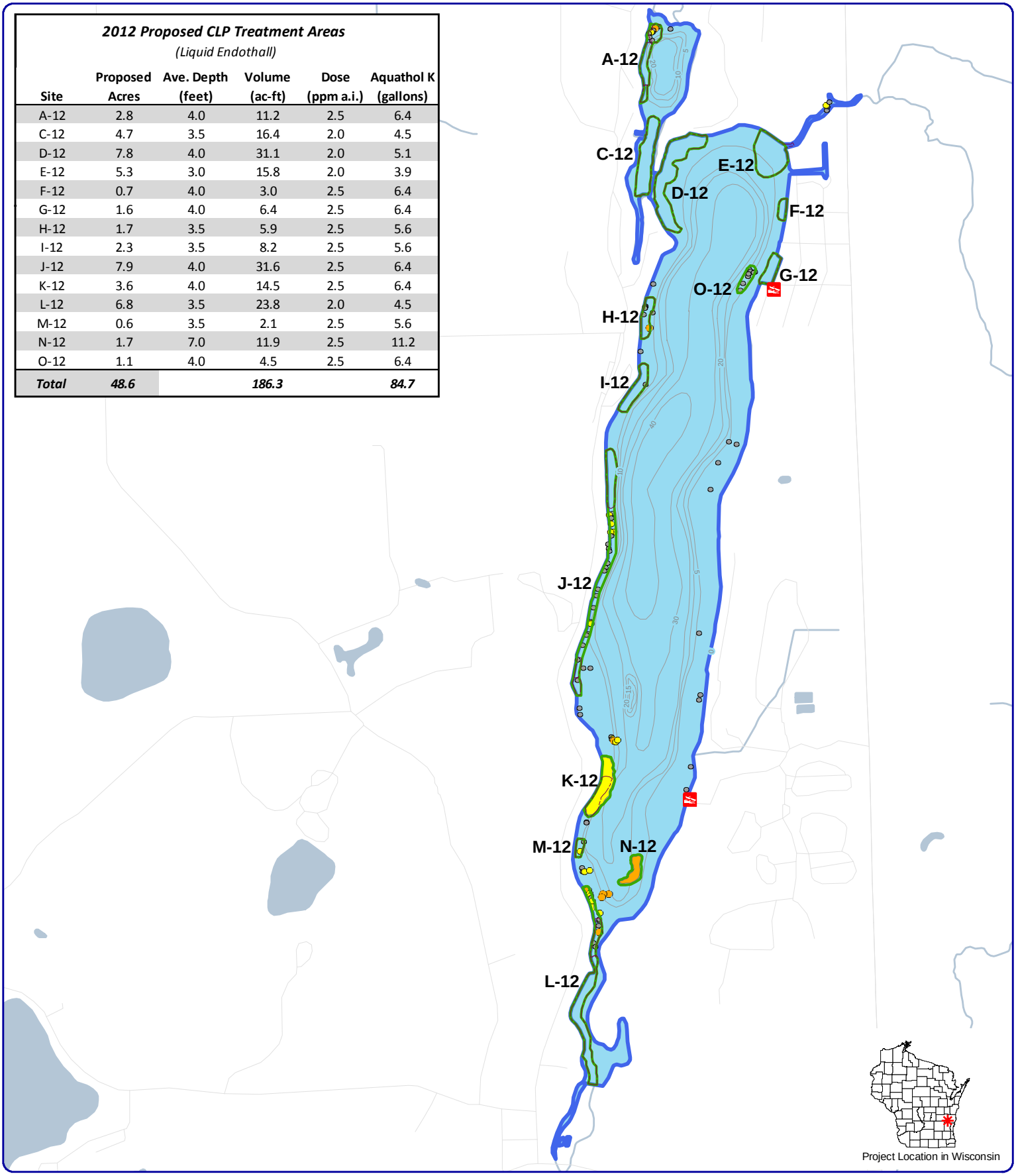
Fond du Lac County, Wisconsin

2011 Final CLP Treatment Areas & Applicator Track

2012 Proposed CLP Treatment Areas

(Liquid Endothall)

Site	Proposed Acres	Ave. Depth (feet)	Volume (ac-ft)	Dose (ppm a.i.)	Aquathol K (gallons)
A-12	2.8	4.0	11.2	2.5	6.4
C-12	4.7	3.5	16.4	2.0	4.5
D-12	7.8	4.0	31.1	2.0	5.1
E-12	5.3	3.0	15.8	2.0	3.9
F-12	0.7	4.0	3.0	2.5	6.4
G-12	1.6	4.0	6.4	2.5	6.4
H-12	1.7	3.5	5.9	2.5	5.6
I-12	2.3	3.5	8.2	2.5	5.6
J-12	7.9	4.0	31.6	2.5	6.4
K-12	3.6	4.0	14.5	2.5	6.4
L-12	6.8	3.5	23.8	2.0	4.5
M-12	0.6	3.5	2.1	2.5	5.6
N-12	1.7	7.0	11.9	2.5	11.2
O-12	1.1	4.0	4.5	2.5	6.4
Total	***48.6***		***186.3***		***84.7***



1,750

Feet

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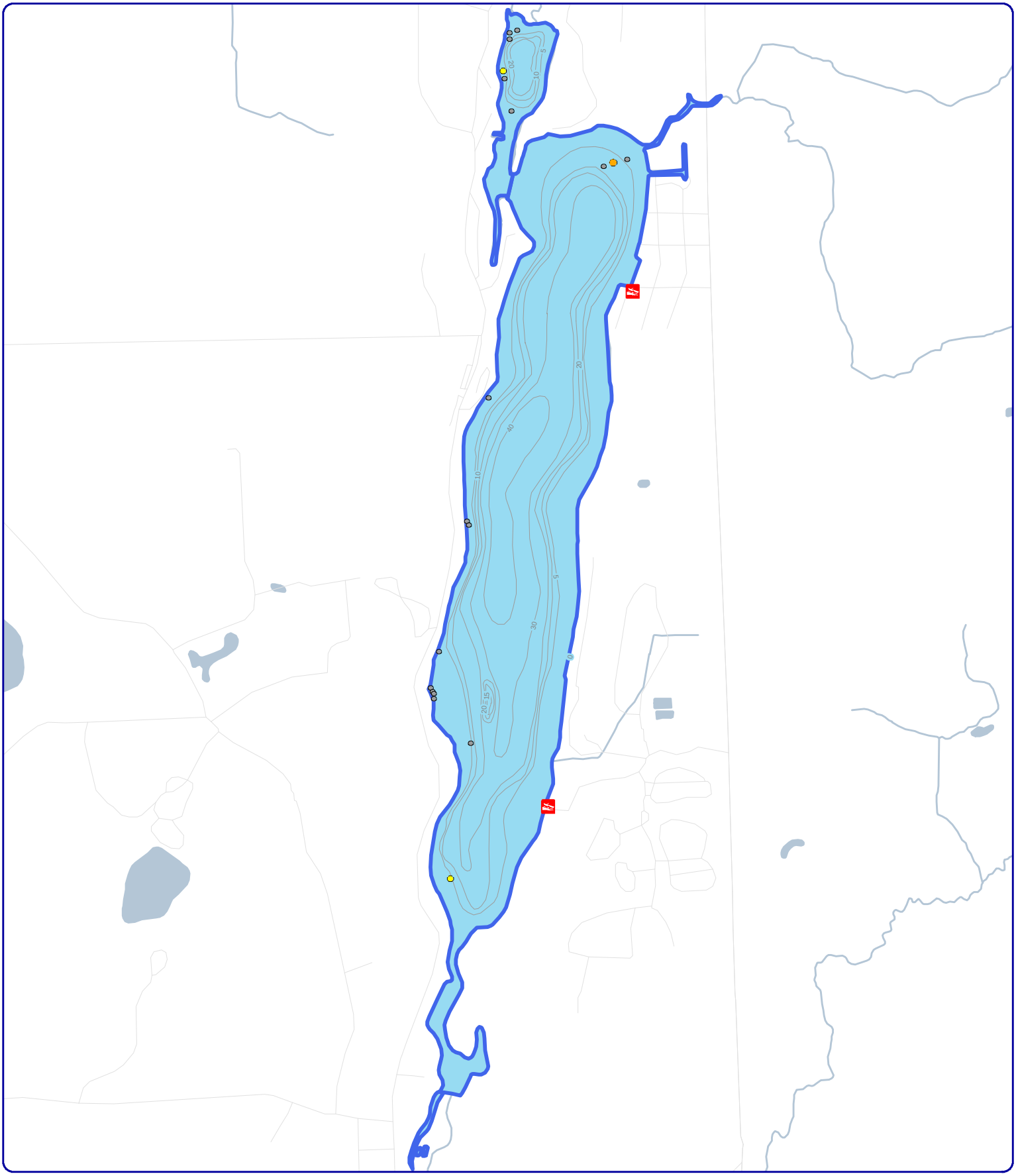
Sources:
Roads and Hyrdo: WDNR
Aquatic Plants: Onterra, 2011
Map Date: January 19, 2012
Filename: *Map3_LongFDL_CLP_T2012_Cond1.mxd*

Legend

- Highly Scattered *(None)*
- Scattered *(None)*
- Dominant
- Highly Dominant
- Surface Matting *(None)*
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony
- 2011 Final Treatment Area
- 2012 Proposed Treatment Area

Map 3
Long Lake
Fond du Lac County, Wisconsin
June 2011 CLP Locations & 2012 Proposed Treatment Areas v.1



1,900

Feet

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Sources:
Roads and Hyrdo: WDNR
Aquatic Plants: Onterra, 2011
Map Date: January 19, 2012
Filename: *Map4_LongFDL_EWMPB_June11.mxd*

Project Location in Wisconsin

Legend

- Highly Scattered *(None)*
- Scattered *(None)*
- Dominant *(None)*
- Highly Dominant *(None)*
- Surface Matting *(None)*
- Single or Few Plants
- Clumps of Plants
- Small Plant Colony

Map 4
Long Lake
Fond du Lac County, Wisconsin

2011 EWM Locations