Appendix J

2012—2020 Beaver Dam Lake EWM and CLP Treatment Plans

2012 Beaver Dam Lake Proposed Herbicide Treatment

The proposed 2012 Beaver Dam Lake herbicide treatment program includes spring treatment of 222.4 acres (Figures 1 and 2). If the 2012 summer plant survey of the lake indicates some areas need to be treated in the fall, a fall treatment of these areas will occur, provided a DNR treatment permit is obtained.

West Lake Spring Treatment

As shown in Figure 1, the proposed 2012 treatment program includes 39 acres in three West Lake treatment areas: (1) Rabbit Island Bay – 15.6 acres (located adjacent to Library Lake), (3) Williams Bay – 4.6 acres (located between Rabbit Island Bay and the Main Lake), and (4) Main West Lake – 19.0 acres (Figure 1). Liquid 2,4-D at a dose of 4 ppm is proposed for all 2012 treatment areas. Also shown on Figure 1 is the estimated post-treatment concentration of 2,4-D in the treatment areas after mixing and dilution have occurred. The expected post-treatment concentration of 2,4-D was calculated by dividing the total amount of herbicide added to the treatment area by the volume of water that could mix with the herbicide following treatment. It was assumed that stratification would occur before treatment and that only the upper 20 feet of water would mix in areas deeper than 20 feet. Hence, the volume of water used to estimate whole lake or whole bay concentration after mixing was assumed to be all water within the upper 20 feet of the treatment area. The estimated mixing depth was based upon data collected in a 2007 water quality study and was verified by herbicide residue data collected in 2011. The observed and estimated whole lake or whole bay herbicide residue concentrations in 2011 were in close agreement. Using this mixing assumption, the estimated 2,4-D concentrations in the West Lake treatment areas (i.e., whole lake or bay) after mixing has occurred are:

- West Lake – 0.06 ppm 2,4-D
- Williams Bay – 0.04 ppm 2,4-D
- Rabbit Island Bay – 0.3 ppm 2,4-D

East Lake Spring Treatment

As shown in Figure 2, the proposed 2012 treatment program includes 183.2 acres in four East Lake treatment Areas: (1) Norwegian Bay – 22.9 acres (2) East Lake – 27.5 acres (3) City Bay – 79.5 acres and Cemetery Bay – 53.4 acres. Liquid 2,4-D is proposed for all 2012 treatment areas, but the dose will vary. Proposed 2,4-D doses are:

- Norwegian Bay – 0.48 ppm
- East Lake – 4.0 ppm if the lake is not stratified and 3.6 ppm if the lake is stratified (assume stratification at 20 foot depth).

- City Bay – 0.36 ppm
- Cemetery Bay – 0.30 ppm

Temperature profiles will be measured in the Center of East Lake at the deepest location beginning a week or two after ice-out and then at a minimum of weekly intervals until shortly before treatment. The temperature data will be used to determine whether the East Lake is stratified and, if so, at what depth stratification occurs. The treatment dose in East Lake will be based upon stratification information. If at all possible, the East Lake treatment should occur when the East Lake is stratified. Situations that would require treatment before stratification occurs are (1) waiting for stratification would result in EWM growth that would result in such a large EWM biomass that a dissolved oxygen sag could occur from degradation of EWM after treatment and (2) waiting for stratification could result in such a late treatment that the native plant community could be expected to suffer harm from the treatment. Inspection of EWM growth in the East Lake will be made at the time of temperature measurement and an estimate of the average EWM plant height will be noted. Stratification information and average EWM height in the East Lake will be reported to the DNR prior to treatment.

Cemetery Bay will be treated with Endothall in addition to 2,4-D. Individually 2,4-D and Endothall control EWM and, when used in combination, are effective in EWM control. Because Cemetery Bay observed 8.45 acres of curly-leaf pondweed (CLP) during the fall of 2011, treatment with Endothall is proposed to control the CLP as well as EWM. A dose of 0.7 ppm Endothall will be used in combination with 0.3 ppm 2,4-D in Cemetery Bay.

Figure 2 shows the proposed herbicide dose for each treatment polygon as well as its area. Also shown on Figure 2 is the estimated lake-wide or bay-wide post-treatment mixing concentration of herbicide after mixing and dilution have occurred. The post-mixing concentration of 2,4-D in East Lake was calculated using both stratified and unstratified assumptions. The stratified assumption was calculated using the same method described earlier for the West Lake. The unstratified computation assumed the entire water column mixed. Norwegian Bay, City Bay, and Cemetery Bay are shallow and the entire water volume of each treatment area was used to estimate post-treatment whole bay concentrations. The estimated herbicide concentrations in the East Lake treatment areas (i.e., whole lake or bay) after mixing has occurred is:

- Norwegian Bay – 0.3 ppm 2,4-D
- East Lake – 0.3 ppm 2,4-D if treated when stratified and 0.2 ppm 2,4-D if treated when not stratified
- City Bay – 0.3 ppm 2,4-D
- Cemetery Bay – 0.3 ppm 2,4-D and 0.7 ppm Endothall

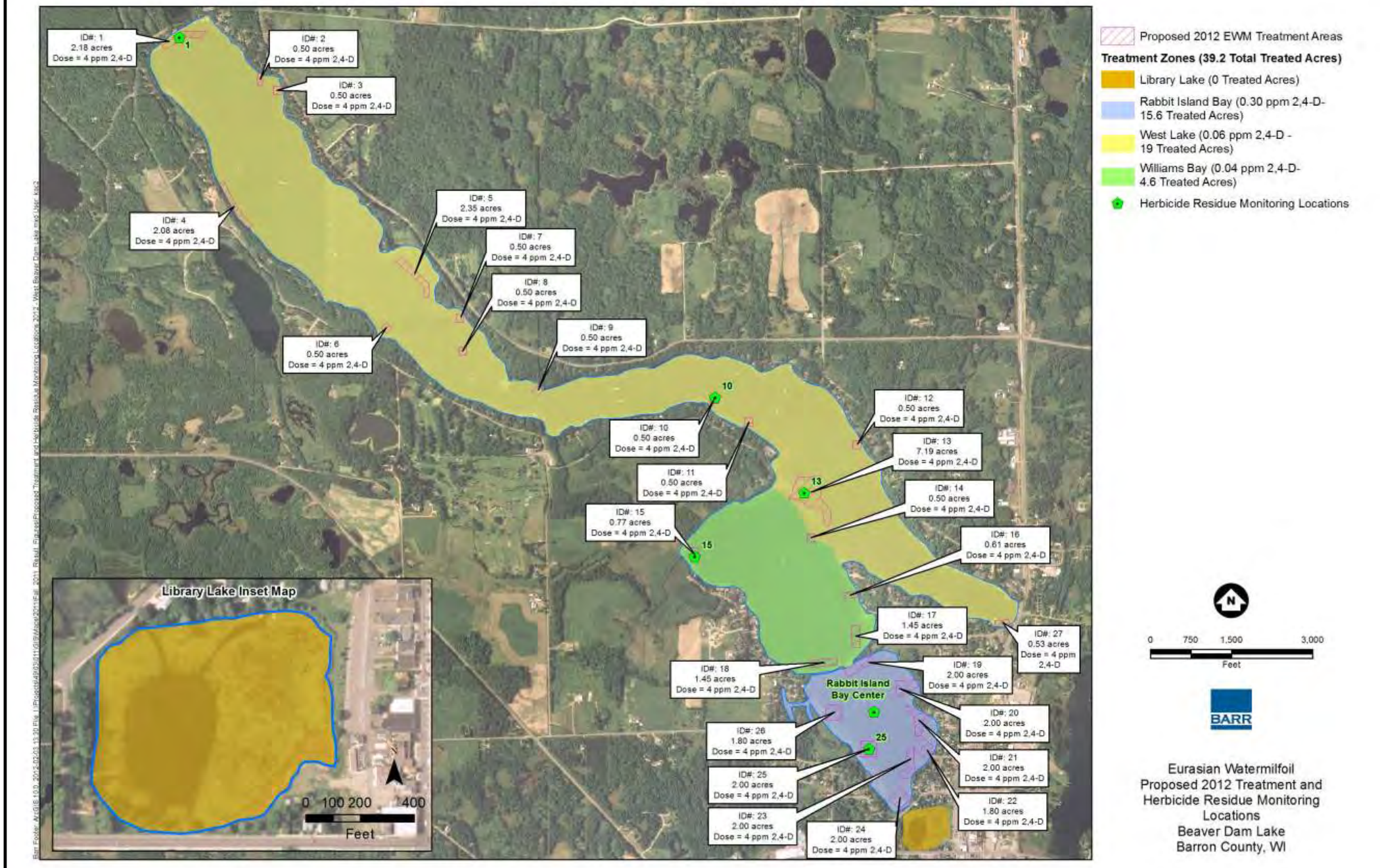

Figure 1 Proposed 2012 Beaver Dam Lake Treatment: West Lake

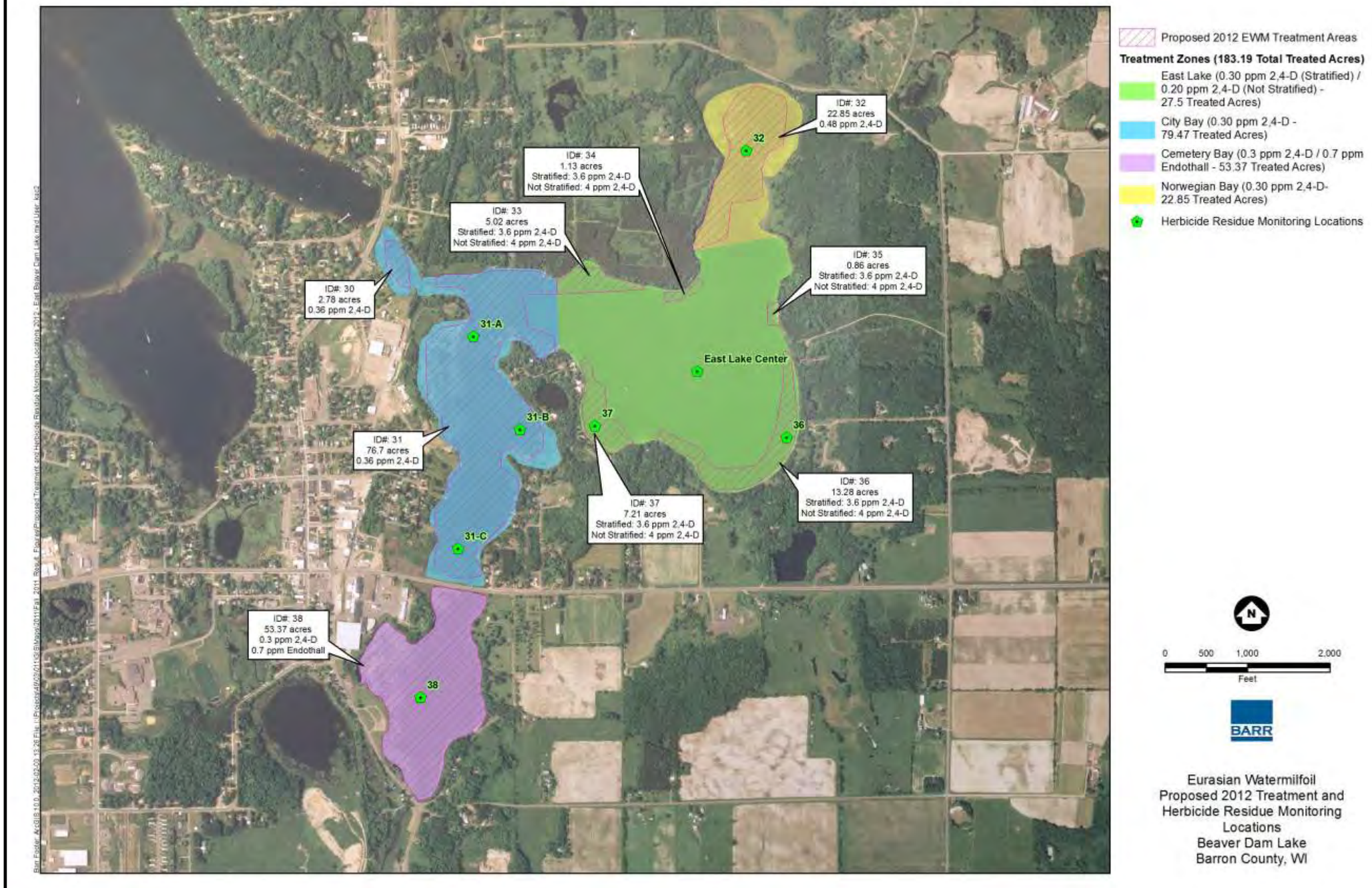

Figure 2 Proposed 2012 Beaver Dam Lake Treatment: East Lake

2012 Monitoring Program

The 2012 monitoring program to assess results of the 2012 herbicide treatment program will consist of an aquatic plant monitoring program and a herbicide residual monitoring program.

Aquatic Plant Monitoring Program

The 2012 aquatic plant monitoring program will duplicate the 2009-2011 programs.

1. During July, a point intercept survey of about 1,339 sample points (Figure 3) will assess the entire plant community in Beaver Dam Lake. Data will be summarized in tabular format using the WDNR pre-treatment/post-treatment spreadsheet. In addition, maps will be prepared showing location and density of each species identified in the July plant survey.

2. During late October or early November, a fall point intercept survey of about 1,339 sample points (Figure 3) will assess aquatic invasive species (EWM and curly-leaf pondweed) coverage in Beaver Dam Lake. The results of the fall survey will determine 2013 treatment areas.

Herbicide Residual Monitoring Program

Herbicide residual monitoring will occur in 14 representative treatment polygons to determine whether the target dose was attained as well as the rate of herbicide decline due to dilution, mixing, and natural degradation. Monitoring locations are shown in Figures 1 and 2. Samples will be collected at mid-depth from each location. Samples will be collected from polygons in West Lake and Williams Bay during a 7 day period (Table 1). Samples from all other treatment areas will be collected during a 26 day period (Table 2). The shorter sample collection period is proposed for West Lake and Williams Bay because dilution and mixing are expected to reduce herbicide concentrations below detection limits within 7 days. Because herbicide residue is expected to be detected for a longer period of time in Rabbit Island Bay of West Lake and all East Lake treatment areas, a longer sample collection period is proposed. Specific sample collection times for the treatment areas are shown in Tables 2 and 3. Sample collection times during the first six hours after treatment will depend upon treatment completion times for individual polygons and won't be known until treatment has been completed. Hence, it is possible that the scheduled sample time could occur after dark or at an hour that is too late to be practicable for sample collection. Whenever the sample collection time occurs during non-daylight hours or during a time that is not practicable for sample collection, the sample will not be collected. In addition, if weather conditions (e.g., high winds or lightning) make sample collection unsafe during any of the scheduled times for sample collection, samples will not be collected.

Table 1 2012 Beaver Dam Lake Residual Sample Collection Times for West Lake and Williams Bay

Treatment Polygon Location and ID #	Sample Collection Times
Williams Bay – ID # 15 West Lake – Main – ID # 1, 10, and 13	Hours After Treatment
	1-3
	4-6
	Days After Treatment
	1
	2
	3
	5
	7

Table 2 2012 Beaver Dam Lake Herbicide Residual Sample Collection Times for Rabbit Island Bay in West Lake and for East Lake Treatment Areas

Treatment Polygon Location and ID #	Sample Collection Times
West Lake Locations: Rabbit Island Bay – ID# 25 and Rabbit Island Bay Center East Lake Locations: Norwegian Bay – ID # 32 East Lake – ID # 36, 37 and East Lake Center City Bay – ID# 31-A, 31-B, and 31-C Cemetery Bay – ID# 38	Hours After Treatment
	1-3
	4-6
	Days After Treatment
	1
	2
	3
	5
	7
	12
	19
	26

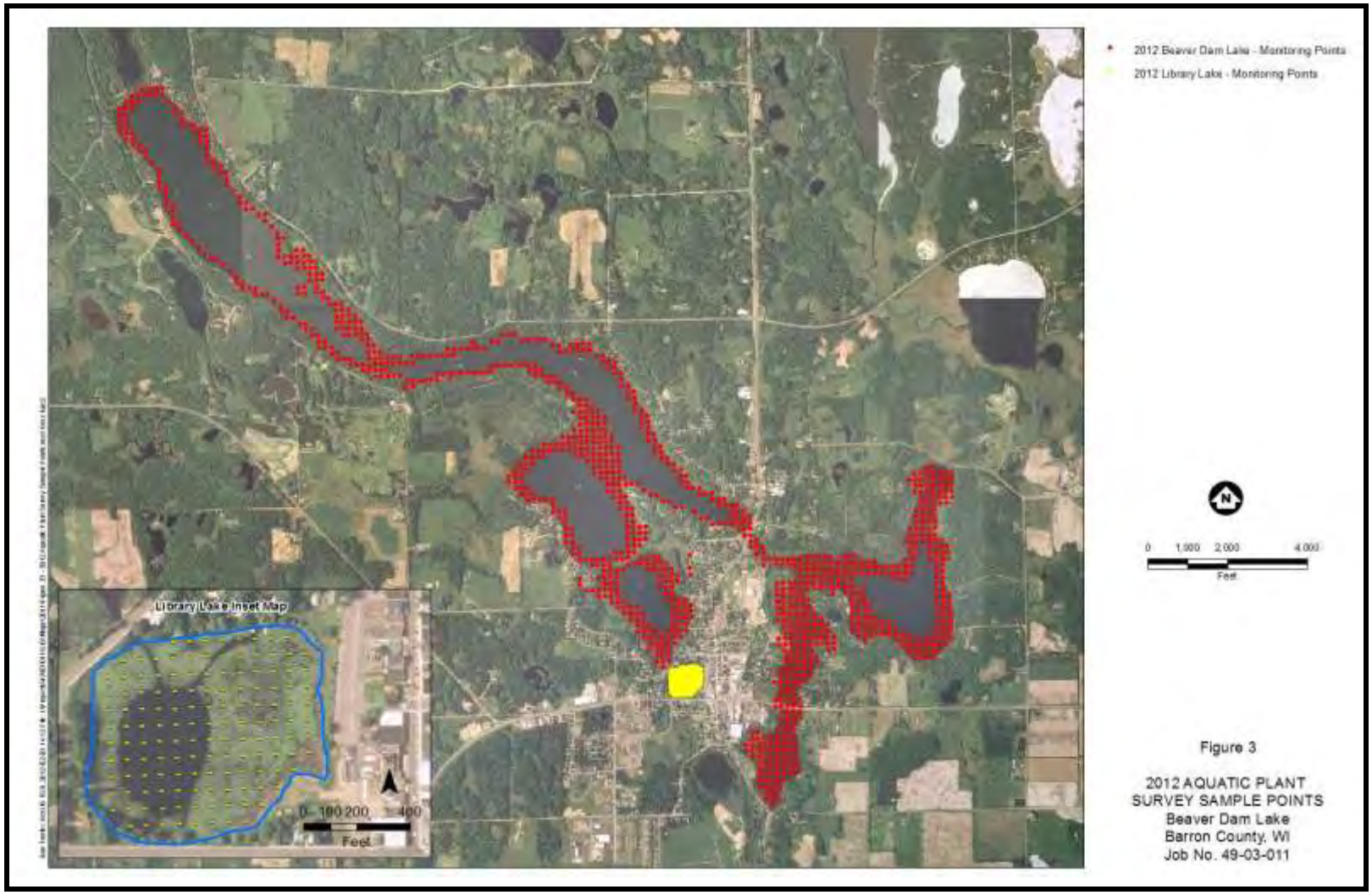

Figure 3 2012 Aquatic Plant Survey Sample Points

Memorandum

To: Beaver Dam Lake Management District (Board of Commissioners)
From: Barr Engineering Company (Meg Rattei)
Subject: 2013 Beaver Dam Lake Herbicide Treatment Plan
Date: December 11, 2012
Project: 49030011.11
c: Lake Restoration, Inc. (Kevin Kretsch, Chad Hadler) and John Skogerboe

The purpose of this memorandum is to detail the proposed 2013 Beaver Dam Lake spring herbicide treatment program and associated monitoring programs. As detailed in the Beaver Dam Lake Aquatic Plant Management Plan (APM Plan), the herbicide treatment plan for the lake is comprised of treatment plans for each of the eight treatment areas within the lake (Figure 1). The herbicide dose selected for each treatment area is based upon a threshold lake wide herbicide concentration that will attain control of the target plant species. Whenever it is not possible to attain a lake wide herbicide concentration that will attain control of the target plant species, the maximum allowable dose is applied to treatment areas. The proposed 2013 Beaver Dam Lake herbicide treatment program includes spring treatment for Eurasian watermilfoil (EWM) and curly-leaf pondweed (CLP).

1.0 EWM Treatment

As detailed in the Beaver Dam Lake APM Plan, the lake-wide goal of EWM treatment is to reduce EWM to a frequency of occurrence of 10 percent of the littoral area, which is defined as the area of the lake up to 20 feet deep. The 2013 Beaver Dam Lake EWM treatment program includes spring treatment of 247.13 acres (Figures 2 and 3). The four West Lake treatment areas total 64.92 acres and the four East Lake treatment areas total 182.21 acres. Liquid 2,4-D will be used in all treatment areas, but dose will vary between treatment areas. Treatment will occur after the lake stratifies to minimize the volume of water that mixes with herbicide which in turn will minimize the herbicide dose needed to attain the lake-wide herbicide concentration required for control of the target species. The eight treatment areas and 2,4-D dose for each treatment area as well as the expected whole lake concentration are summarized in Table 1.

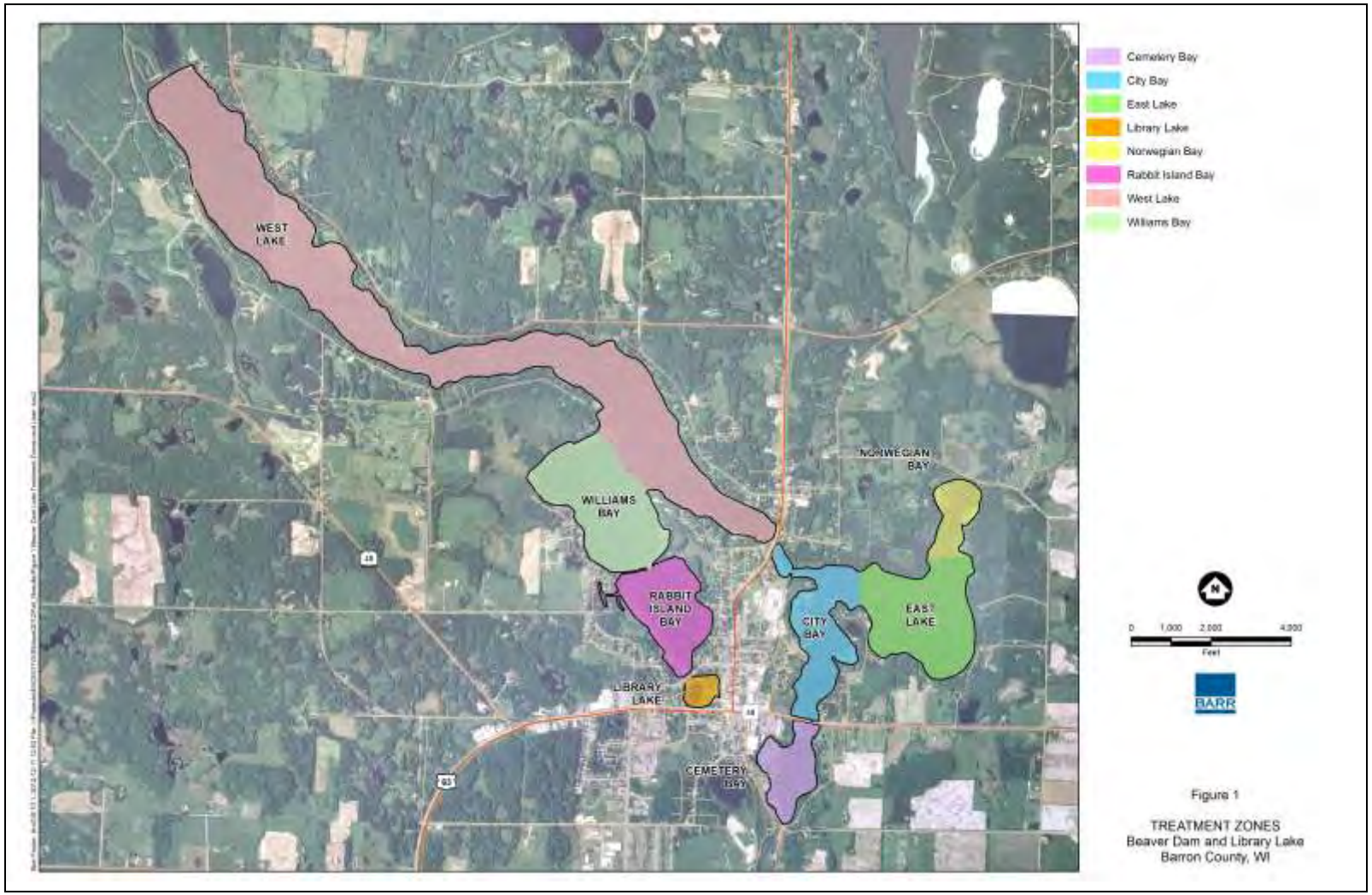

Figure 1

TREATMENT ZONES
Beaver Dam and Library Lake
Barron County, WI

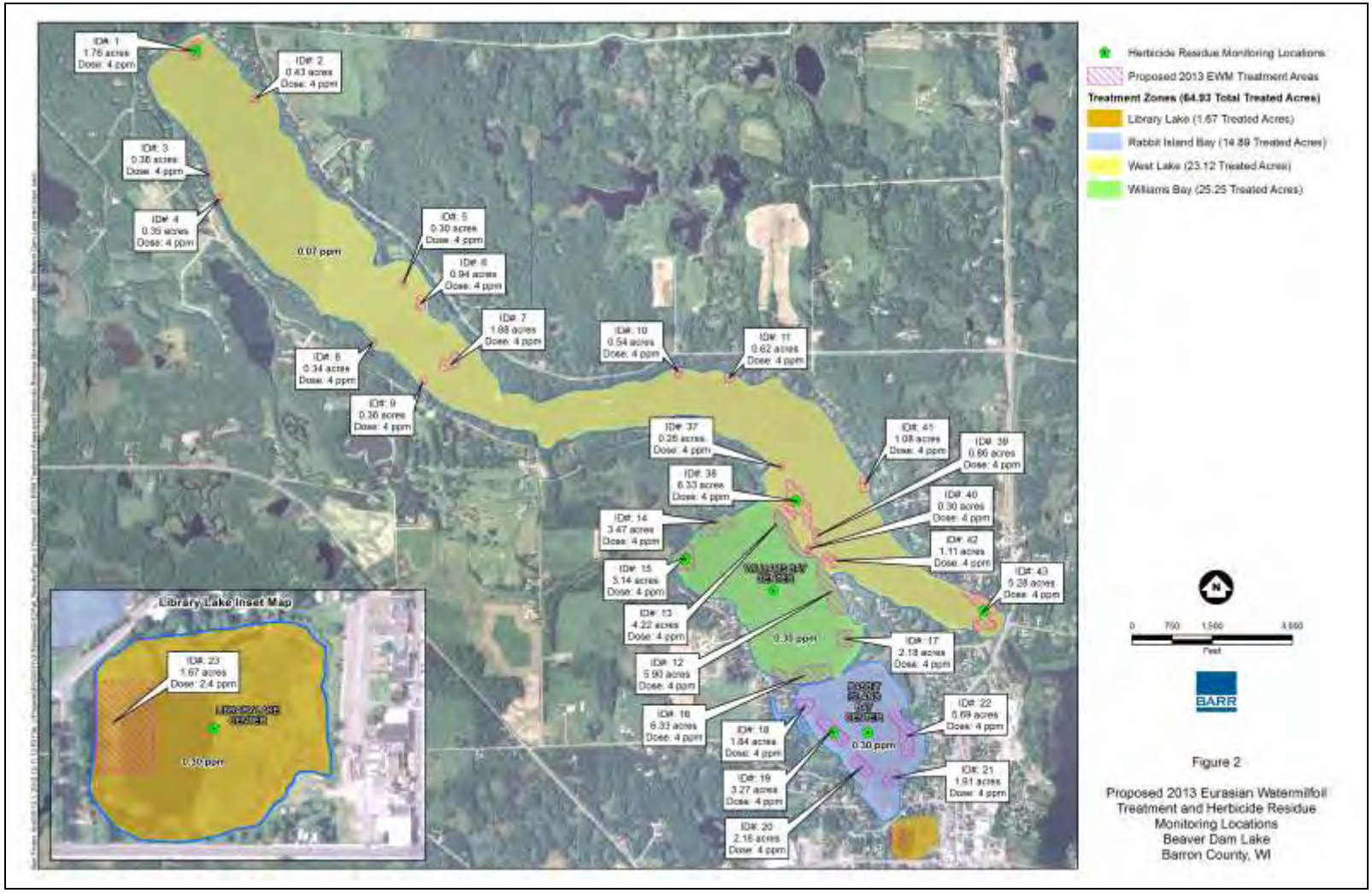

Figure 2

Proposed 2013 Eurasian Watermilfoil Treatment and Herbicide Residue Monitoring Locations
Beaver Dam Lake
Barron County, WI

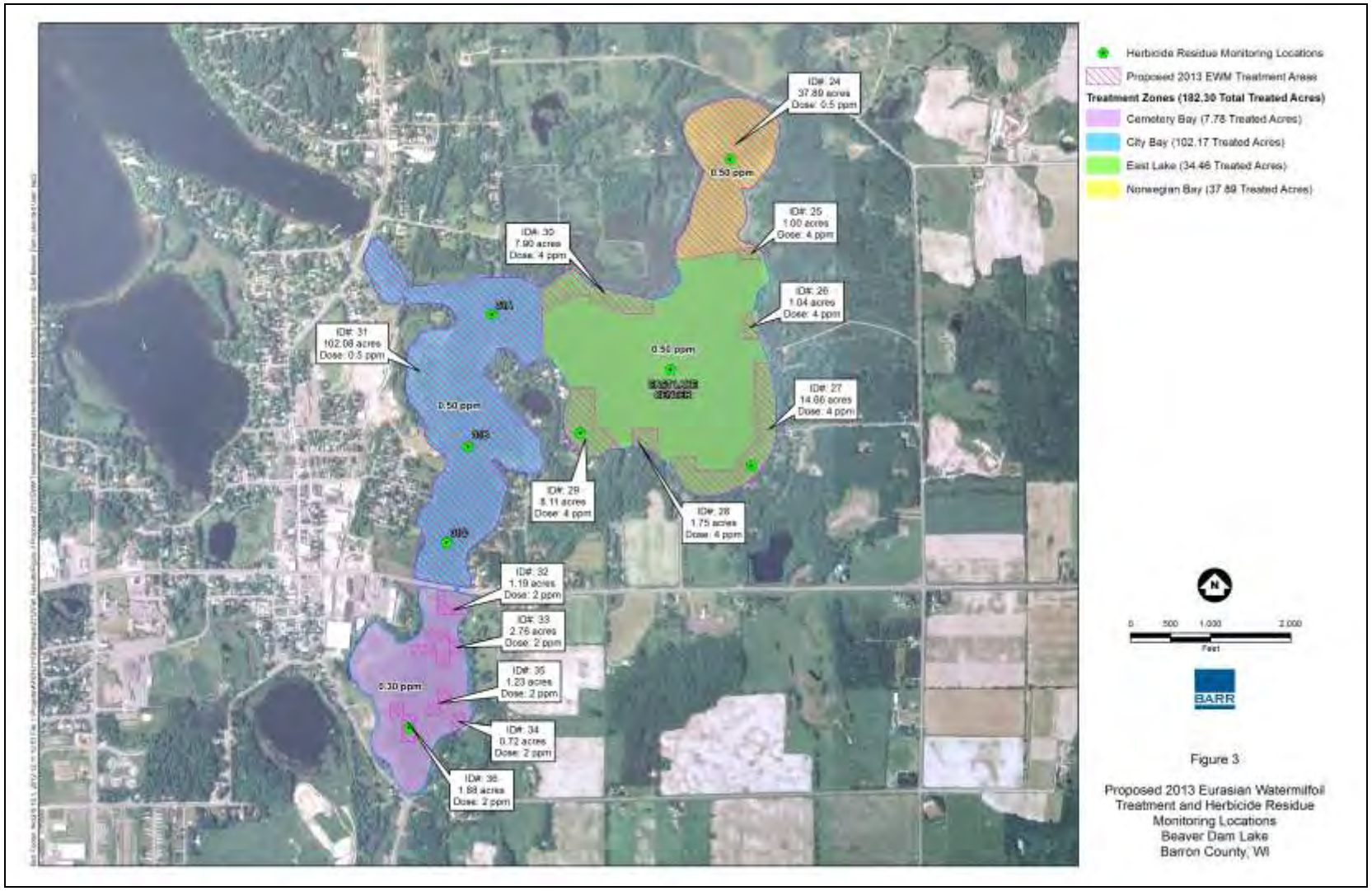

Figure 3

Proposed 2013 Eurasian Watermilfoil Treatment and Herbicide Residue Monitoring Locations
Beaver Dam Lake
Barron County, WI

Table 1 2013 EWM Treatment Plan

Treatment Area	Acres Treated	2,4-D Concentration Applied to Each Treatment Area (ppm)	Expected Lake-Concentration of 2,4-D (ppm)
West Lake Basins			
West Lake	23.12	4	0.07
Williams Bay	25.24	4	0.3
Rabbit Island Bay	14.89	4	0.3
Library Lake	1.67	2.3	0.3
East Lake Basins			
Norwegian Bay	37.89	0.5	0.5
East Lake	34.46	4	0.5
City Bay	102.08	0.5	0.5
Cemetery Bay	7.78	2	0.3

The doses shown in Table 1 and Figures 2 and 3 assume stratification will occur at the twenty-foot depth for all treatment areas with depths greater than 20 feet. If stratification occurs at a shallower depth, doses may need to be adjusted downward to attain the desired whole lake concentration shown in Table 1 and on Figures 2 and 3. To determine when stratification occurs, temperature profiles will be measured in the Center of East Lake, Rabbit Island Bay, and Williams Bay at the deepest locations beginning a week or two after ice-out and then at a minimum of weekly intervals until shortly before treatment. Prior to treatment, the stratification information will be used to determine whether an adjustment in dose is warranted in these basins.

2.0 CLP Treatment

As detailed in the Beaver Dam Lake APM Plan, the goal of the CLP treatment is to contain CLP to a frequency of occurrence less than 10 percent of the littoral area, which is defined as the area of the lake up to 20 feet deep, and to prevent the accumulation of turions, which cause future growth and expansion of CLP in the lake. This approach prevents CLP dominance and the subsequent required long-term control to hold the plant back from a resurgence to dominance. Results of June 2012 CLP surveys of Norwegian Bay, City Bay, and Rabbit Island Bay indicate problematic CLP beds extent totaled approximately 16 acres in City Bay, 10 acres in Norwegian Bay, and less than half an acre in the channels adjacent to Rabbit Island Bay (Table 2). Rabbit Island Bay did not contain problematic beds of CLP and observed a low CLP frequency of occurrence (5 percent of sample locations less than the maximum depth of plant growth). Hence, while CLP treatment of the channels adjacent to Rabbit Island Bay is necessary,

CLP treatment of Rabbit Island Bay is unwarranted. The 2013 Beaver Dam Lake CLP treatment program includes spring treatment of 26.25 acres (Figure 4). Endothall will be used in all treatment areas. The treatment areas and Endothall dose for each treatment area as well as the expected whole lake or whole channel concentration are summarized in Table 2.

Table 2 2013 CLP Treatment Plan

Treatment Area (Treatment Site ID)	Acres Treated	Endothall Concentration Applied to Each Treatment Area (ppm)	Expected Lake-or Channel Concentration of Endothall (ppm)
West Lake Treatment Areas			
Rabbit Island Bay Channel (ID 1)	0.15	3	0.31
Rabbit Island Bay Channel (ID 2)	0.28	2	0.32
East Lake Treatment Areas			
Norwegian Bay (ID 3)	9.62	2	0.44
City Bay (ID 4, 5, and 6)	16.20	2	0.39

3.0 2013 Monitoring Programs

The 2013 monitoring programs to assess results of the 2013 herbicide treatment program will consist of herbicide residue monitoring programs to monitor 2,4-D and Endothall concentrations following treatment as well as aquatic plant monitoring programs to assess treatment success and native plant response to EWM and CLP treatment programs.

3.1 Herbicide Residue Monitoring Program – 2,4-D

2,4-D herbicide residue monitoring will occur in 17 representative locations to determine whether the target dose was attained as well as the rate of herbicide decline due to dilution, mixing, and natural degradation. Monitoring locations are shown in Figures 2 and 3. Samples will be collected at mid-depth from each location. Samples will be collected from polygons in West Lake during a 7 day period (Table 3). Samples from all other treatment areas will be collected during a 26 day period (Table 3). The shorter sample collection period is proposed for West Lake because dilution and mixing are expected to reduce herbicide concentrations below detection limits within 7 days. Because herbicide residue is expected to be detected for a longer period of time in the other treatment areas, a longer sample collection period is proposed. Specific sample collection times for the treatment areas are shown in Table 3. It should be noted that (1) if the sample collection time for 1 and 4 hours after treatment occurs after dark, the sample

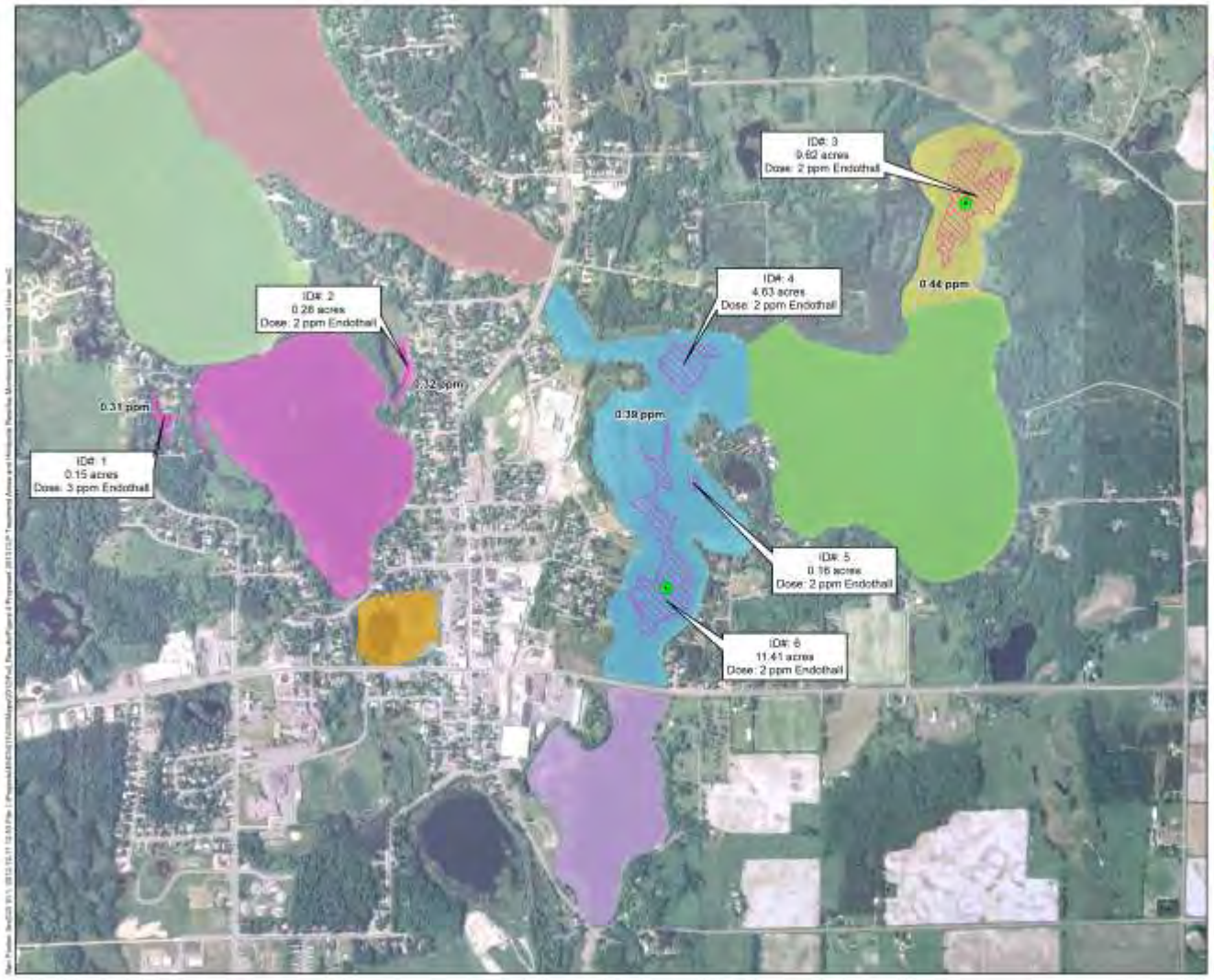

Figure 4

Proposed 2013 Curly-leaf Pondweed Treatment and Herbicide Residue Monitoring Locations
Beaver Dam and Library Lake
Barron County, WI

will not be collected; (2) if weather conditions make sample collection unsafe during any of the scheduled sample collection times, samples will not be collected.

Table 3 2013 2,4-D Sample Collection Times

Treatment Area (Sample Site ID)	Sample Collection Time (Hours After Treatment)	Sample Collection Time (Days After Treatment)
West Lake Basins		
West Lake (ID 1, 38, and 43)	1,4	1, 2, 3, 5,and 7
Williams Bay (ID 15 and Williams Bay Center	1,4	1, 2, 3 5, 7, 12, 19, and 26
Rabbit Island Bay (ID 19 and Rabbit Island Bay Center)	1,4	1, 2, 3 5, 7, 12, 19, and 26
Library Lake (ID 23 and Library Lake Center)	1,4	1, 2, 3 5, 7, 12, 19, and 26
East Lake Basins		
Norwegian Bay (ID 24)	1,4	1, 2, 3 5, 7, 12, 19, and 26
East Lake (ID 27, 29, and East Lake Center)	1,4	1, 2, 3 5, 7, 12, 19, and 26
City Bay (ID 31A, 31B, and 31C)	1,4	1, 2, 3 5, 7, 12, 19, and 26
Cemetery Bay (ID 36)	1,4	1, 2, 3 5, 7, 12, 19, and 26

3.2 Herbicide Residue Monitoring Program – Endothall

Endothall herbicide residue monitoring will occur in two representative locations to determine whether the target dose was attained as well as the rate of herbicide decline due to dilution, mixing, and natural degradation. Monitoring locations are shown in Figure 4. Samples will be collected at mid-depth from each location. Samples will be collected during a 26 day period (Table 4). It should be noted that (1) if the sample collection time for 1 and 4 hours after treatment occurs after dark, the sample will not be collected; (2) if weather conditions make sample collection unsafe during any of the scheduled sample collection times, samples will not be collected.

Table 4 2013 Endothall Sample Collection Times

Treatment Area (Sample Site ID)	Sample Collection Time (Hours After Treatment)	Sample Collection Time (Days After Treatment)
East Lake Basins		
Norwegian Bay (ID 3)	1,4	1, 2, 3 5, 7, 12, 19, and 26
City Bay (ID 6)	1,4	1, 2, 3 5, 7, 12, 19, and 26

3.3 Aquatic Plant Monitoring Programs

The 2013 aquatic plant monitoring programs will include a July survey of all plant species, an October survey of aquatic invasive species (EWM and CLP), an early spring pre-treatment survey of CLP treatment areas, and a June post-treatment survey of CLP treatment areas. In addition, a couple areas will be surveyed in June to determine whether CLP is problematic and in need of treatment during 2014. Details of the aquatic plant monitoring programs follow.

3.3.1 July Aquatic Plant Survey – All Species

During July, a point intercept survey of about 1,339 sample points will assess the entire plant community in Beaver Dam Lake. The survey will also include bed mapping of EWM beds. Maps showing the sample locations are found in Appendix E of the Beaver Dam Lake Aquatic Plant Management Plan. Data will be summarized in tabular format using the WDNR pre-treatment/post-treatment spreadsheet. Maps will be prepared showing location and density of each species identified in the July plant survey. Chi squared analysis will compare 2013 data with 2012 data to identify significant changes in frequency of occurrence of native species. The July monitoring program duplicates monitoring programs completed during 2009 through 2012, except that EWM bed mapping will be completed for the first time in 2013.

3.3.2 Fall Aquatic Invasive Species Survey

During October, a fall point intercept survey of about 1,339 sample points will assess aquatic invasive species (EWM and CLP) coverage in Beaver Dam Lake. Maps showing the sample locations are found in Appendix E of the Beaver Dam Lake Aquatic Plant Management Plan. The results of the EWM data collected during the fall aquatic invasive species survey will determine 2014 EWM treatment areas. The results of the CLP data collected during the fall aquatic invasive species survey will be evaluated to identify areas in need of additional CLP monitoring during June of 2014 when CLP is at its peak growth stage. The fall aquatic invasive species monitoring program duplicates monitoring programs completed during 2006 through 2012.

3.3.3 Spring Pre-Treatment Aquatic Plant Survey - CLP Treatment Areas

During early spring, when the water temperature is at least 48ºF, point intercept surveys will be completed in areas that will be treated with Endothall to control CLP in 2013: Norwegian Bay, City Bay, and the channels located adjacent to Rabbit Island Bay. The surveys will verify the presence of CLP in the proposed CLP treatment areas and/or to determine warranted changes in CLP treatment areas due to changes in locations where CLP is found. In addition to fine tuning CLP treatment polygons, the pre-treatment data will be used to measure success of the CLP treatment. Pre-treatment data will be compared with post-treatment data to quantify the success of CLP treatment.

3.3.4 June Aquatic Plant Surveys and CLP Bed Mapping – CLP Treatment Areas, Cemetery Bay, and West Lake Area Near Eagle Point Boat Landing

During June, post-treatment point intercept surveys and CLP bed mapping will be completed in Norwegian Bay, City Bay, and the channels located adjacent to Rabbit Island Bay. The surveys will determine CLP treatment success and the native plant response to CLP treatment. CLP bed mapping will identify problematic CLP beds that will require treatment in 2014.

In June, point intercept surveys and CLP bed mapping will also be completed in two areas that noted CLP extents of three to five acres during the fall 2012 aquatic invasive species survey: Cemetery Bay and the area near the Eagle Point boat landing in West Lake (Figures 5 and 6). The purpose of these surveys is to define CLP coverage and density at its peak growth stage. The District will evaluate the June CLP survey data to determine whether CLP treatment during 2014 is warranted

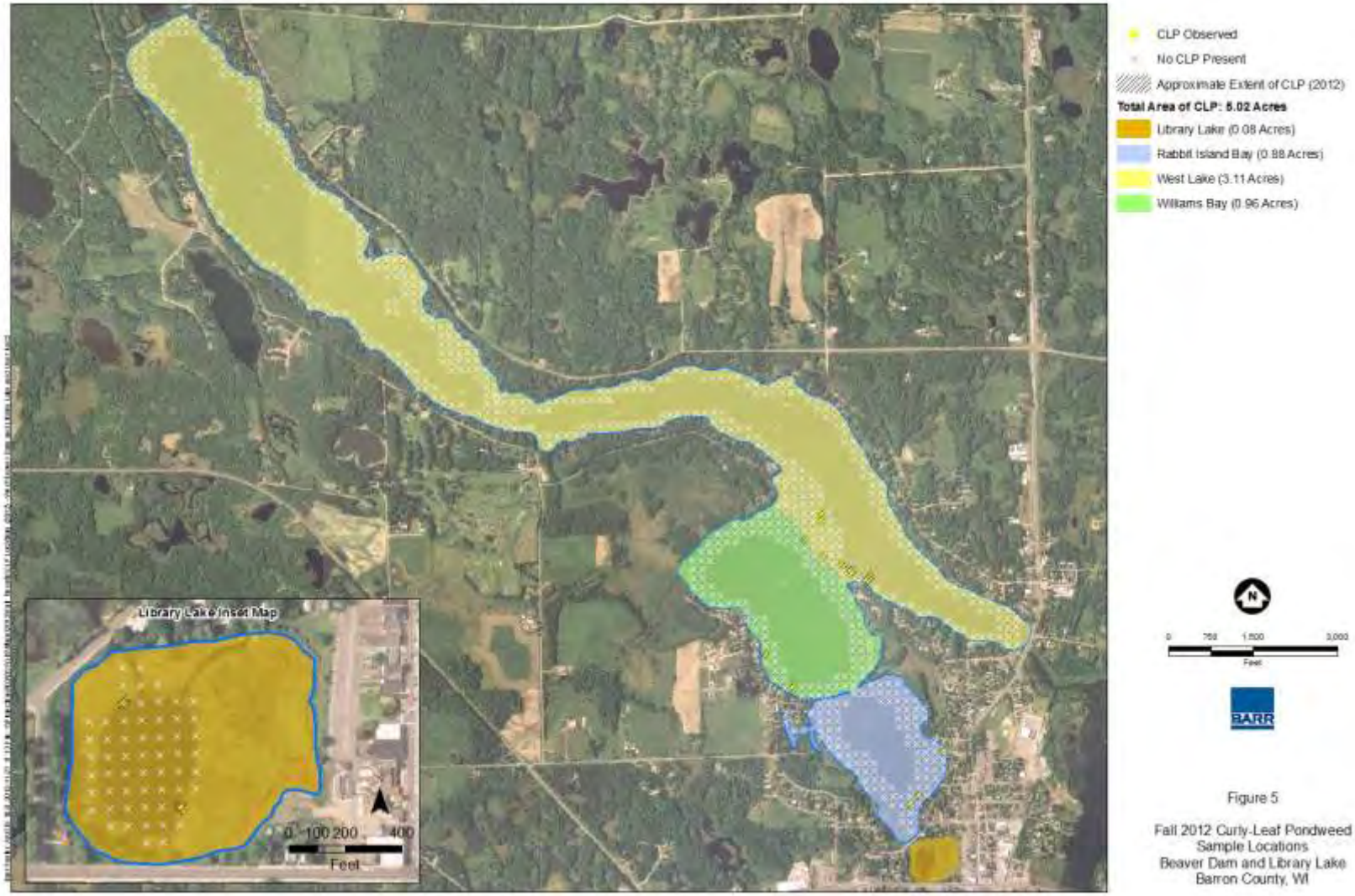

Figure 5

Fall 2012 Curly-Leaf Pondweed
Sample Locations
Beaver Dam and Library Lake
Barron County, WI

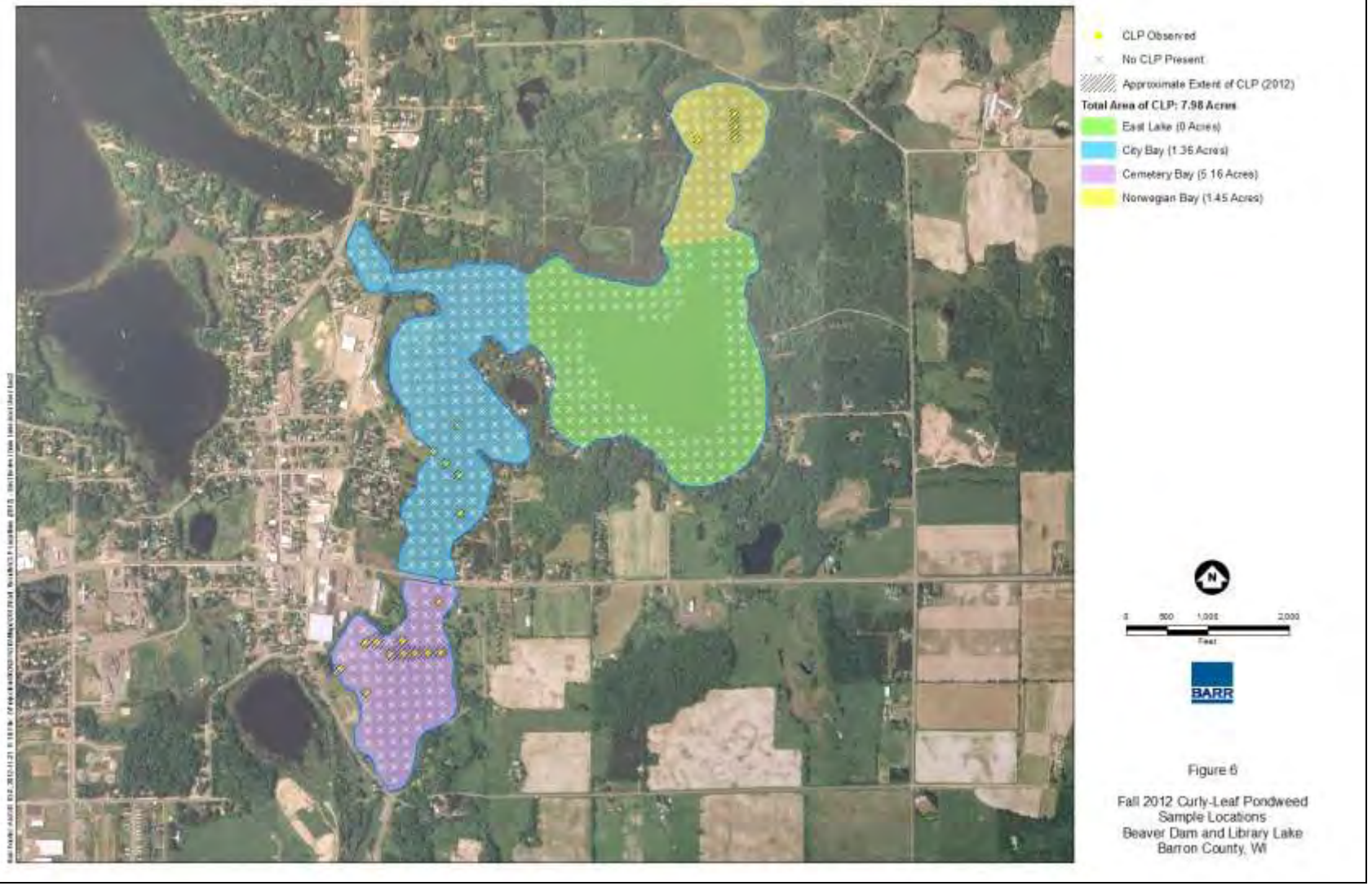

Figure 6

Fall 2012 Curly-Leaf Pondweed
Sample Locations
Beaver Dam and Library Lake
Barron County, WI

Memorandum

To: Wisconsin Department of Natural Resources (Mark Sundeen & Alex Smith)
From: Barr Engineering Company (Meg Rattei)
Subject: Beaver Dam Lake Amended CLP Herbicide Treatment Plan
Date: May 14, 2013
Project: 49030011.12
c: Lake Restoration, Inc. (Kevin Kretsch, Chad Hadler, and Jim Bartlett), John Skogerboe, and Beaver Dam Lake Management District Board (Dave Evenson, Alan Carlson, Nancy Bentz, Tom Schroeder, Paul Flottum, Don Horstman, and Bert Skinner)

The purpose of this memorandum is to present the amended CLP herbicide treatment plan for Beaver Dam Lake. Specifically, the treatment areas within Norwegian Bay, City Bay, and the channels adjacent to Rabbit Island Bay have been changed based upon the results of the May 12, 2013 pre-treatment curly-leaf pondweed (CLP) surveys. CLP was not observed in the channels adjacent to Rabbit Island Bay. Hence, there will be no CLP treatment of the channels adjacent to Rabbit Island Bay in 2013. CLP locations within Norwegian Bay and City Bay have changed since June of 2012. Hence, the treatment map has been amended to treat where CLP was observed during the May 12, 2013 plant surveys. Table 1 and Figures 1 and 2 present the amended 2013 treatment plans for Norwegian Bay and City Bay.

The amended treatment area in Norwegian Bay is essentially the same number of acres as the previous plan. The previous plan included treatment of 9.6 acres and the amended plan includes treatment of 9.7 acres. However, the specific location of the treatment area has changed (Figure 1). In both the previous and amended plans, Endothall will be used for the treatment at a dose of 2 ppm. The estimated post-treatment whole bay concentration in the previous plan was 0.44 ppm, which is very similar to the estimated post-treatment whole bay concentration in the amended plan of 0.46 ppm (Table 1).

The amended treatment area in City Bay contains a similar number of acres as the previous plan. The previous plan included treatment of 16.2 acres and the amended plan includes treatment of 19.1 acres. However, the specific location of the treatment area has changed (Figure 2). In both the previous and amended plans, Endothall will be used for the treatment at a dose of 2 ppm. The estimated post-treatment whole bay concentration in the previous plan was 0.39 ppm, which is similar to the estimated post-treatment whole bay concentration in the amended plan of 0.43 ppm (Table 1).

Because the locations of CLP have changed in Norwegian Bay and City Bay, the herbicide monitoring locations have changed accordingly. The herbicide monitoring locations of the amended CLP treatment plan are presented in Figures 1 and 2.

Table 1 Amended 2013 Beaver Dam Lake CLP Treatment Plan from May 2013 Plant Surveys

Treatment Area (Treatment Site ID)	Acres Treated	Endothall Concentration Applied to Each Treatment Area (ppm)	Expected Post-Treatment Whole Bay Concentration of Endothall (ppm)
East Lake Treatment Areas			
Norwegian Bay (ID 1)	9.7	2	0.46
City Bay (ID 2-8)	19.1	2	0.43

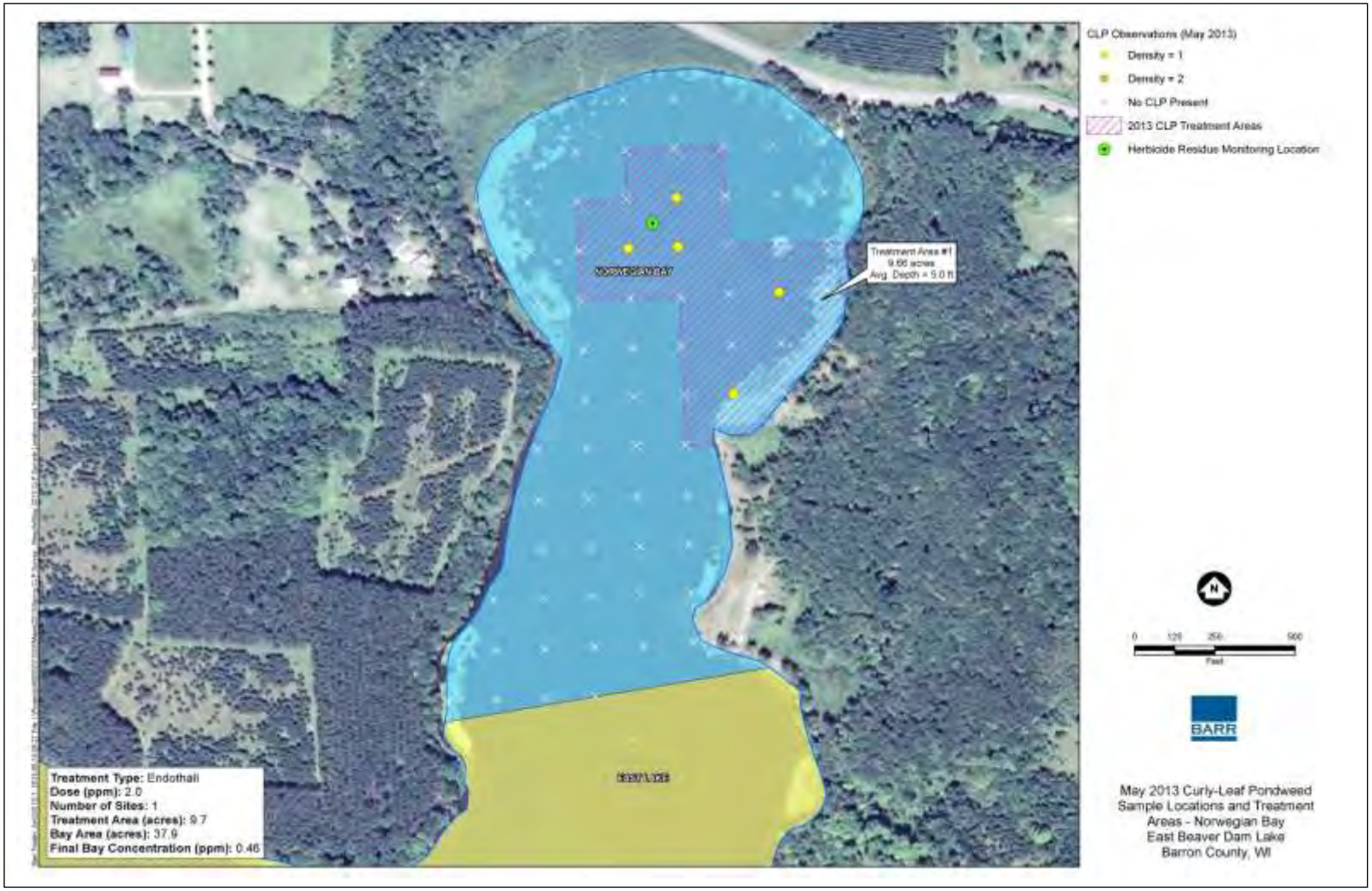

Figure 1 Amended 2013 CLP Treatment Plan for Norwegian Bay

To: Wisconsin Department of Natural Resources (Mark Sundeen and Alex Smith)
From: Barr Engineering Company (Meg Rattei)
Subject: Beaver Dam Lake Amended CLP Herbicide Treatment Plan
Date: May 14, 2013
Page: 4
Project: 49030011.12
c: Lake Restoration, Inc. (Kevin Kretsch, Chad Hadler, and Jim Bartlett), John Skogerboe, and Beaver Dam Lake Management District Board (Dave Evenson, Alan Carlson, Nancy Bentz, Tom Schroeder, Paul Flottum, Don Horstman, and Bert Skinner)

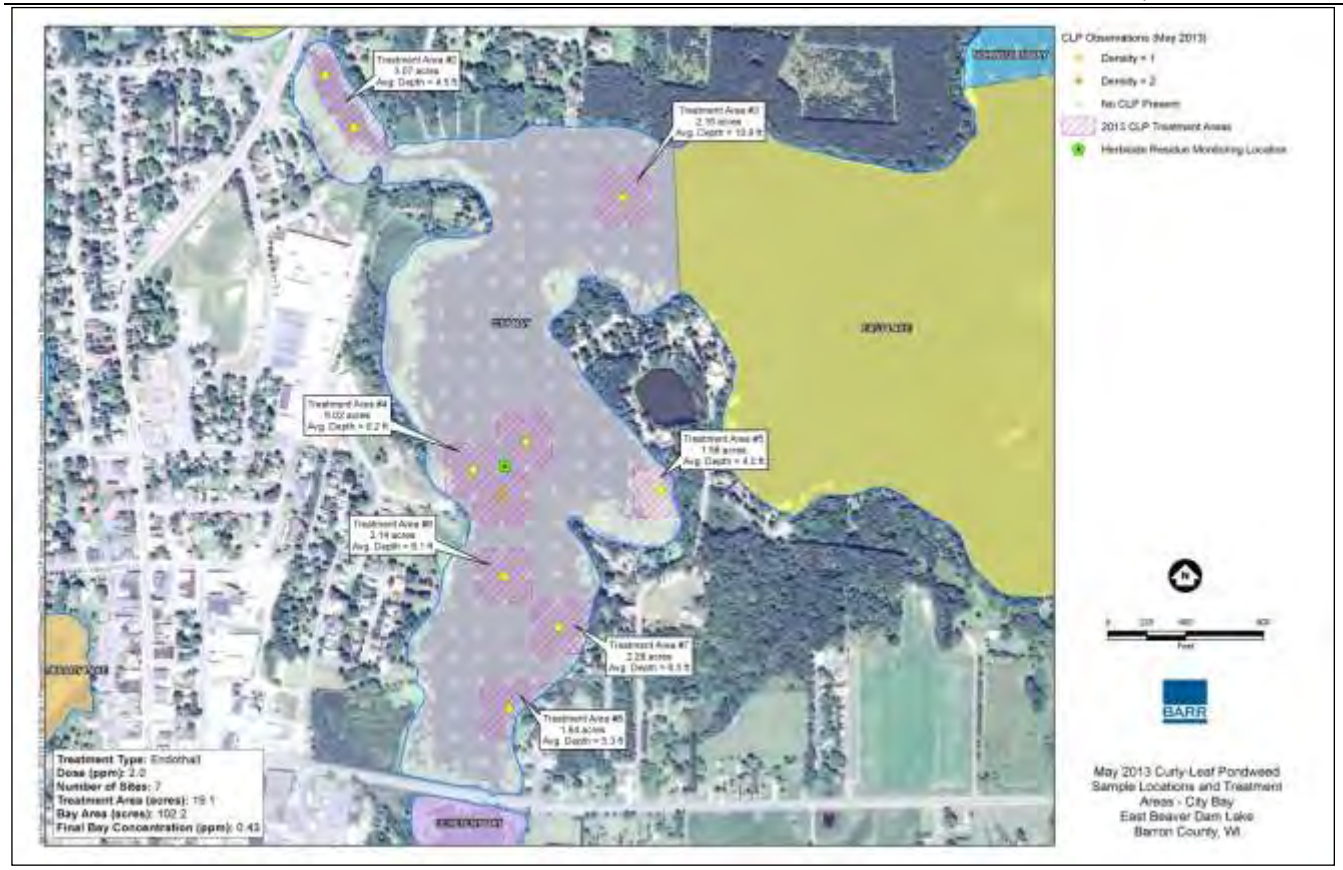

Figure 2 Amended 2013 CLP Treatment Plan for City Bay

Memorandum

To: Beaver Dam Lake Management District (Board of Commissioners)
From: Barr Engineering Company (Meg Rattei)
Subject: Proposed 2014 Beaver Dam Lake Herbicide Treatment Plan
Date: November 22, 2013
Project: 49030011.12

The purpose of this memorandum is to present:

1. Results of the fall plant survey,
2. Proposed 2014 herbicide treatment plan,
3. Proposed 2014 monitoring programs.

As detailed in the Beaver Dam Lake Aquatic Plant Management Plan (APM Plan), Beaver Dam Lake is divided into two separate basins, East Lake located east of US 63 and West Lake located west of US 63. Each basin is further divided into 4 sub basins or bays. The herbicide treatment plan for the lake is comprised of a treatment plan for each of the eight sub basins or bays within the lake (Figure 1). Hence, monitoring results are presented for each sub basin or bay.

1.0 2013 Fall Plant Survey Results

2013 fall plant survey results indicate the 2013 herbicide treatment reduced EWM frequency in the littoral area of Beaver Dam Lake by about 7 percent. The littoral area is defined as the area of the lake up to the 20 foot depth. As shown in Table 1 and Figure 2, EWM frequency of occurrence during fall of 2013 was 22 percent, an improvement from the 29 percent frequency of occurrence observed during fall of 2012.

The EWM extent data shown in Table 2 indicate the 2013 treatment reduced the percent of the littoral area infested with EWM by about 5 percent. The littoral area of Beaver Dam Lake, estimated from depth measurements made during the fall 2013 plant survey, is the 482 acre area of the lake with a depth of 20 feet or less. To determine percent of littoral area infested with EWM, the EWM extent shown in Table 2 was divided by 482, the littoral area of Beaver Dam Lake, and then multiplied by 100 to convert to percent. As shown in Figure 3, the percent of the littoral area infested with EWM in the fall of 2013 was 25 percent, an improvement from the 30 percent observed during fall of 2012.

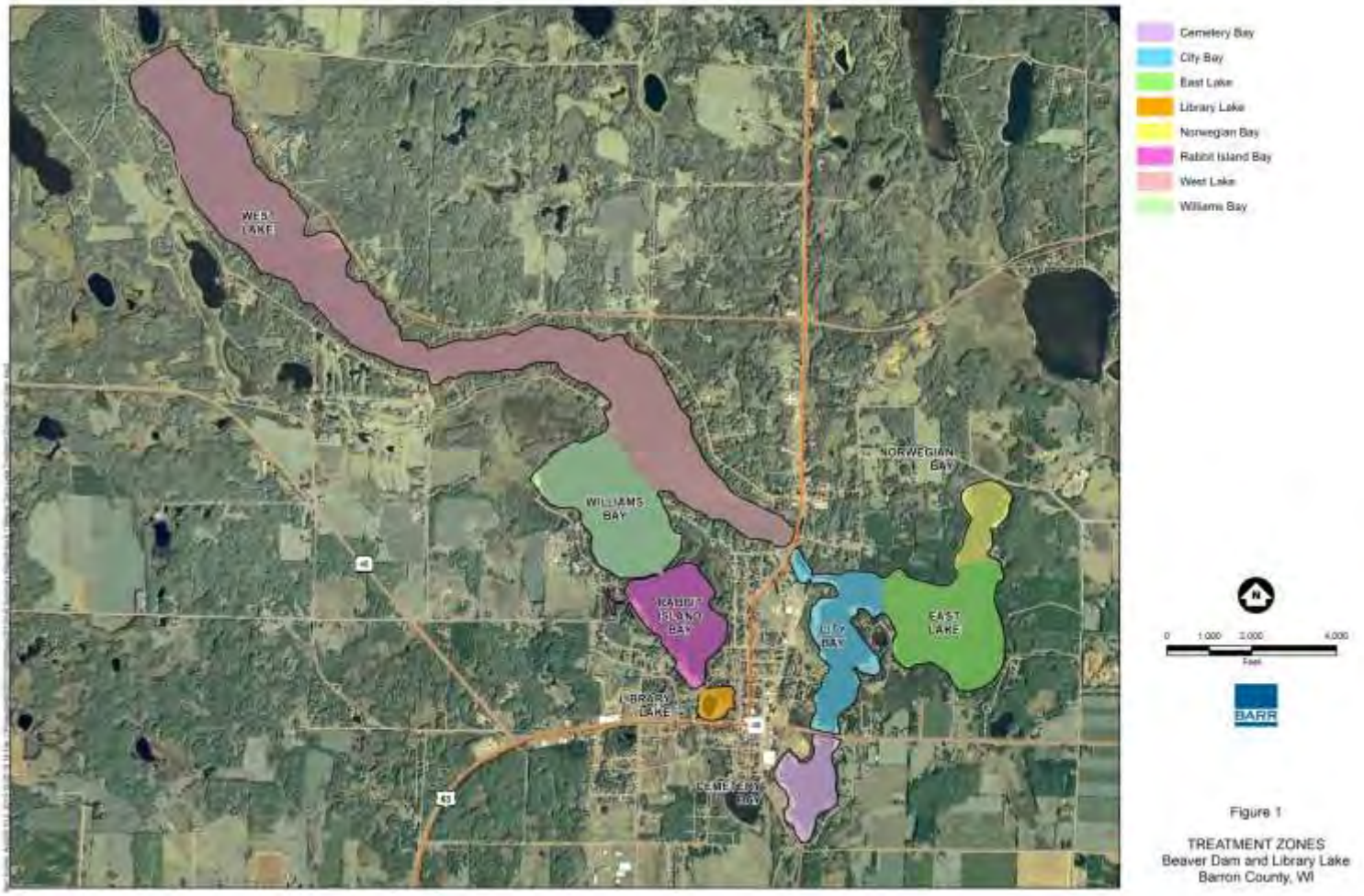

Figure 1 Beaver Dam Lake Treatment Zones

Table 1 2006-2013 Beaver Dam Lake EWM Summary

	% of Sample Points up to 20-foot depth with Eurasian watermilfoil, Including Visuals															
Location	**Fall 2006**	**Fall 2007**	**Fall 2008**	**Jul-2009**	**Fall 2009**	**July 2010**	**Fall 2010**	**July 2011**	**Fall 2011**	**June 2012**	**July 2012**	**Fall 2012**	**May 2013**	**June 2013**	**July 2013**	**Fall 2013**
West Lake	19.21	11.74	24.24	16.72	15.22	11.68	15.46	7.99	11.22	N/A	9.72	15.60	N/A	16.33	7.43	20.49
Williams Bay	15.38	29.87	26.88	19.78	12.77	4.30	14.13	11.49	11.58	N/A	4.40	17.65	N/A	4.35	1.09	7.53
Rabbit Island Bay	39.80	30.34	31.63	19.64	21.50	13.51	28.30	11.01	18.18	0.00	1.77	12.50	0.00	0.00	0.88	3.88
Library Lake	73.33	21.36	25.93	5.07	1.59	0.75	6.40	0.00	0.00	N/A	3.01	1.96	N/A	N/A	0.00	1.03
East Lake	6.06	0.00	15.20	17.65	33.91	27.83	36.54	35.40	40.83	N/A	22.03	35.45	N/A	N/A	3.57	24.79
City Bay	53.71	7.34	73.75	32.78	62.87	21.55	55.93	55.00	68.11	8.89	48.07	58.90	46.93	0.00	21.79	48.54
Norwegian Bay	26.67	16.13	49.23	39.71	78.79	33.82	28.36	11.76	51.52	13.24	54.41	72.13	39.71	0.00	7.35	63.49
Cemetery Bay	39.47	0.00	38.64	0.00	6.82	0.00	10.23	3.37	47.73	N/A	0.00	18.39	N/A	3.37	0.00	2.27
West Basins	**29.66**	**19.87**	**26.27**	**15.16**	**13.15**	**8.60**	**15.63**	**7.31**	**10.11**	N/A	**6.08**	**14.01**	**N/A**	**N/A**	**3.78**	**14.41**
East Basins	**35.61**	**5.32**	**46.35**	**23.46**	**46.33**	**20.75**	**37.84**	**33.33**	**54.68**	N/A	**32.89**	**46.32**	**N/A**	**N/A**	**10.71**	**35.08**
Beaver Dam Lake - Whole Lake	**34.58**	**14.16**	**34.82**	**18.61**	**26.90**	**13.69**	**24.63**	**18.29**	**28.68**	**N/A**	**17.59**	**28.56**	**N/A**	**N/A**	**6.65**	**22.07**

Limited areas surveyed - not the whole lake/bay area. Survey included Rabbit Island Bay channels and a small area near the Eagle Point boat landing.

Table 2 2006-2013 EWM Extent in Beaver Dam Lake

	Acreage of EWM (based on plant surveys)															
Treatment Area	**Fall 2006**	**Fall 2007**	**Fall 2008**	**July 2009**	**Fall 2009**	**July 2010**	**Fall 2010**	**July 2011**	**Fall 2011**	**June 2012**	**July 2012**	**Fall 2012**	**May 2013**	**June 2013**	**July 2013**	**Fall 2013**
West Lake	25.27	11.36	33.19	24.59	19.67	15.80	25.15	8.65	14.78	N/A	15.31	23.11	N/A	3.15	10.05	29.13
Williams Bay	3.63	10.23	12.64	9.48	4.80	1.15	6.68	4.57	4.65	N/A	1.68	6.92	N/A	0.26	0.33	2.46
Rabbit Island Bay	5.80	12.36	13.21	10.57	8.51	6.26	11.47	4.22	8.01	0	0.51	5.64	0	0	0.38	1.45
Library Lake	0.66	0.59	3.62	0.40	0.09	0.04	0.72	0.00	0.00	N/A	0.2	0.04	N/A	N/A	0.00	0.06
East Lake	0.00	0.00	9.34	8.14	19.37	14.13	17.48	17.18	23.93	N/A	11.33	19.98	N/A	N/A	1.18	15.72
City Bay	60.25	3.94	68.06	27.89	61.62	20.11	54.01	47.97	73.66	7.65	48.76	55.75	50.85	N/A	20.70	49.01
Norwegian Bay	3.64	4.75	18.12	8.65	28.23	12.09	9.61	1.99	19.67	3.36	21.21	26.91	15.16	N/A	2.19	23.37
Cemetery Bay	10.90	0.00	17.80	0.00	1.81	0.00	3.97	0.86	21.32	N/A	0	7.17	N/A	0.75	0.00	0.51
East Basins:	**74.79**	**8.69**	**113.32**	**44.68**	**111.03**	**46.33**	**85.07**	**67.99**	**138.58**	**N/A**	**81.30**	**109.81**	**N/A**	**N/A**	**24.07**	**88.60**
West Basins:	**35.36**	**34.54**	**62.66**	**45.04**	**33.07**	**23.25**	**44.02**	**17.44**	**27.44**	**N/A**	**17.70**	**35.70**	**N/A**	**N/A**	**10.76**	**33.10**
Beaver Dam Lake –Whole Lake	**110.15**	**43.23**	**175.98**	**89.72**	**144.10**	**69.58**	**129.09**	**85.43**	**166.02**	**N/A**	**99.00**	**145.51**	**N/A**	**N/A**	**35.88**	**121.70**

Limited areas surveyed - not the whole lake/bay area. Survey included Rabbit Island Bay channels and a small area near the Eagle Point boat landing.

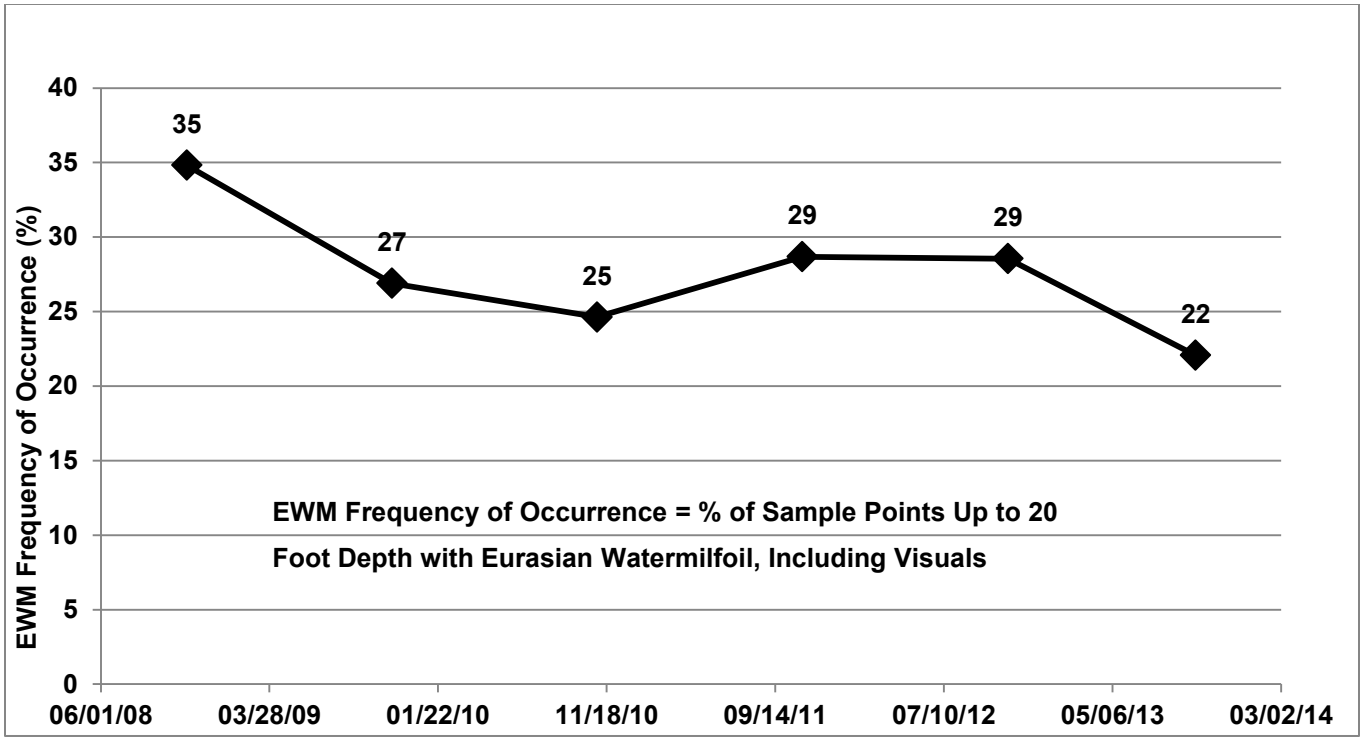

Figure 2 2008-2013 Beaver Dam Lake Eurasian Watermilfoil Frequency of Occurrence during Fall

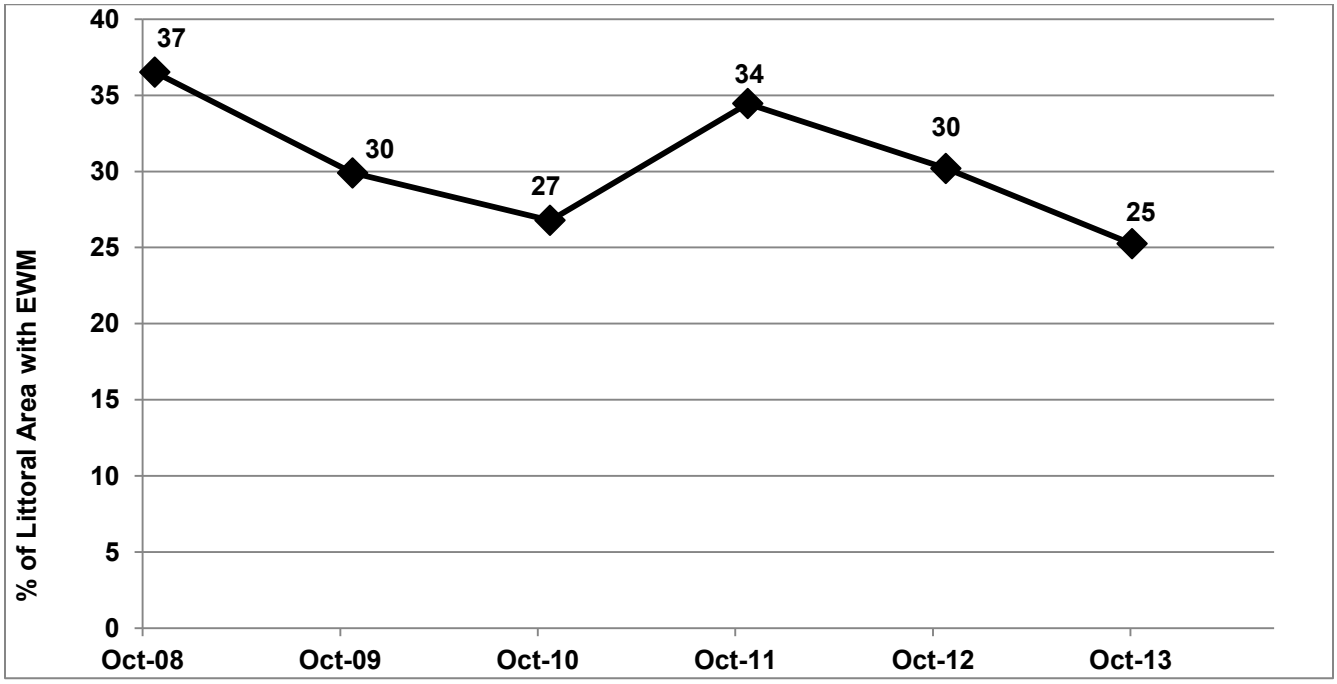

Figure 3 2008-2013 Beaver Dam Lake Percent of Littoral Area with EWM during Fall

On a lake-wide basis, EWM extent was reduced from 146 acres in fall of 2012 to 122 acres in fall of 2013. All four East Lake treatment areas observed a reduction in EWM extent in 2013. The overall change in East Lake areas was a decline in EWM extent from 110 acres in fall of 2012 to 89 acres in fall of 2013. In West Lake treatment areas, Rabbit Island Bay and Williams Bay observed a reduction in EWM extent, West Lake observed an increase in EWM extent, and EWM extent remained about the same in Library Lake. The overall change in West Lake areas was a small decline in EWM extent from 36 acres in fall of 2012 to 33 acres in fall of 2013 (Table 2).

The cause of the 2013 increase in West Lake EWM extent is likely the spread of EWM fragments by boat traffic. During navigation channel inspections during June through August, shredding and spreading of EWM fragments by boat traffic was observed at the far end of West Lake. Since the lake's flow pattern is from the west end of the lake eastward toward East Lake, EWM fragments from the far West end of the lake spread eastward populating West Lake with EWM. During fall of 2013, 72 percent of West Lake sample points with EWM were located outside of 2013 treatment areas. The data provide verification that most of the EWM in West Lake during fall resulted from the spread of EWM fragments by boat traffic. This spread increased EWM extent in West Lake from 23 acres during the fall of 2012 to 29 acres during the fall of 2013.

Boat traffic through canopied beds of EWM at the far West end of West Lake, shown above, caused the spread of EWM fragments to other parts of West Lake.

In Library Lake, EWM was found at one sample location during the fall of 2012 and 2013. Hence, EWM extent remained about the same. Because EWM was not observed in Library Lake during July, the presence of EWM in fall is likely due the spread of EWM fragments from other parts of the lake by boats conveying the fragments to Library Lake.

2013 EWM extent in Williams Bay and Rabbit Island Bay was the lowest observed during the 2006 through 2013 monitoring period. EWM extent in Williams Bay decreased from 7 acres during the fall of 2012 to 2 acres during the fall of 2013. EWM extent in Rabbit Island Bay decreased from 6 acres during the fall of 2012 to 1 acre during the fall of 2013.

In Norwegian Bay and East Lake, EWM extent was reduced more than an order of magnitude between the fall of 2012 and July of 2013. However, EWM extent increased by an order of magnitude between July and October of 2013. In City Bay, EWM extent was reduced by more than half between the fall of 2012 and July of 2013. However, EWM extent more than doubled between July and October of 2013. While no EWM was observed in Cemetery Bay during July of 2013, about half an acre of EWM was observed in October.

During the July plant survey, all EWM plants observed in Norwegian Bay, East Lake, and City Bay were new growth from old root crowns. This observation suggests the 2013 herbicide

concentrations applied to these areas were not high enough to destroy the EWM root crowns. Consequently, the viable root crowns populated these areas with EWM.

Additionally, observations made during the July plant survey and summer navigation channel inspections indicated boats were shredding and spreading EWM fragments as they proceeded through a EWM bed located east of the City Bay boat landing. EWM fragments were observed everywhere along the north shore of East Lake and the wind was funneling them towards Norwegian Bay. The combination of EWM growing from old root crowns and boats spreading EWM fragments increased EWM extent in the four East Lake areas from a total of 24 acres in July to 89 acres in October. The data verify the importance of applying a herbicide dose that is high enough to kill the EWM root crowns. Viable root crowns not only populate the lake with EWM, but boats traveling through the resultant EWM beds then shred and spread EWM fragments which further populate the lake with EWM. Despite the increase in EWM extent between summer and fall, the 2013 fall EWM extent in the four East Lake treatment areas was 21 acres lower than the 2012 fall EWM extent. Hence, the 2013 herbicide treatment resulted in an overall reduction of EWM in East Lake sub basins and bays.

All EWM observed in Norwegian Bay, East Lake, and City Bay during July was new growth from old root crowns, shown above.

2.0 Proposed 2014 EWM Treatment Plan

As detailed in the Beaver Dam Lake APM Plan, the lake-wide goal of EWM treatment is to reduce EWM to 10 percent of the littoral area. Since the lake-wide goal of 10 percent has not yet been attained, herbicide treatment in 2014 is proposed.

The 2014 Beaver Dam Lake EWM treatment program includes spring treatment of 277.91 acres (Figures 4 and 5). The four West Lake treatment areas total 95.93 acres and the four East Lake treatment areas total 181.98 acres. Liquid 2,4-D will be used in all treatment areas, but dose will vary between treatment areas:

- 4 parts per million (ppm) dose will be applied to spot treatment areas in West Lake, Williams Bay, Rabbit Island Bay, Library Lake, and East Lake
- 2 ppm dose will be applied to spot treatment areas in Cemetery Bay
- 0.6 ppm dose will be applied to Norwegian Bay and City Bay which are whole bay treatments

The 2014 treatment plan is discussed in Sections 2.1 through 2.4 and shown in Table 3 and Figures 4 and 5.

Table 3 2014 EWM Treatment Plan for Beaver Dam Lake

Treatment Area	Acres Treated	2,4-D Concentration Applied to Each Treatment Area (ppm)	Expected 2,4-D Whole Bay-Concentration (ppm)
West Lake Basins			
West Lake	65.12	4	0.3*
Williams Bay	15.95	4	0.3
Rabbit Island Bay	12.97	4	0.3
Library Lake	1.89	4	0.3
East Lake Basins			
Norwegian Bay	37.90	0.6	0.6
East Lake	33.83	4	0.6
City Bay	102.17	0.6	0.6
Cemetery Bay	8.08	2	0.3

*As detailed in Section 2.1, the West Lake post-treatment whole lake concentration is expected to be less than 0.3 ppm because a longer (e.g., 2 week) application period is required in West Lake to effectively treat EWM.

The doses shown in Table 3 and Figures 4 and 5 assume stratification will occur at the 20-foot depth for all treatment areas with depths greater than 20 feet. If stratification occurs at a deeper or shallower depth, doses may need to be adjusted accordingly to attain the desired whole lake concentration shown in Table 3 and on Figures 4 and 5. To determine when stratification occurs, temperature profiles will be measured in the Center of East Lake, Rabbit Island Bay, Williams Bay, and West Lake at the deepest locations. Measurements would begin shortly after ice-out and continue on a daily basis during the business week until the time of treatment. The stratification information will be used to determine when treatment should occur and whether dose adjustments are needed.

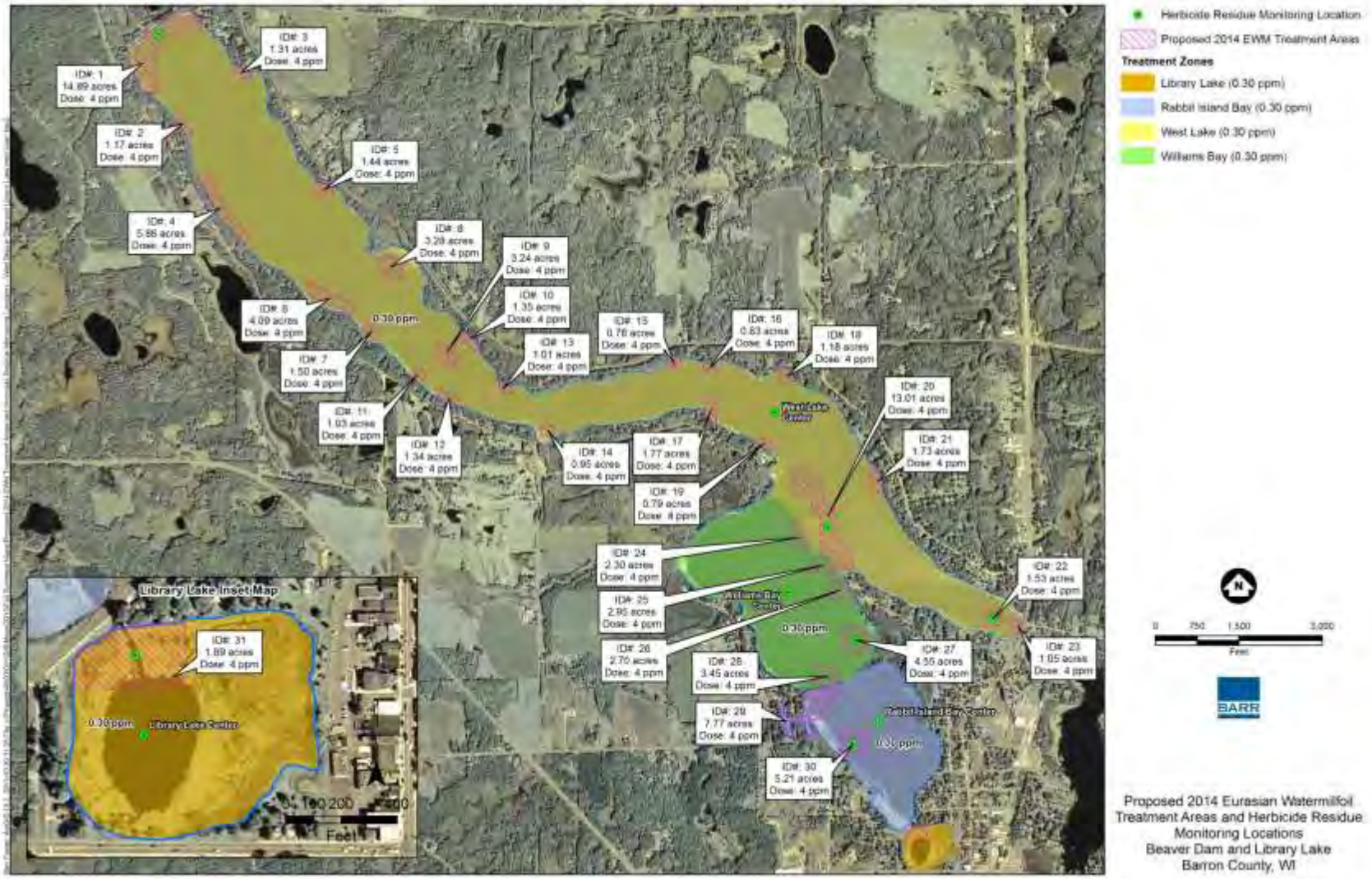

Figure 4 Proposed 2014 Treatment Plan for West Lake, Williams Bay, Rabbit Island Bay, and Library Lake

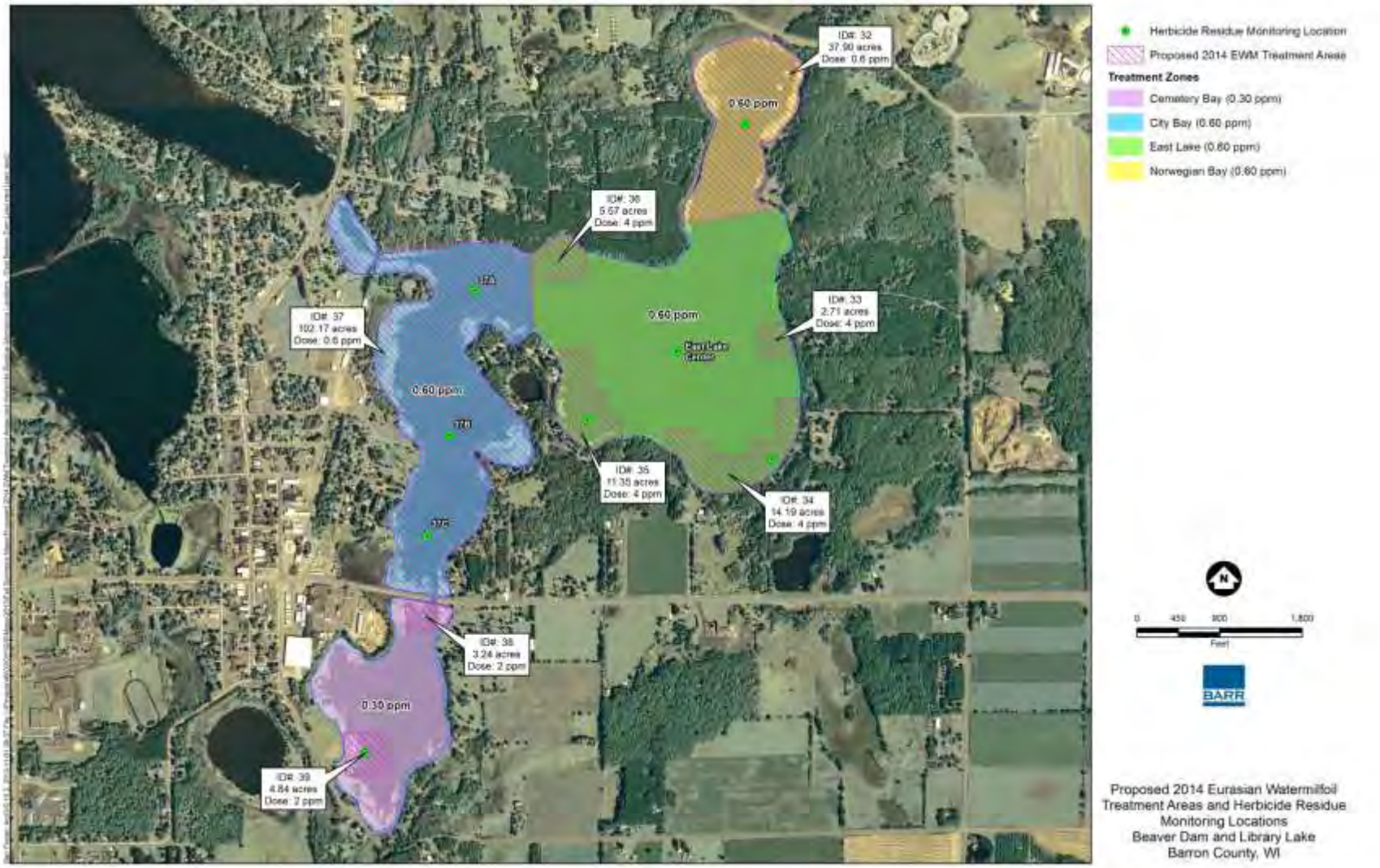

Figure 5 Proposed 2014 Treatment Plan for Norwegian Bay, East Lake, City Bay, and Cemetery Bay

2.1 West Lake

The West Lake treatment is a spot treatment with an expected bay wide 2,4-D concentration of up to 0.3 parts per million (ppm) (Figure 4).

The EWM in the West Lake sub basin grows at a range of depths, including very deep depths. EWM begins growing sooner in the shallow depths than deeper depths. The treatment approach in 2014 will be to wait until the EWM at the deeper depths reaches an ideal growth stage for treatment and then commence with treatment. To determine the ideal treatment stage, a team consisting of Lake Restoration, Inc. (applicator) and Endangered Resource Services, LLC (plant surveyor) will assess the EWM in the deeper areas. When the team concurs that the EWM is at an ideal growth stage for treatment, the herbicide treatment of West Lake will commence. It is anticipated that the treatment will occur around mid-June.

Because the timing of EWM growth and the rate of EWM growth can vary from year to year, it is possible that some deeper areas of West Lake near the sharp breaks to the deeper depths may not exhibit EWM growth when it is determined that treatment needs to commence in the rest of the lake to protect the native plant community. In the event that this scenario occurs in 2014, treatment will commence on areas exhibiting EWM growth considered ideal for treatment and areas that exhibit later EWM growth will be treated at a later time.

Although the goal of the treatment is to attain a whole bay 2,4-D concentration that is as close as possible to 0.3 ppm, there are many variables that can prevent attainment of that goal. As noted in the previous paragraph, it may not be possible to treat all of the EWM areas in the lake if deeper areas near the sharp breaks to the deeper depths begin growing so late that it becomes necessary to treat the rest of the lake in advance of these deeper areas. In that situation, the expected whole lake concentration would be expected to be below 0.3 ppm .

Due to the large size of the West Lake, it will take several days to apply the herbicide, even under ideal application conditions. Weather conditions have a great impact on West Lake and impact treatment conditions. In the event that poor weather conditions delay completion of treatment, the treatment of West Lake could be spread out over a longer time period. The whole lake concentration attained after treatment will depend upon how long it takes to complete the treatment. Increased application time may reduce the whole lake 2,4-D concentration attained after treatment. Nonetheless, the time period required for application is determined by uncontrollable factors such as weather conditions.

West Lake is not only large in size, but is a deep lake containing two bays around 100 feet deep. The treatment will be completed after stratification has occurred when it is anticipated that only the upper 20 feet or so of water will mix with the herbicide and impact whole lake 2,4-D concentrations attained after treatment. However, the depth variations in the lake and the mixing complexities that can occur in the lake create a lot of unknowns that can impact the whole lake 2,4-D concentration attained after treatment.

These mixing unknowns create a lot of uncertainty regarding the whole lake 2,4-D concentration attained after treatment. It is important to recognize the uncertainties and their impacts to insure realistic expectations for treatment results.

2.2 Williams Bay, Rabbit Island Bay, Library Lake, and Cemetery Bay

Williams Bay, Rabbit Island Bay, Library Lake, and Cemetery Bay are spot treatments with an expected bay wide 2,4-D concentration of 0.3 ppm after treatment, assuming dissipation of the herbicide throughout the bay. The whole bay 2,4-D concentrations expected after the 2014 treatment are the same as the whole bay concentrations that were anticipated after the 2013 treatment. Sites within Williams Bay, Rabbit Island Bay, and Library Lake will be treated with a 2,4-D concentration of 4 ppm. Sites within Cemetery Bay will be treated with a 2,4-D concentration of 2 ppm.

2.3 East Lake

East Lake is a spot treatment with an expected bay wide 2,4-D concentration of 0.6 ppm after treatment, assuming dissipation of the herbicide throughout the bay. The whole bay 2,4-D concentration expected after the 2014 treatment is 0.1 ppm higher than the 2,4-D concentration anticipated after the 2013 treatment. The higher whole bay 2,4-D concentration is proposed to effectively destroy EWM root crowns, which were viable after the 2013 treatment per the July 2013 aquatic plant survey of East Lake. Sites within East Lake will be treated with a 2,4-D concentration of 4 ppm.

2.4 Norwegian Bay and City Bay

Norwegian Bay and City Bay are whole bay treatments with a 2,4-D concentration of 0.6 ppm. Hence, the expected whole bay 2,4-D concentrations after treatment are 0.6 ppm. The whole bay 2,4-D concentrations expected after the 2014 treatment are 0.1 ppm higher than the concentrations anticipated after the 2013 treatment. The higher whole bay 2,4-D concentrations are proposed to effectively destroy EWM root crowns, which were viable after the 2013 treatment per the July 2013 aquatic plant surveys of Norwegian Bay and City Bay.

3.0 Proposed 2014 Monitoring Programs

The 2014 monitoring programs to assess results of the 2014 herbicide treatment program will consist of herbicide residue monitoring programs to monitor 2,4-D concentrations following treatment as well as aquatic plant monitoring programs to: (1) assess treatment success; (2) determine native plant response to treatment; and (3) design the 2015 EWM treatment plan.

3.1 2,4-D Herbicide Residue Monitoring Program

2,4-D herbicide residue monitoring will occur in 18 representative locations to determine whether the target dose was attained as well as the rate of herbicide decline due to dilution, mixing, and natural degradation. Monitoring locations are shown in Figures 4 and 5. Samples will be collected at mid-depth from each location during a 26 day period (Table 4). Specific sample collection times for the treatment areas are shown in Table 4. It should be noted that: (1) if the sample collection time for 1 and 4 hours after treatment occurs after dark, the sample will not be collected; (2) if weather conditions make sample collection unsafe during any of the scheduled sample collection times, samples will not be collected.

Table 4 2014 Herbicide Residue Monitoring Plan

Treatment Area (Sample Site ID)	Sample Collection Time (Hours After Treatment)	Sample Collection Time (Days After Treatment)
West Lake Basins		
West Lake (ID 1, 20, 22, and West Lake Center)	1,4	1, 2, 3, 5, 7, 12, 19, and 26
Williams Bay (ID 27 and Williams Bay Center	1,4	1, 2, 3 5, 7, 12, 19, and 26
Rabbit Island Bay (ID 30 and Rabbit Island Bay Center)	1,4	1, 2, 3 5, 7, 12, 19, and 26
Library Lake (ID 31 and Library Lake Center)	1,4	1, 2, 3 5, 7, 12, 19, and 26
East Lake Basins		
Norwegian Bay (ID 32)	1,4	1, 2, 3 5, 7, 12, 19, and 26
East Lake (ID 34, 35, and East Lake Center)	1,4	1, 2, 3 5, 7, 12, 19, and 26
City Bay (ID 37A, 37B, and 37C)	1,4	1, 2, 3 5, 7, 12, 19, and 26
Cemetery Bay (ID 39)	1,4	1, 2, 3 5, 7, 12, 19, and 26

3.2 Aquatic Plant Monitoring Programs

The 2014 aquatic plant monitoring programs will include a July survey of all plant species and an October survey of aquatic invasive species (EWM and CLP). Details of the aquatic plant monitoring programs follow.

3.2.1 July Aquatic Plant Survey – All Species

During July, a point intercept survey of about 1,346 sample points will assess the entire plant community in Beaver Dam Lake. Maps showing the sample locations are found in Appendix E of the Beaver Dam Lake APM Plan. Data will be summarized in tabular format using the WDNR pre-treatment/post-treatment spreadsheet. Maps will be prepared showing location and density of each species identified in the July plant survey. Chi squared analysis will compare 2013 data with 2012 data to identify significant changes in frequency of occurrence of native species. The July monitoring program duplicates monitoring programs completed during 2009 through 2013.

3.2.2 Fall Aquatic Invasive Species Survey

During October, a fall point intercept survey of about 1,346 sample points will assess aquatic invasive species (EWM and CLP) coverage in Beaver Dam Lake. Maps showing the sample locations are found in Appendix E of the Beaver Dam Lake APM Plan. The results of the EWM data collected during the fall aquatic invasive species survey will determine 2015 EWM treatment areas and will be used to design the 2015 herbicide treatment program. The results of the CLP data collected during the fall aquatic invasive species survey will be evaluated to determine whether any areas would need additional CLP monitoring during June of 2015 when CLP is at its peak growth stage. The fall aquatic invasive species monitoring program duplicates monitoring programs completed during 2006 through 2013.

Memorandum

To: Beaver Dam Lake Management District (Board of Commissioners)
From: Barr Engineering Company (Meg Rattei)
Subject: Proposed 2015 Beaver Dam Lake Herbicide Treatment Plan
Date: December 4, 2014
Project: 49030011.14

The purpose of this memorandum is to present:

1. Proposed 2015 herbicide treatment plan,
2. Proposed 2015 monitoring programs.

Beaver Dam Lake is divided into 8 bays. Four bays are located east of US 63 and four bays are located west of US 63. The herbicide treatment plan for the lake is comprised of a treatment plan for each of the eight bays within the lake (Figure 1).

1.0 Proposed 2015 EWM Treatment Plan

As detailed in the Beaver Dam Lake APM Plan, the lake-wide goal of EWM treatment is to reduce EWM to 7 percent of the littoral zone. The results of the fall 2014 Beaver Dam Lake plant survey indicated EWM frequency in the littoral zone was 9 percent. EWM extent was 67 acres, which is 13 percent of the 520 acre littoral zone. Since the lake-wide goal of 7 percent has not been attained, herbicide treatment in 2015 is proposed.

The 2015 Beaver Dam Lake EWM treatment program includes spring treatment of 308.57 acres (Figures 2 and 3). The four bays west of US 63 total 134.79 acres (Figure 2) and the four bays east of US 63 total 173.78 acres (Figure 3). Liquid 2,4-D will be used in all treatment areas, but dose will vary between treatment areas:

- 4 parts per million (ppm) dose will be applied to spot treatment areas in West Lake, Library Bay, and East Lake (Figures 1-3)
- 4 ppm dose will be applied to the spot treatment area in Williams Bay that is adjacent to the Eagle Point Boat Landing and 2 ppm dose will be applied to all other spot treatment areas in Williams Bay (Figures 1-2)
- 0.3 ppm dose will be applied to spot treatment areas in the channels adjacent to Rabbit Island Bay and 4 ppm dose will be applied to the spot treatment areas in Rabbit Island Bay (Figures 1-2)
- 2 ppm dose will be applied to the spot treatment area in Cemetery Bay (Figures 1 and 3)
- 0.8 ppm dose will be applied to Norwegian Bay and City Bay, which are whole bay treatments (Figures 1 and 3)

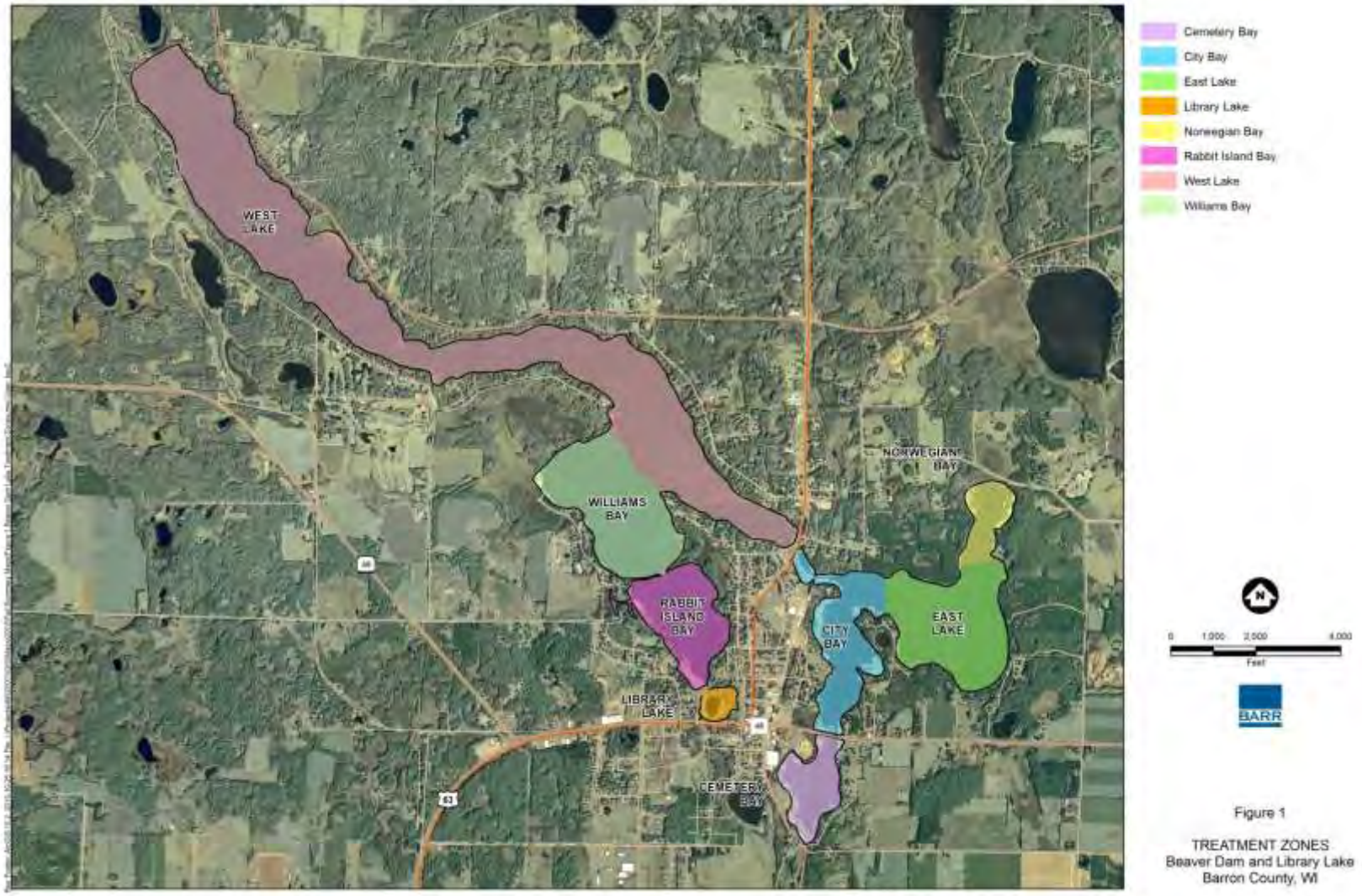

Figure 1 Beaver Dam Lake Treatment Areas

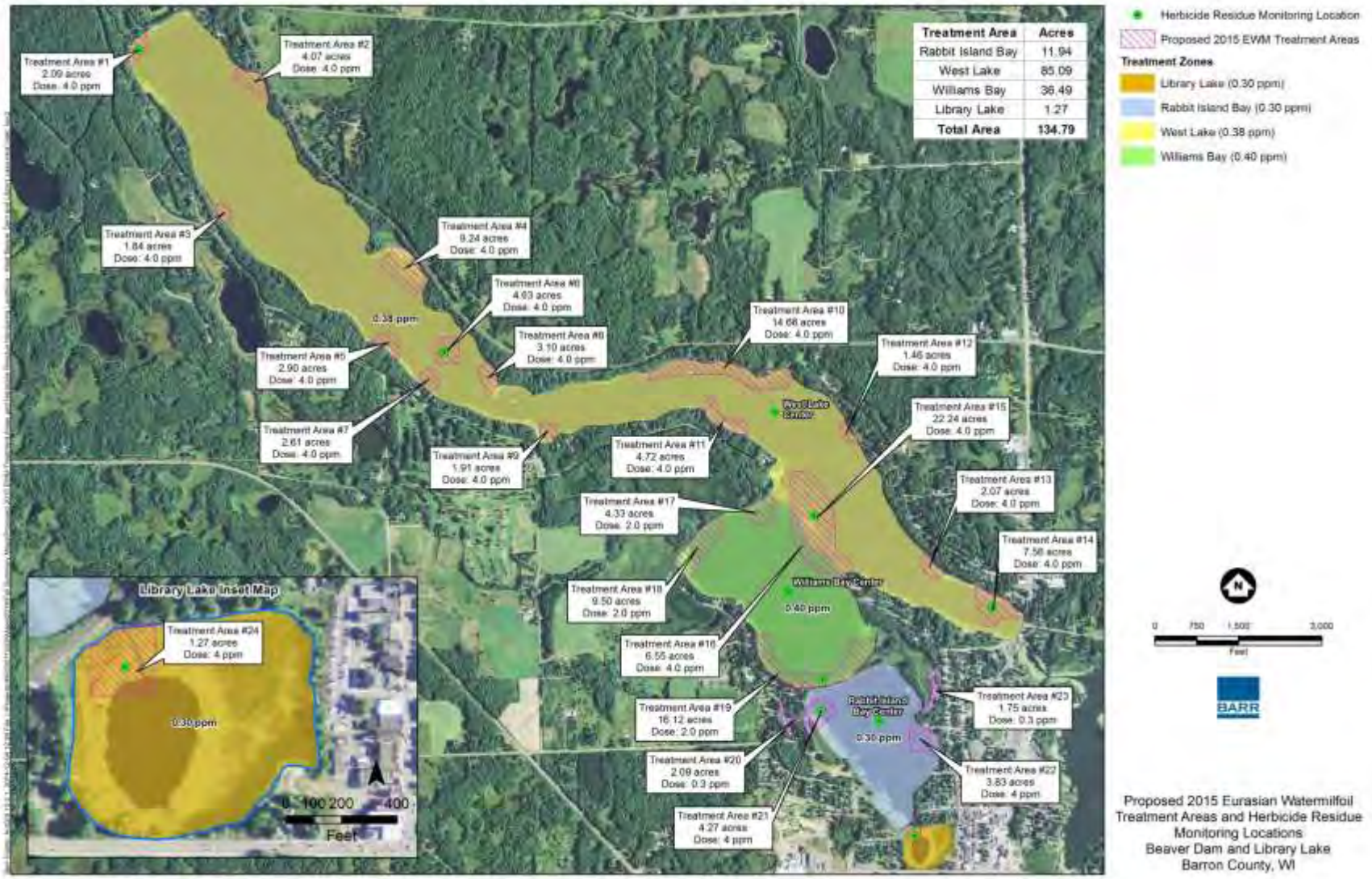

Figure 2 2015 Treatment Plan and Herbicide Residue Monitoring Locations for West Lake, Williams Bay, Rabbit Island Bay, and Library Lake

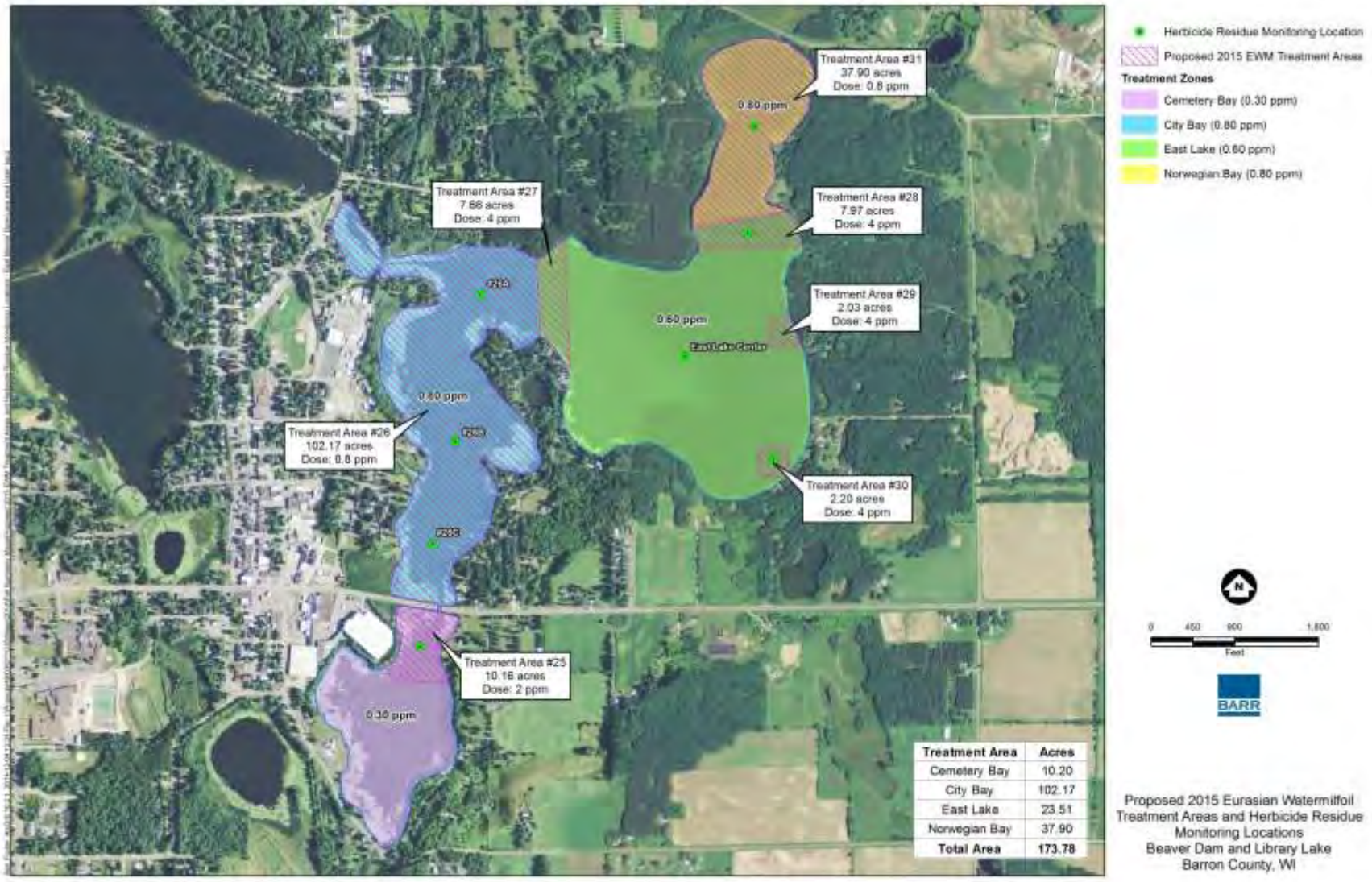

Figure 3 2015 Treatment Plan and Herbicide Residue Monitoring Locations for Norwegian Bay, East Lake, City Bay, and Cemetery Bay

The 2015 treatment plan is discussed in Sections 2.1 through 2.8.

The doses shown in Figures 2 and 3 assume stratification will occur at the 20-foot depth for all treatment areas with depths greater than 20 feet. If stratification occurs at a deeper or shallower depth, doses may need to be adjusted accordingly to attain the desired whole bay concentrations shown in Figures 2 and 3. To determine when stratification occurs, temperature profiles will be measured at the deepest locations in East Lake, Rabbit Island Bay, Williams Bay, and West Lake (i.e., deepest location of both deep basins in West Lake). Measurements would begin shortly after ice-out and continue until the time of treatment. The stratification information will be used to determine when treatment should occur and whether dose adjustments are needed.

2.1 West Lake

The West Lake treatment is a spot treatment with a 2,4-D dose of 4 ppm and an expected bay-wide 2,4-D concentration of approximately 0.38 parts per million (ppm) (Figure 2). Although the 2,4-D dose applied to individual treatment areas in 2015 will be the same as 2014, the expected bay-wide 2,4-D concentration of 0.38 ppm is slightly higher than the 2014 expected bay-wide concentration of 0.3 ppm. The increase in bay-wide concentration in 2015 is warranted because 2014 data indicated a higher 2,4-D bay-wide target concentration is needed to attain the dose and contact time required for bay-wide EWM control. In 2014, EWM in the northwestern area of the lake had the 2,4-D dose and contact time needed to attain lasting control, but EWM in other areas of the lake did not have the 2,4-D dose and contact time needed to attain lasting control of EWM. Apparently the mixing within this complex bay resulted in more dilution of herbicide by untreated waters than was expected, resulting in lower than expected 2,4-D concentrations in much of the bay during 2014. Hence, increasing the bay-wide target 2,4-D concentration in 2015 is needed to mitigate this additional dilution and attain the 2,4-D dose and contact time needed to attain lasting EWM control throughout the bay.

The EWM in the West Lake bay grows at a range of depths, including very deep depths. EWM begins growing sooner in the shallow depths than deeper depths. The treatment approach in 2015 will be to wait until the EWM at the deeper depths reaches an ideal growth stage for treatment and then commence with treatment. To determine the ideal treatment stage, a team consisting of Lake Restoration, Inc. (applicator) and Endangered Resource Services, LLC (plant surveyor) will assess the EWM in the deeper areas. When the team concurs that the EWM is at an ideal growth stage for treatment, the herbicide treatment of West Lake will commence. It is anticipated that the treatment will occur around mid-June.

Because the timing of EWM growth and the rate of EWM growth can vary from year to year, it is possible that some deeper areas of West Lake near the sharp breaks to the deeper depths may not exhibit EWM growth when it is determined that treatment needs to commence in the rest of the lake to protect the native plant community. In the event that this scenario occurs in 2015 treatment will commence in areas

exhibiting EWM growth considered ideal for treatment and areas that exhibit later EWM growth will be treated at a later time.

Although the goal of the treatment is to attain a bay-wide 2,4-D concentration that is as close as possible to 0.38 ppm, there are many variables that can prevent attainment of that goal. As noted in the previous paragraph, it may not be possible to treat all of the EWM areas in the lake if deeper areas near the sharp breaks to the deeper depths begin growing so late that it becomes necessary to treat the rest of the lake in advance of these deeper areas. In that situation, the expected whole lake concentration would be expected to be below 0.38 ppm. Weather conditions have a great impact on West Lake and poor weather conditions could prevent treatment of the entire bay in a day. In the event that poor weather conditions prevent treatment of the entire bay in a day, the expected bay-wide concentration of 0.38 ppm may not be attained.

2.2 Williams Bay

Williams Bay is a spot treatment with a 2,4-D dose of 4 ppm applied to the spot treatment area adjacent to the Eagle Point Boat Landing and a 2,4-D dose of 2 ppm applied to all other spot treatment areas in Williams Bay. The treatment will result in an expected bay-wide 2,4-D concentration of approximately 0.4 ppm (Figure 2). In 2014, a 2,4-D dose of 4 ppm was applied to all treatment areas and the expected bay-wide concentration was 0.3 ppm. However, mixing in the vicinity of the Eagle Point Boat Landing resulted in more dilution of herbicide by untreated waters than was expected, resulting in lower than expected 2,4-D concentrations in this area. Hence, EWM in the vicinity of the Eagle Point Boat Landing did not have the 2,4-D dose and contact time needed to attain lasting control and, consequently, EWM was not controlled in the Eagle Point Boat Landing area. During late summer of 2014, a lake resident observed wind and wave action from a strong north wind moving EWM fragments from the Eagle Point boat landing area into Williams Bay. EWM was not observed in Williams Bay during the July plant survey, but increased to a frequency of 9 percent and extent of 7 acres by fall. The locations where EWM was found in the fall of 2014 corresponded with locations where EWM fragments were deposited by wind and wave action during late summer. The data indicate a higher herbicide dose is needed in both Williams Bay and adjacent West Lake to effectively control EWM in the Eagle Point Boat landing area. Unless controlled, EWM in this high traffic area spreads to other areas, including Williams Bay. Hence, the 2015 treatment plan for Williams Bay will increase the bay-wide concentration to 0.4 ppm. In addition to increasing the bay-wide concentration, treatment timing will strive to treat Williams Bay on the day preceding West Lake. By treating the two bays within a day of each other, dilution from mixing between the two bays will be minimized thus optimizing the herbicide concentration of both bays, especially the areas adjacent to Eagle Point Boat Landing.

2.3 Rabbit Island Bay

Rabbit Island Bay is a spot treatment of the two channels adjacent to Rabbit Island Bay with a 2,4-D concentration of 0.3 ppm and a spot treatment of Rabbit Island Bay with a 2,4-D concentration of 4 ppm. The treatment will result in an expected bay-wide 2,4-D concentration of 0.3 ppm as well as an expected 2,4-D concentration of 0.3 ppm throughout both side channels. The 2015 plan for Rabbit Island Bay is consistent with 2014.

2.4 Library Lake

Library Lake is a spot treatment with a 2,4-D concentration of 4 ppm and an expected bay-wide concentration of 0.3 ppm. The 2015 plan for Library Lake is consistent with 2014.

2.5 Cemetery Bay

Cemetery Bay is a spot treatment with a 2,4-D concentration of 2 ppm and an expected bay-wide concentration of 0.3 ppm. The 2015 plan for Cemetery Bay is consistent with 2014.

2.6 East Lake

East Lake is a spot treatment with a 2,4-D concentration of 4 ppm and an expected bay-wide concentration of 0.6 ppm. The 2015 plan for East Lake is consistent with 2014.

2.7 Norwegian Bay and City Bay

Norwegian Bay and City Bay are whole bay treatments with a 2,4-D concentration of 0.8 ppm. The 2,4-D dose and expected bay-wide 2,4-D concentration of 0.8 ppm are 0.2 ppm higher than the 2,4-D dose and bay-wide concentration of 0.6 ppm used in 2014. The higher bay-wide 2,4-D concentration is proposed to attain better EWM control than 2014. In 2014, the bay-wide target 2,4-D concentration of 0.6 ppm was attained in City Bay, but was only sustained for a day or two. In 2014, the target bay-wide 2,4-D concentration of 0.6 ppm was never attained in Norwegian Bay, probably due to dilution from inflowing waters from the bay's inlet. In both bays, EWM recolonized between summer and fall and was observed at a higher frequency and extent than the bays in which the target bay-wide concentration was both attained and sustained for at least 3 days. Hence, increasing the target bay-wide concentration in 2015 is warranted to attain a higher bay-wide concentration which is expected to result in better EWM control.

2.8 Treatment Sequencing

Treatment sequencing is important to insure that upstream basins are treated prior to downstream basins, thus optimizing post treatment bay-wide concentrations of 2.4-D. In 2015, herbicide will be applied to the eight treatment areas in the following order: Library Lake, Norwegian Bay, East Lake, City Bay, Cemetery Bay, Rabbit Island Bay, Williams Bay, and West Lake. In order to optimize the 2,4-D concentration of Williams Bay, herbicide treatment of Williams Bay will occur on the day preceding the treatment of West

Lake, weather permitting. By treating these two bays within a day of each other, weather permitting, the bay-wide herbicide concentrations will be optimized, thus improving EWM control. Optimization of post-treatment 2,4-D concentrations in the areas adjacent to the Eagle Point Boat Landing will help attain control in this high traffic area and minimize spread of EWM to other areas during the summer.

3.0 Proposed 2015 Monitoring Programs

The 2015 monitoring programs to assess results of the 2015 herbicide treatment program will consist of a herbicide residue monitoring program to monitor 2,4-D concentrations following treatment as well as summer and fall aquatic plant monitoring programs to: (1) assess treatment success; (2) determine native plant response to treatment; and (3) design the 2016 EWM herbicide treatment plan.

3.1 2,4-D Herbicide Residue Monitoring Program

In 2015, 2,4-D herbicide residue monitoring will occur in 18 representative locations to determine whether the target dose was attained as well as the rate of herbicide decline due to dilution, mixing, and natural degradation. Monitoring locations are shown in Figures 2 and 3. Samples will be collected at mid-depth from each location during a 26 day period (Table 1). Specific sample collection times for the treatment areas are shown in Table 1. It should be noted that: (1) if the sample collection time for 1 and 4 hours after treatment occurs after dark, the sample will not be collected; (2) if weather conditions make sample collection unsafe during any of the scheduled sample collection times, samples will not be collected.

Table 1 2015 Herbicide Residue Monitoring Plan

Treatment Area (Sample Site ID)	Sample Collection Time (Hours After Treatment)	Sample Collection Time (Days After Treatment)
West Lake Basins		
West Lake (ID 1, 6, 14, 15 and West Lake Center)	1,4	1, 2, 3, 5, 7, 12, 19, and 26
Williams Bay (ID 19 and Williams Bay Center	1,4	1, 2, 3 5, 7, 12, 19, and 26
Rabbit Island Bay (ID 21 and Rabbit Island Bay Center)	1,4	1, 2, 3 5, 7, 12, 19, and 26
Library Lake (ID 24)	1,4	1, 2, 3 5, 7, 12, 19, and 26
East Lake Basins		
Norwegian Bay (ID 28 and 31)	1,4	1, 2, 3 5, 7, 12, 19, and 26
East Lake (ID 30 and East Lake Center)	1,4	1, 2, 3 5, 7, 12, 19, and 26
City Bay (ID 26A, 26B, and 26C)	1,4	1, 2, 3 5, 7, 12, 19, and 26
Cemetery Bay (ID 25	1,4	1, 2, 3 5, 7, 12, 19, and 26

3.2 Aquatic Plant Monitoring Programs

The 2015 aquatic plant monitoring programs will include a July survey of all plant species and an October survey of aquatic invasive species (EWM and CLP). Details of the aquatic plant monitoring programs follow.

3.2.1 July Aquatic Plant Survey – All Species

During July, a point intercept survey of about 1,346 sample points will assess the entire plant community in Beaver Dam Lake. Maps showing the sample locations are found in Appendix E of the Beaver Dam Lake APM Plan. Data will be summarized in tabular format using the WDNR pre-treatment/post-treatment spreadsheet. Maps will be prepared showing location and density of each species identified in the July plant survey. Chi squared analysis will compare 2014 data with 2015 data to identify significant changes in frequency of occurrence of native species. The July monitoring program duplicates monitoring programs completed during 2009 through 2014.

3.2.2 Fall Aquatic Invasive Species Survey

During October, a fall point intercept survey of about 1,346 sample points will assess aquatic invasive species (EWM and CLP) coverage in Beaver Dam Lake. Maps showing the sample locations are found in Appendix E of the Beaver Dam Lake APM Plan. The results of the EWM data collected during the fall aquatic invasive species survey will determine 2016 EWM treatment areas and will be used to design the 2016 herbicide treatment program. The results of the CLP data collected during the fall aquatic invasive species survey will be evaluated to determine whether any areas would need additional CLP monitoring during June of 2016 when CLP is at its peak growth stage. The fall aquatic invasive species monitoring program duplicates monitoring programs completed during 2006 through 2014.

Memorandum

To: Beaver Dam Lake Management District (Board of Commissioners)

From: Barr Engineering Company (Meg Rattei)

Subject: Proposed 2016 Beaver Dam Lake Eurasian Watermilfoil (EWM) Management Plan

Date: February 4, 2016

Project: 49030011.17

cc: Alex Smith (WDNR), Mark Sundeen (WDNR), Kevin Kretsch (Lake Restoration, Inc.), and John Skogerboe (Research Scientist)

1.0 2016 EWM Management Plan

The 2016 EWM management plan is a combination of herbicide treatment and hand removal, with the intent to use Diver Assisted Suction Harvesting (DASH) for the hand removal of EWM. Herbicide treatment would occur in Library Lake (Figure 1), Cemetery Bay (Figure 2), and City Bay (Figure 3). EWM hand removal (DASH) would occur in West Lake (Figure 4), Rabbit Island Bay (Figure 5), and Norwegian Bay (Figure 6). Table 1 summarizes the recommended 2016 EWM management plan.

Table 1 2016 Beaver Dam Lake EWM Management Plan

Location	EWM Extent (ac)	Method of EWM Management	EWM Management Area (ac)	For Herbicide Treatment, Target Dose (ppm)	For Herbicide Treatment, Expected Whole Bay/Lake Concentration (ppm)
West Lake	1.72	DASH	1.72	--	--
Rabbit Island Bay	1.37	DASH	1.37	--	--
Library Lake	1.90	Herbicide Treatment with Liquid 2,4-D*	10.99	0.31	0.3
Cemetery Bay	31.56	Herbicide Treatment with Liquid 2,4-D*	53.17	0.3	0.3
City Bay	6.87	Herbicide Treatment with Liquid 2,4-D*	102.20	0.8	0.8
Norwegian Bay	0.81	DASH	0.81	--	--

*If EWM is observed during the July plant survey and/or August inspection, the observed EWM will be removed by DASH during July and/or August.

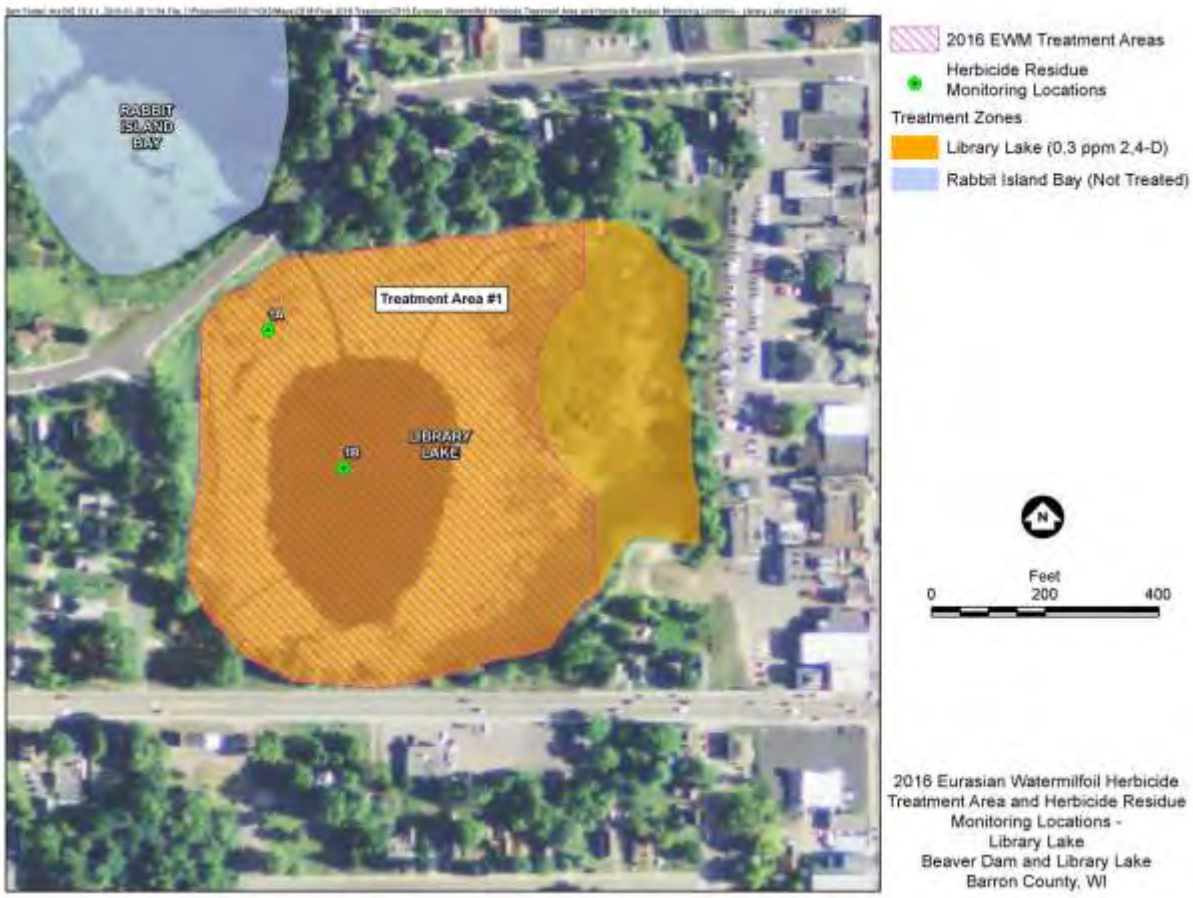

Figure 1 2016 Eurasian Watermilfoil Herbicide Treatment Area and Herbicide Residue Monitoring Locations - Library Lake

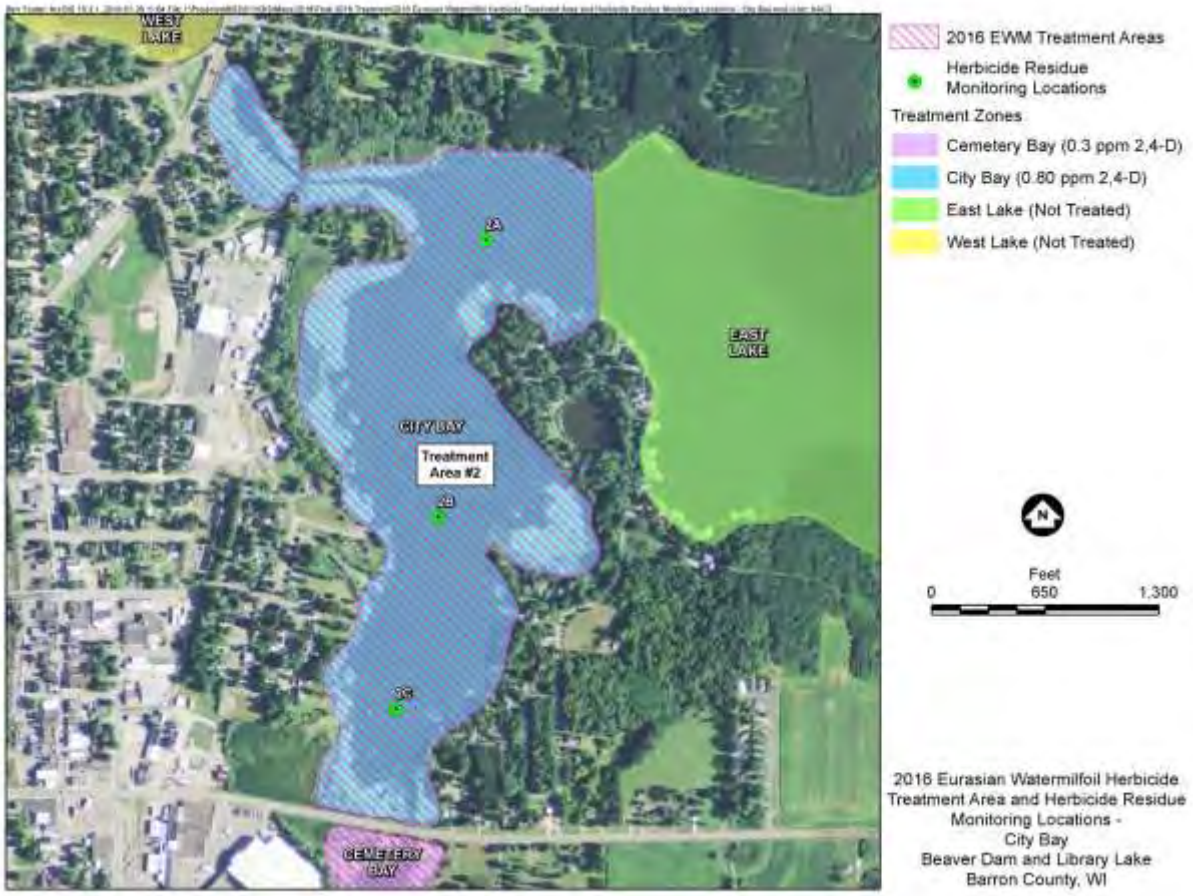

Figure 2 2016 Eurasian Watermilfoil Herbicide Treatment Areas and Herbicide Residue Monitoring Locations – City Bay

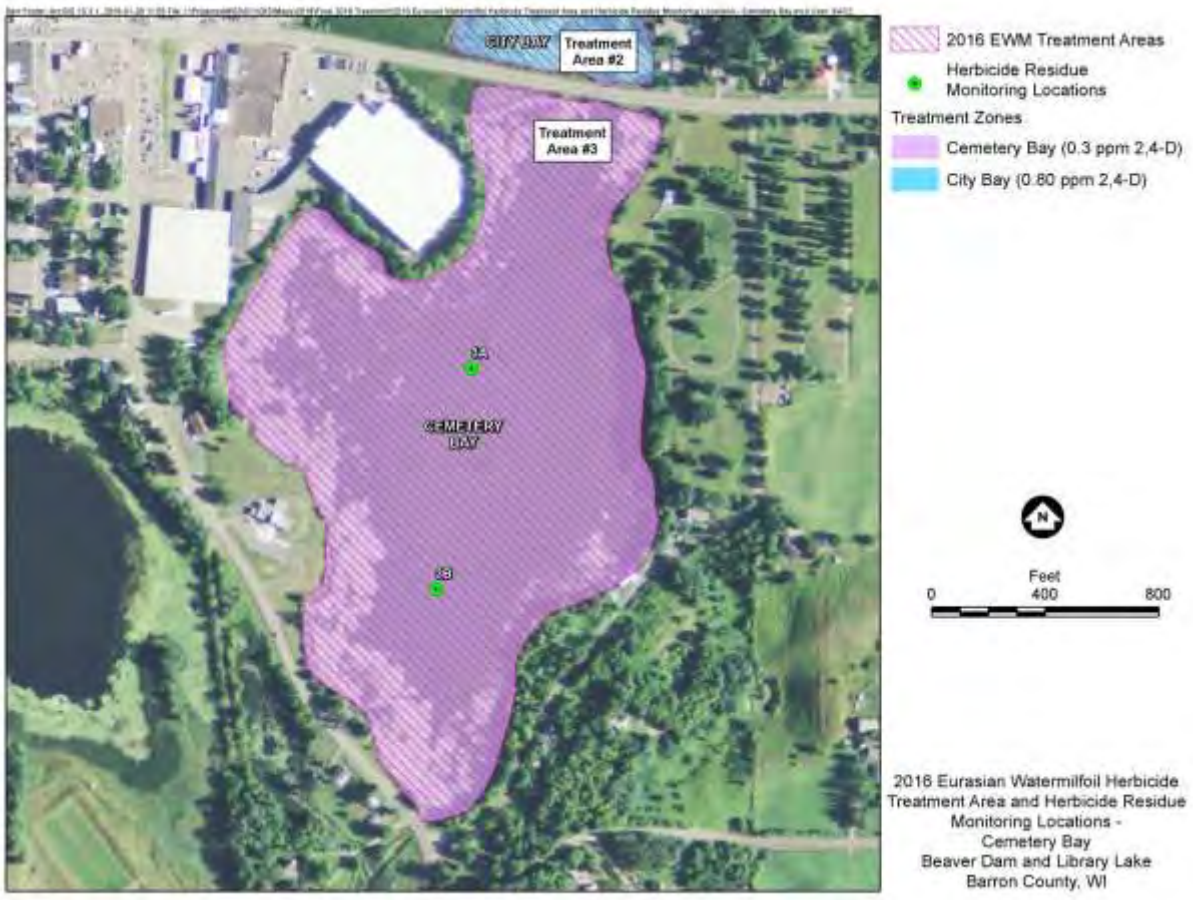

Figure 3 2016 Eurasian Watermilfoil Herbicide Treatment Area and Herbicide Residue Monitoring Locations – Cemetery Bay

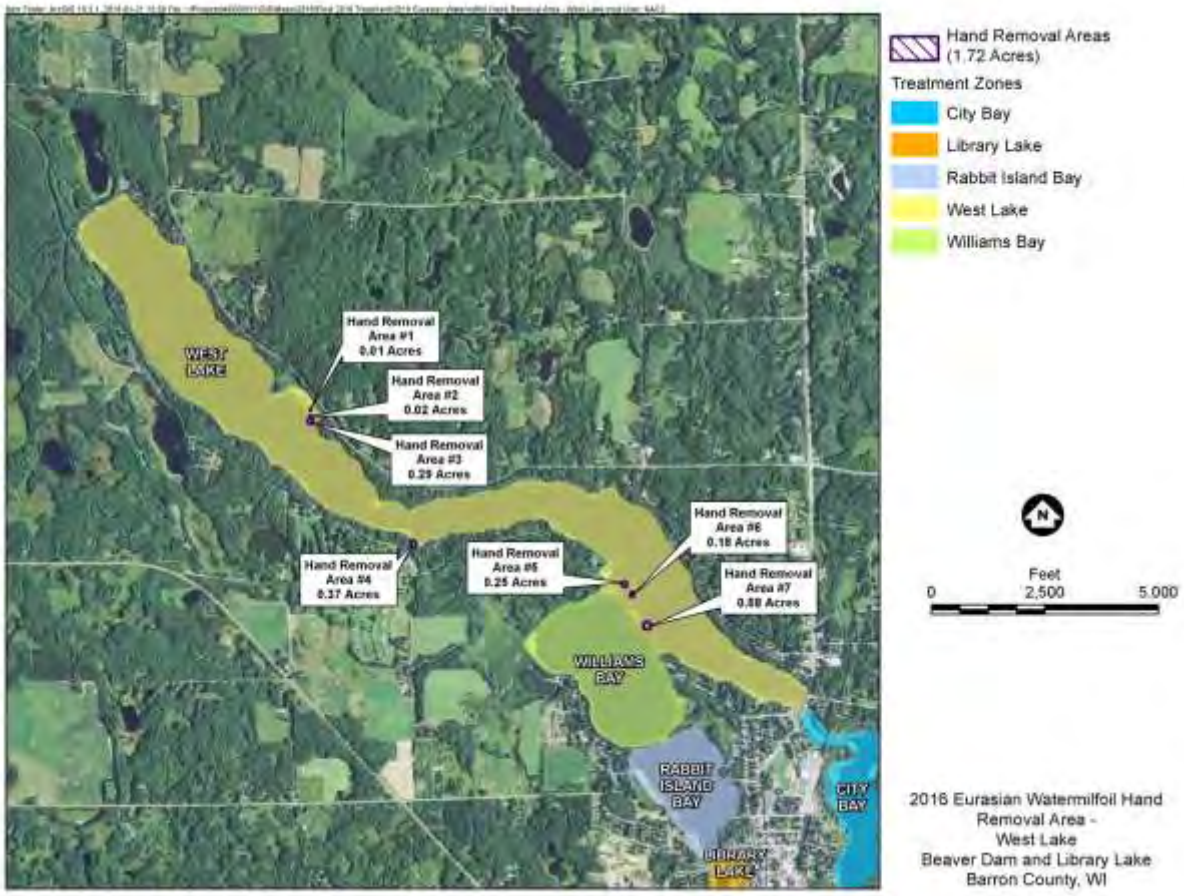

Figure 5 2016 Hand Removal Areas – West Lake

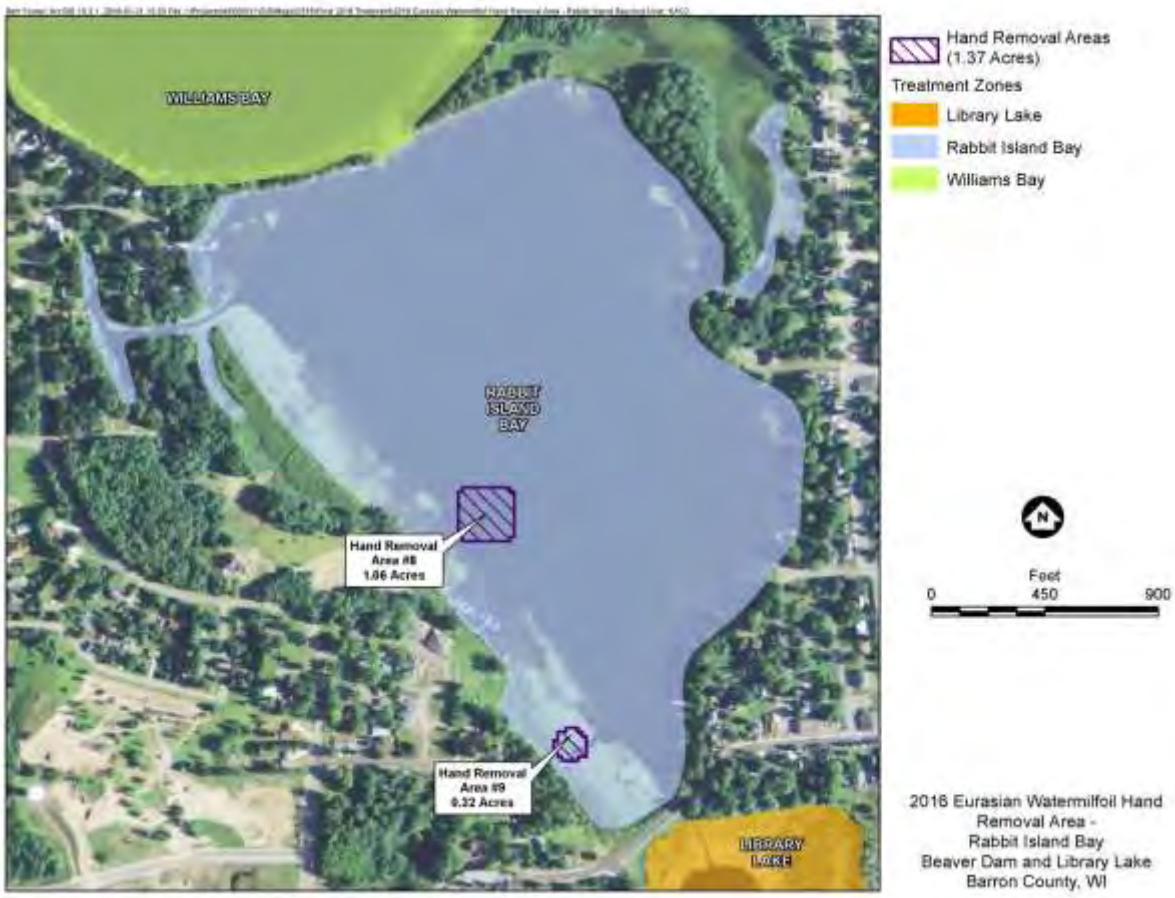

Figure 5 2016 Eurasian Watermilfoil Hand Removal Area – Rabbit Island Bay

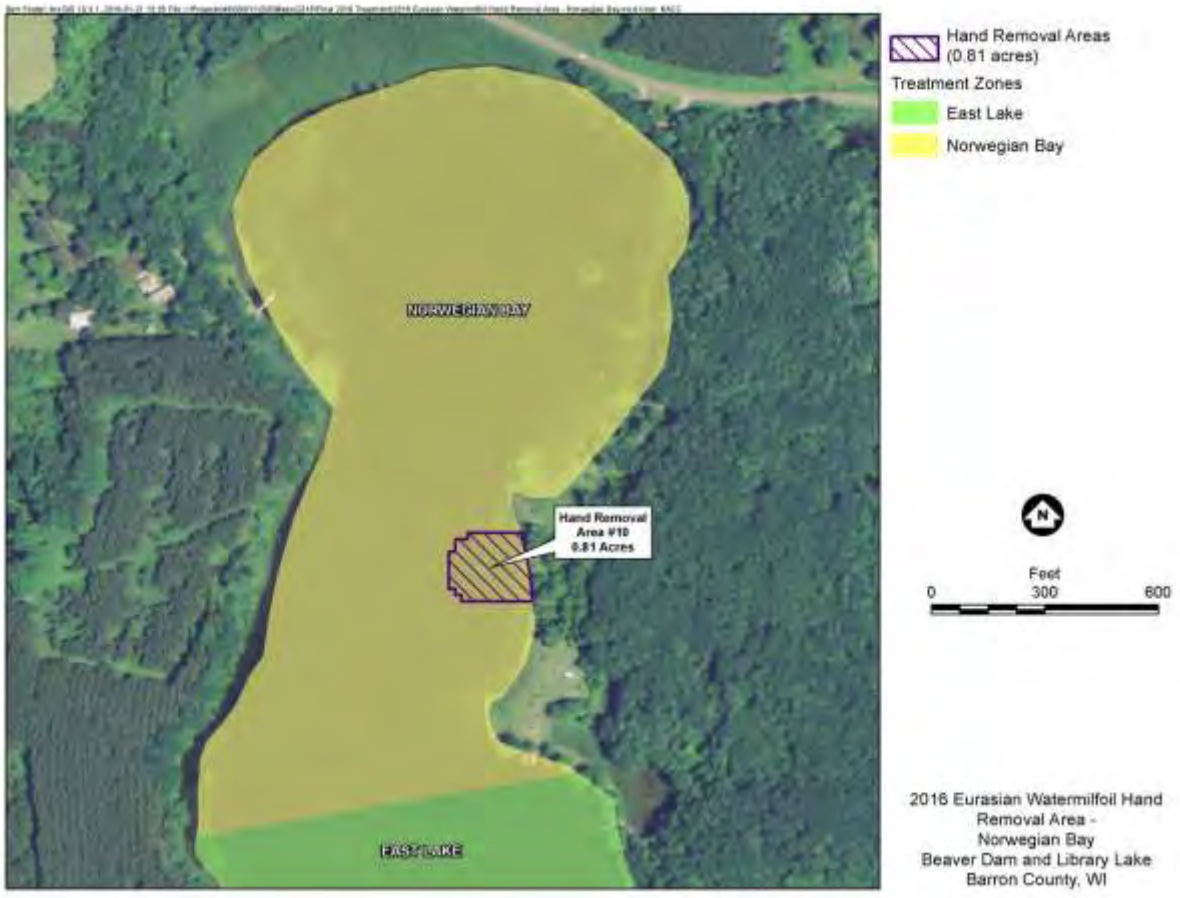

Figure 6 2016 Eurasian Watermilfoil Hand Removal Area – Norwegian Bay

The herbicide would be applied to Library Lake, City Bay, and Cemetery Bay when the average water column water temperature is between 55 and 60 degrees Fahrenheit to selectively control EWM while protecting the native plant community. Temperature profiles will be measured at the middle of each basin at designated temperature monitoring locations (Figure 7, Figure 8, and Figure 9). Daily temperature measurements would begin one week after ice-out, continuing until, and including, the day of treatment. When the average water column temperature is between 55 and 60 degrees Fahrenheit, the herbicide would be applied to Library Lake, City Bay, and Cemetery Bay**.** Should unforeseen circumstances prevent the application of herbicide when the average water column water temperature is between 55 and 60 degrees Fahrenheit, no treatment will occur in 2016 to protect the native plant community from harm.

EWM observed during the fall of 2015 in West Lake, Rabbit Island Bay, and Norwegian Bay would be removed by DASH in June. All EWM documented as present in Beaver Dam Lake by the July 2016 plant survey would be removed by DASH during July 2016. The July 2016 EWM DASH removal areas would be checked in August 2016 and any EWM observed during the inspection would be removed by DASH during August 2016.

The proposed 2016 herbicide treatment plan is discussed in Sections 2.1 through 2.3. Treatment sequencing is discussed in Section 2.4. DASH is discussed in Section 2.5

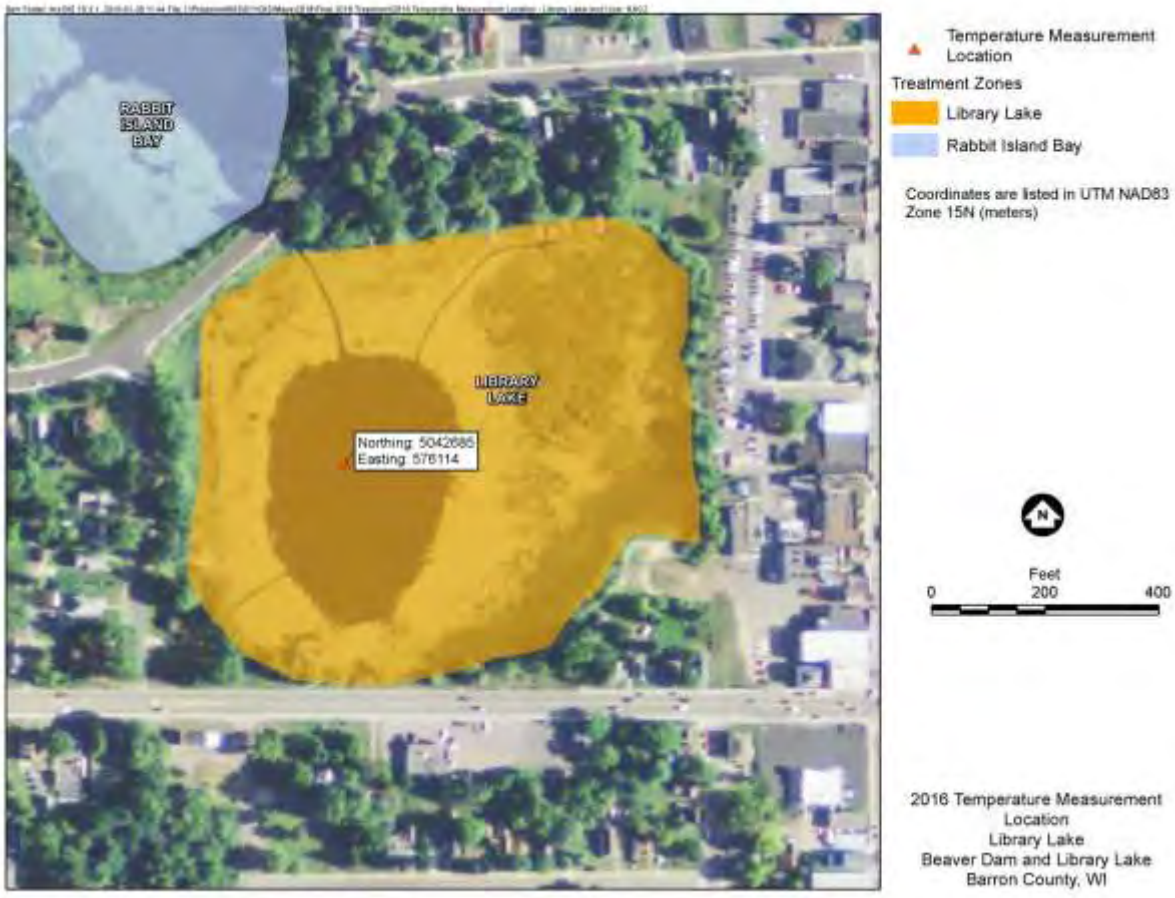

Figure 7 2016 Temperature Measurement Location: Library Lake

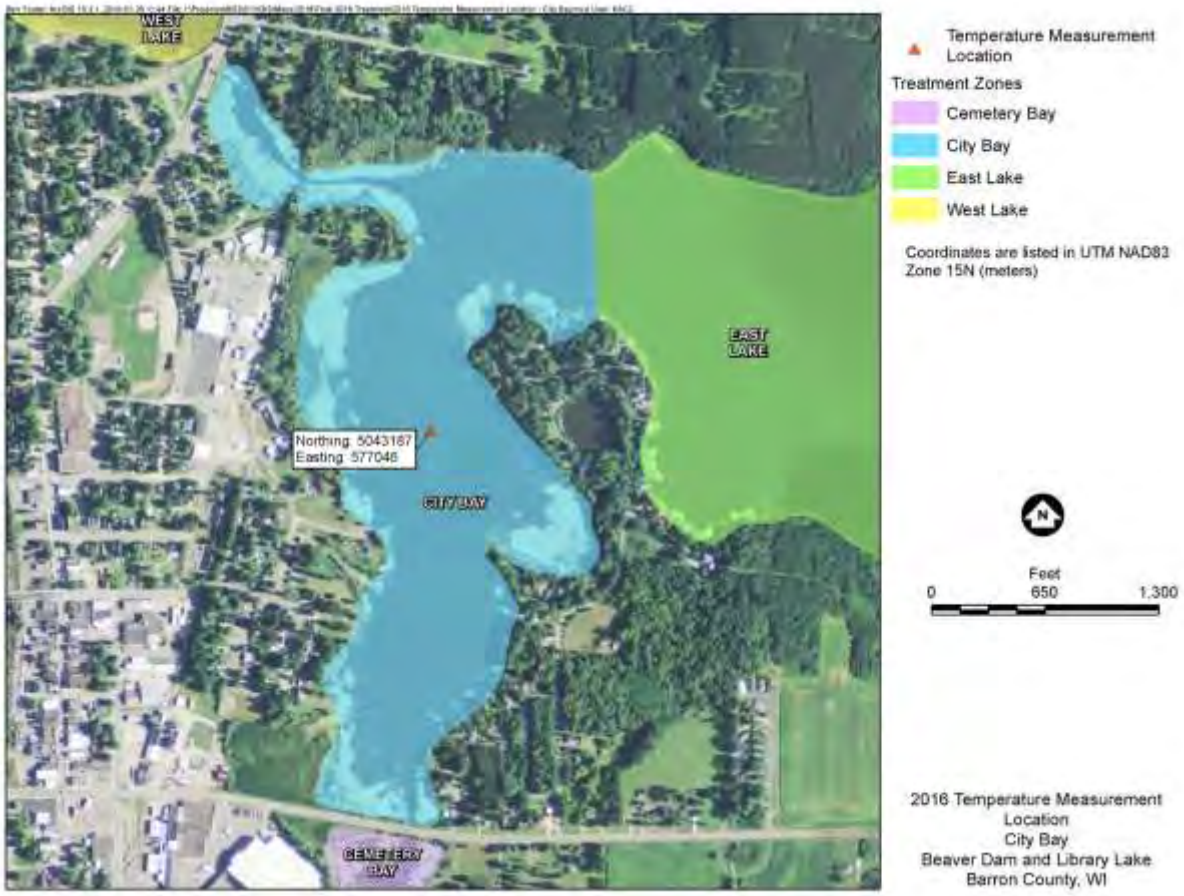

Figure 8 2016 Temperature Measurement Location: City Bay

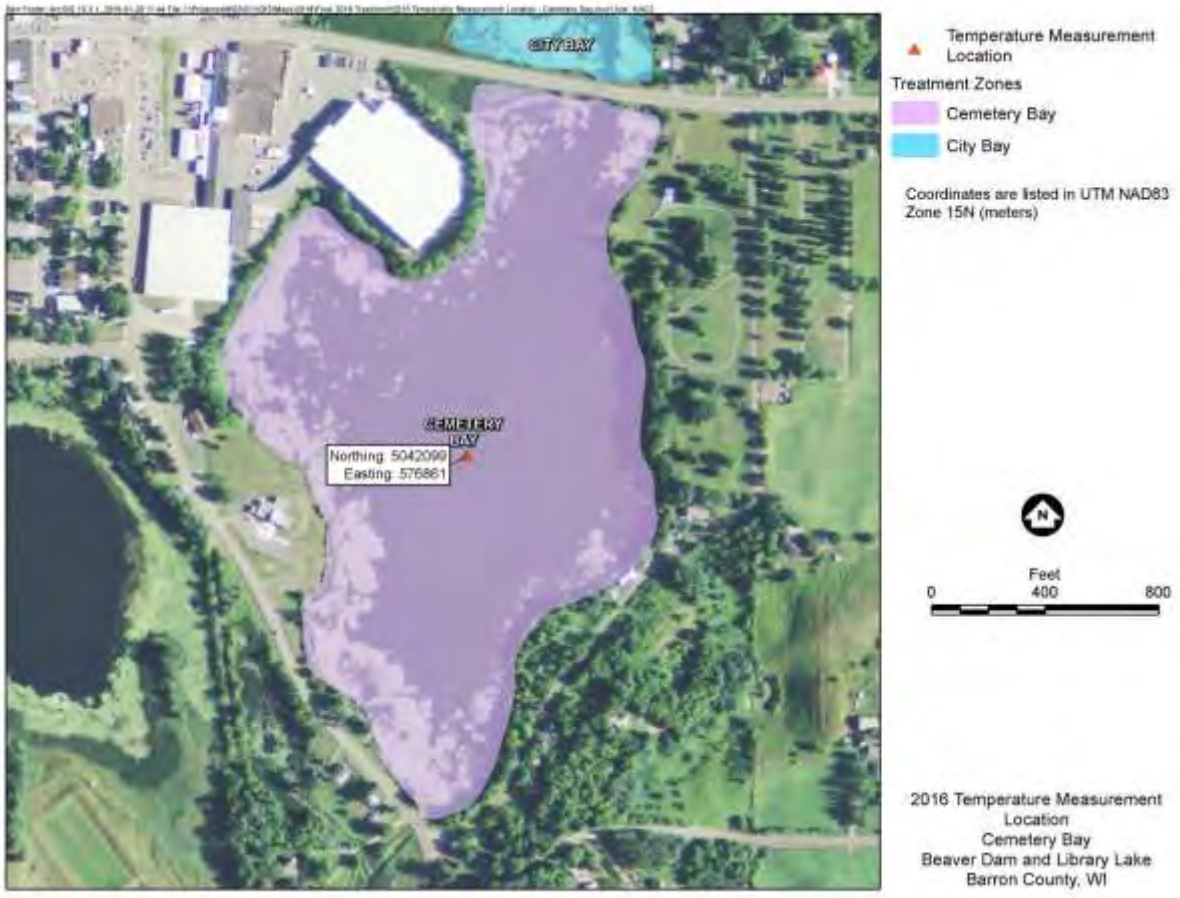

Figure 9 2016 Temperature Measurement Location: Cemetery Bay

1.1 Library Lake

In Library Lake, all but the bog area will be treated with a 2,4-D concentration of 0.31 ppm in 2016 to attain a whole-bay concentration of 0.3 ppm. The 2016 plan for Library Lake is consistent with the 2014 treatment plan for Library Lake. Library Lake was not treated in 2015.

1.2 Cemetery Bay

Cemetery Bay would be a whole bay treatment with a 2,4-D concentration of 0.3 ppm in 2016. The 2016 plan for Cemetery Bay is consistent with the 2014 treatment plan for Cemetery Bay. Cemetery Bay was not treated in 2015.

1.3 City Bay

City Bay would be a whole bay treatment with a 2,4-D concentration of 0.8 ppm in 2016. The 2016 plan for City Bay is consistent with the 2015 treatment plan for City Bay.

1.4 Treatment Sequencing

Treatment sequencing for Cemetery Bay and City Bay are important to optimize the post treatment bay-wide concentration of 2.4-D in Cemetery Bay. In 2016, herbicide would be applied to Cemetery Bay and

City Bay on the same day, but the application to City Bay will occur prior to the application to Cemetery Bay.

1.5 DASH

The Beaver Dam Lake Management District intends to make the DASH equipment required to remove EWM by DASH during 2016 and subsequent years. A professional company would be hired to use the District's equipment to remove EWM by DASH. In June of 2016, EWM observed in West Lake, Rabbit Island Bay, and Norwegian Bay during the October 2015 survey would be removed by DASH. In July of 2016, EWM observed in Beaver Dam Lake during the July 2016 plant survey would be removed by DASH. In August of 2016, areas in which EWM had been removed by DASH in July of 2016 would be checked and any observed EWM would be removed by DASH.

2.0 Proposed 2016 Monitoring Programs

The 2016 monitoring programs would consist of (1) herbicide residue monitoring program to monitor 2,4-D concentrations following treatment and (2) summer and fall aquatic plant monitoring programs.

2.1 2,4-D Herbicide Residue Monitoring Program

In 2016, 2,4-D herbicide residue monitoring would occur in 7 representative locations. The number of sample locations within each treated bay/basin and specific sample collection times for the treatment areas are shown in Table 2. It should be noted that: (1) if the sample collection time for 1 and 4 hours after treatment occurs after dark, the sample will not be collected; (2) if weather conditions make sample collection unsafe during any of the scheduled sample collection times, samples will not be collected. All 2,4-D samples will be analyzed by the Wisconsin State Laboratory of Hygiene in Madison, Wisconsin.

Table 2 2016 Herbicide Residue Monitoring Plan

Treatment Area (Sample Site ID)	Sample Collection Time (Hours After Treatment)	Sample Collection Time (Days After Treatment)
West Lake Basins		
Library Lake (2 locations)	1,4	1, 2, 3 5, 7, 12, 19, and 26
East Lake Basins		
City Bay (3 locations)	1,4	1, 2, 3 5, 7, 12, 19, and 26
Cemetery Bay (2 locations)	1,4	1, 2, 3 5, 7, 12, 19, and 26

2.2 Aquatic Plant Monitoring Programs

The 2016 aquatic plant monitoring programs will include a July survey of all plant species and an October survey of aquatic invasive species (EWM and CLP). Details of the aquatic plant monitoring programs follow.

2.2.1 July Aquatic Plant Survey – All Species

During July, a point intercept survey of about 1,346 sample points will assess the entire plant community in Beaver Dam Lake. Maps showing the sample locations are found in Appendix E of the Beaver Dam Lake Aquatic Plant Management Plan. Data will be summarized in tabular format using the WDNR pre-treatment/post-treatment spreadsheet. Maps will be prepared showing location and density of each species identified in the July plant survey. Chi squared analysis will compare 2015 data with 2016 data to

identify significant changes in frequency of occurrence of native species. The July monitoring program duplicates monitoring programs completed during 2009 through 2015.

2.2.2 Fall Aquatic Invasive Species Survey

During October, a fall point intercept survey of about 1,346 sample points will assess aquatic invasive species (EWM and CLP) coverage in Beaver Dam Lake. Maps showing the sample locations are found in Appendix E of the Beaver Dam Lake Aquatic Plant Management Plan. The results of the EWM data collected during the fall aquatic invasive species survey will determine 2017 EWM management areas and will be used to design the 2017 EWM management program. The results of the CLP data collected during the fall aquatic invasive species survey will be evaluated to determine whether any areas would need additional CLP monitoring during June of 2017 when CLP is at its peak growth stage. The fall aquatic invasive species monitoring program duplicates monitoring programs completed during 2006 through 2015.

Memorandum

To: Beaver Dam Lake Management District (Board of Commissioners)

From: Barr Engineering Co. (Meg Rattei)

Subject: Proposed 2017 Eurasian Watermilfoil (EWM) Management Program, Monitoring Programs, and Navigation Channel Inspection

Date: March 30, 2017

Project: 49030011.17

c: Jim Bartlett (Lake Restoration, Inc.), Alex Smith (WDNR), Mark Sundeen (WDNR), and John Skogerboe (Research Scientist)

The purpose of this memorandum is to present:

1. 2017 EWM Management Program
2. 2017 Monitoring Programs
3. 2017 Navigation Channel Inspection Program

1.0 2017 EWM Management Program

The proposed 2017 EWM management program is a combination of herbicide treatment and manual removal of EWM. Manual removal will include Diver Assisted Suction Harvesting (DASH) wherever feasible and rake removal in shallow areas in which the soft bottom would make it difficult to remove EWM by DASH.

Based upon the results of the 2016 fall plant survey, the following herbicide treatment is planned: (1) 2,4-D whole bay treatment of Norwegian Bay and Cemetery Bay, (2) 2,4-D whole littoral area treatment of Rabbit Island Bay, (3) 2,4-D spot treatment of one area in West Lake , and (4) diquat spot treatment of two areas in West Lake (sunken island and rice beds) and one area in Williams Bay. The 2,4-D treatment areas total 162.30 acres and the diquat treatment areas total 20.51 acres. Manual removal is proposed for East Lake (1.97 acres) and City Bay (1.50 acres). Library Lake does not require EWM management in 2017 because EWM was not observed in Library Lake during the fall plant survey. Table 1 summarizes the proposed 2017 Beaver Dam Lake EWM Management program. Figures 1 and 2 show the herbicide treatment areas. Figures 3 and 4 show the manual removal areas.

Table 1 Proposed 2017 Beaver Dam Lake EWM Management Program

Location	EWM Extent (ac)	Method of EWM Management	EWM Management Area (ac)	For Herbicide Treatment, Name of Herbicide	For Herbicide Treatment, Target Dose in Treatment area	For Herbicide Treatment, Expected Whole Bay/Lake Concentration (ppm)	For Manual Removal, Recommended Removal Method
West Lake	20.64	Herbicide Treatment	25.81	2,4-D	4 ppm	--	--
Williams Bay	5.78	Herbicide Treatment	5.40	Diquat	2 gallons/acre	--	--
Rabbit Island Bay	9.51	Herbicide Treatment	60.50	2,4-D	1.36 ppm	0.4	--
Library Lake	0	None	--	--	--	--	--
Norwegian Bay	6.94	Herbicide Treatment	37.90	2,4-D	0.8 ppm	0.8	--
East Lake	1.97	Manual Removal	1.97	--	--	--	DASH
City Bay	1.50	Manual Removal	1.50	--	--	--	Rake
Cemetery Bay	13.76	Herbicide Treatment	53.20	2,4-D	0.8 ppm	0.8	--

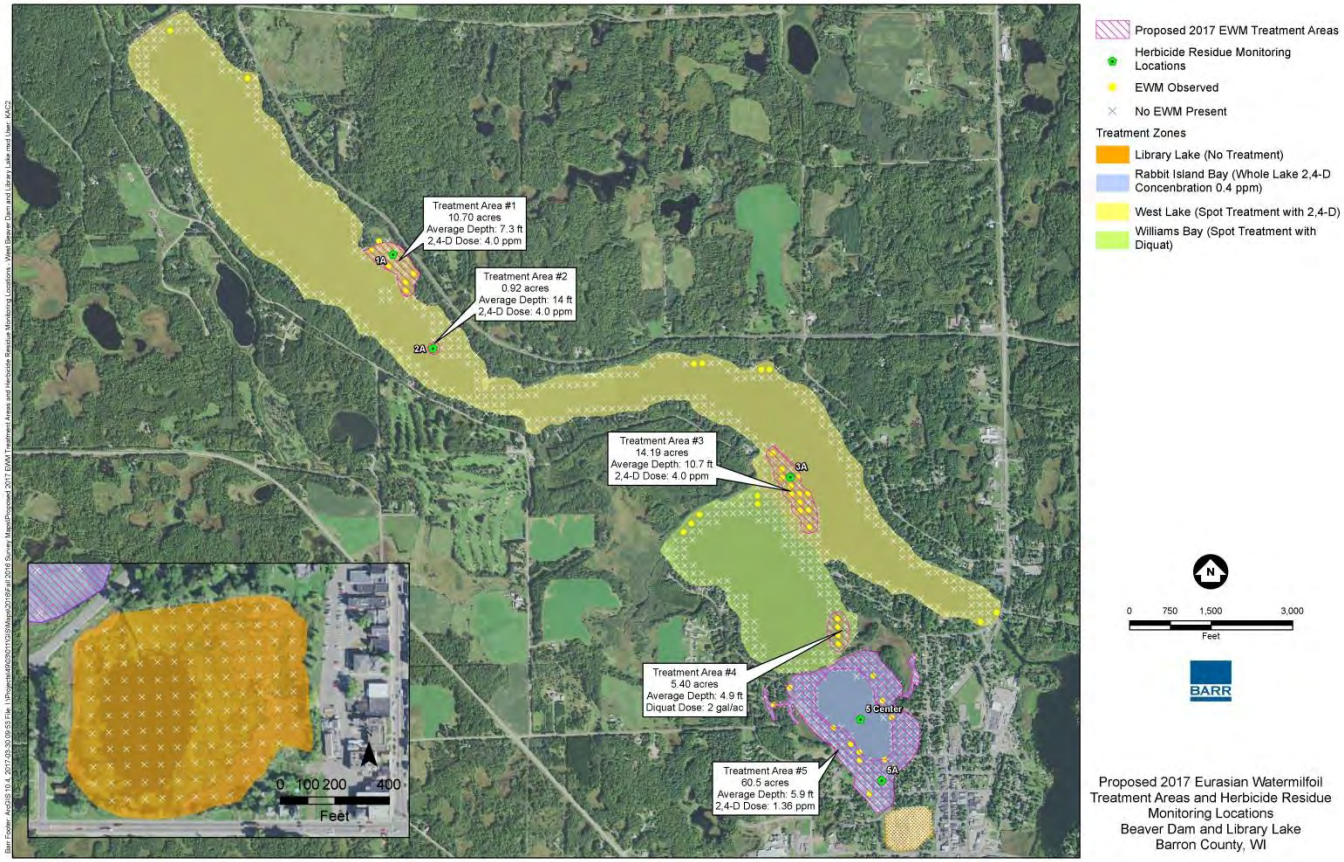

Figure 1: Proposed 2017 Eurasian Watermilfoil Herbicide Treatment Areas and Herbicide Residue Monitoring Locations: West Lake Basins

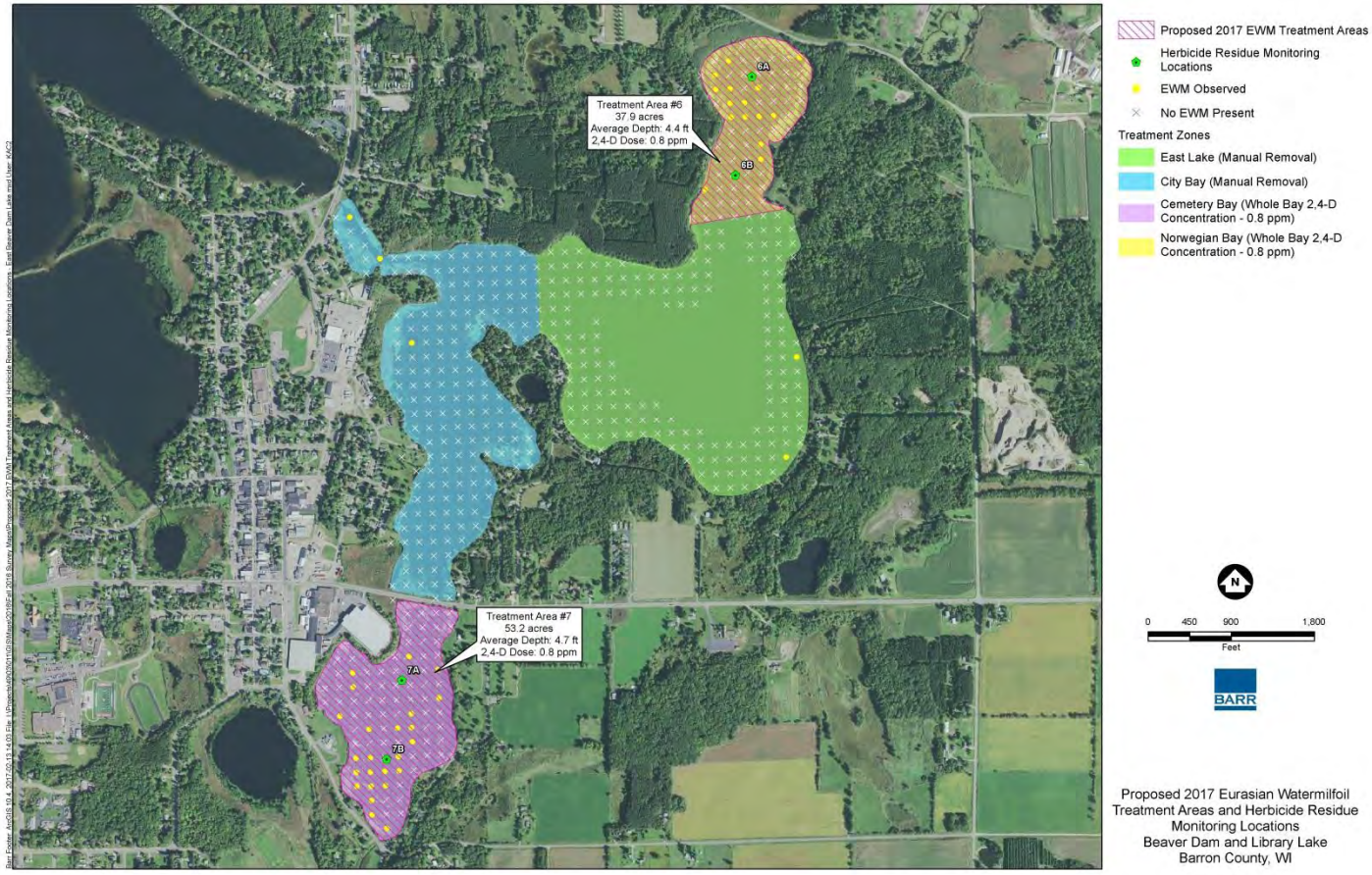

Figure 2: Proposed 2017 Eurasian Watermilfoil Herbicide Treatment Areas and Herbicide Residue Monitoring Locations: East Lake Basins

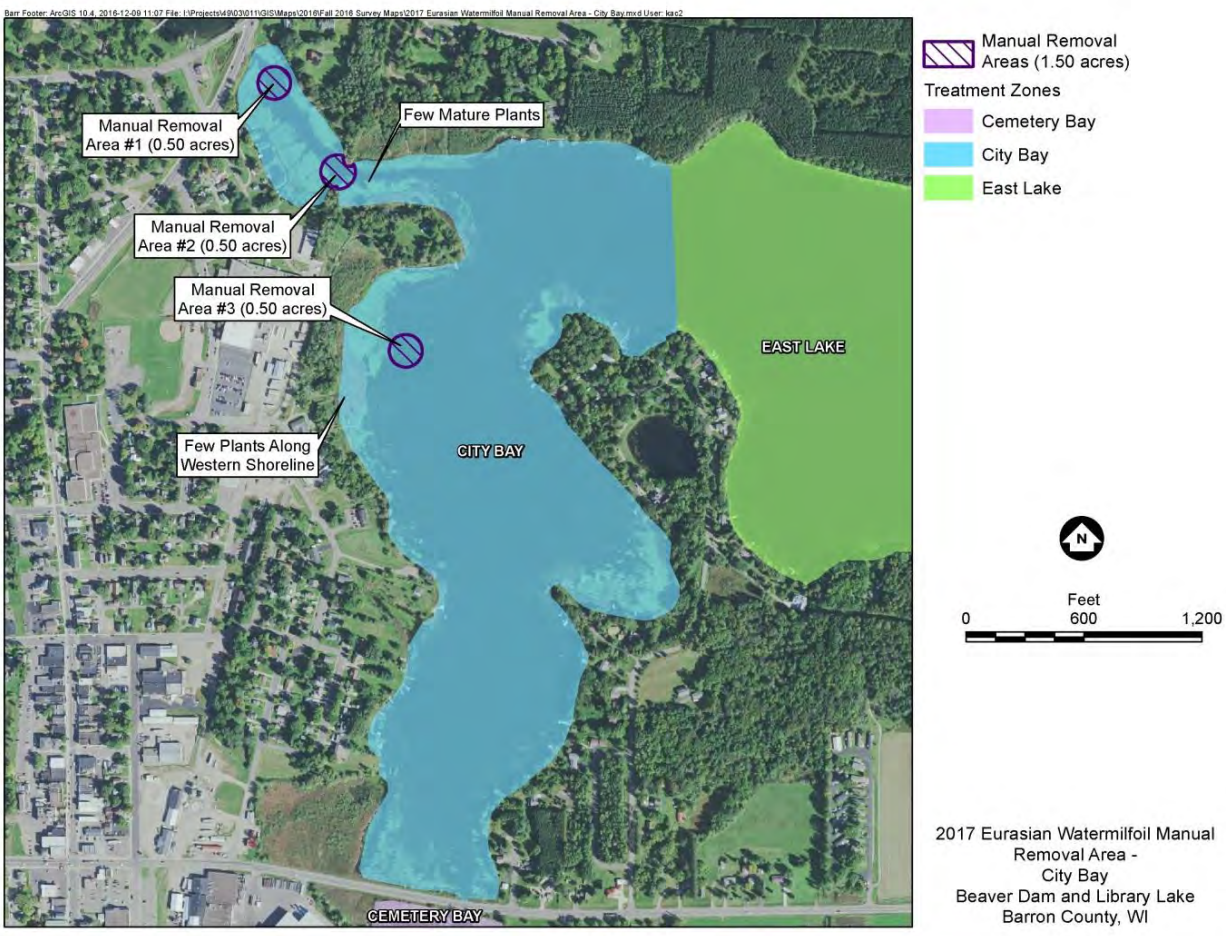

Figure 3: Proposed 2017 Eurasian Watermilfoil Manual Removal Areas: City Bay

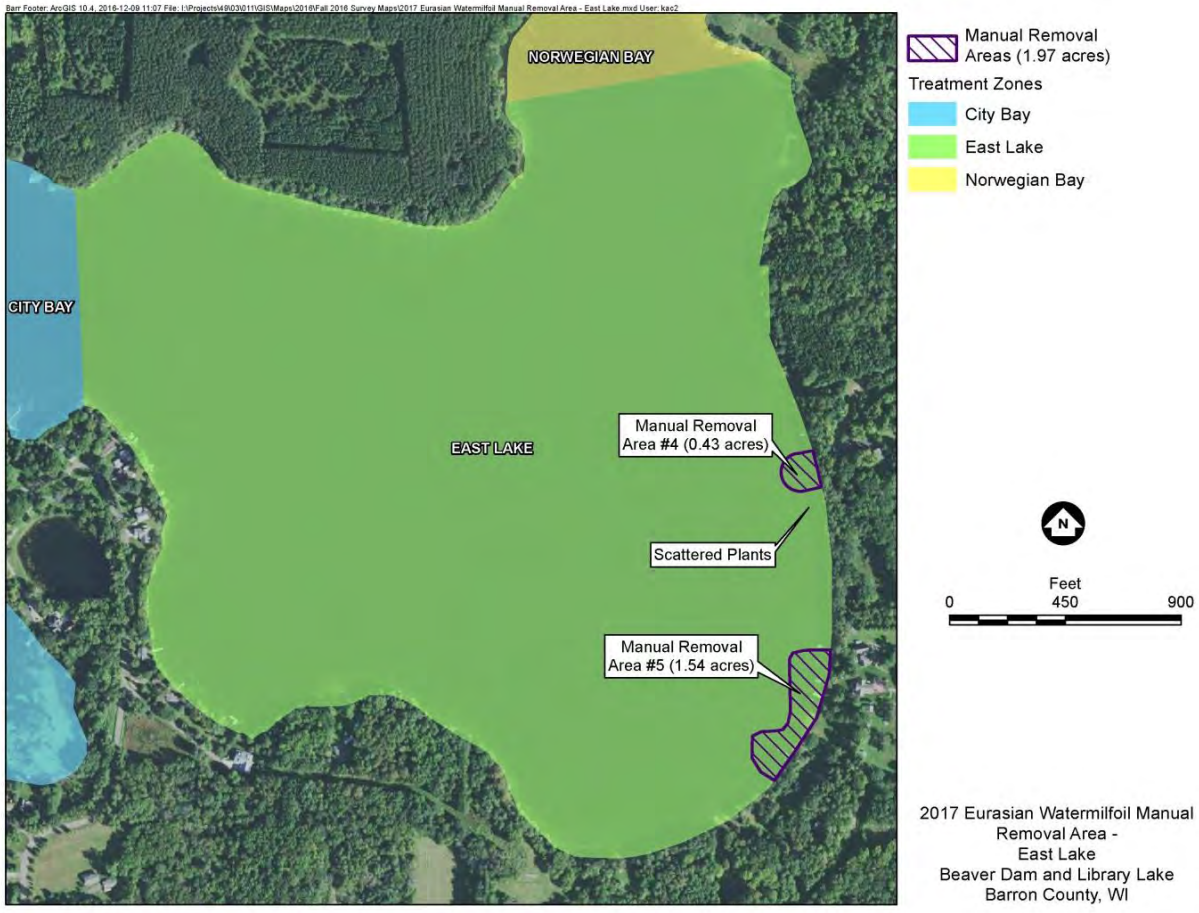

Figure 4: Proposed 2017 Eurasian Watermilfoil Manual Removal Areas: East Lake

The whole bay/littoral area herbicide treatments are expected to suppress the EWM infestation in the treated areas to very low levels, but some EWM will likely survive. Removal of surviving EWM throughout the growing season will be important to keep EWM suppressed to very low levels. EWM spreads explosively in Beaver Dam Lake and a handful of plants become hundreds of plants in just a few months. To keep EWM at very low levels, EWM observed in Beaver Dam Lake will be manually removed whenever feasible during 2017. A detailed discussion of the 2017 EWM management program follows.

1.1 EWM Herbicide Treatments

1.1.1 West Lake

The West Lake 2,4-D herbicide treatment consists of spot treatments in three areas of the lake. Treatment areas 1, 2, and 3 shown on Figure 1 will be treated with a 2,4-D dose of 4 ppm. The treatments will occur within two to three weeks after ice out under no wind conditions when the water is still to minimize mixing with untreated waters.

1.1.2 Williams Bay

The Williams Bay herbicide treatment consists of a spot treatment in one area of the lake. Treatment area 4 shown on Figure 1 will be treated with a diquat dose of 2 gallons per acre. The treatment will occur within two to three weeks after ice out under no wind conditions when the water is still to minimize mixing with untreated waters.

1.1.3 Rabbit Island Bay

The Rabbit Island Bay 2,4-D treatment is a whole littoral area treatment. The littoral area includes the area of the lake up to the 25 foot depth and totals 60.5 acres (Figure 1 and Table 1). A 2,4-D dose of 1.36 ppm will be applied to the entire littoral area. The expected whole lake concentration after dissipation and mixing is 0.4 ppm (Figure 1 and Table 1). The Rabbit Island Bay herbicide treatment will be completed in a single day. Herbicide treatment will occur when the thermocline has been established and the thermocline depth is less than or equal to 20 feet. Applying the herbicide when Rabbit Island Bay is stratified and the thermocline is less than or equal to the 20 foot depth will insure that the volume of water that mixes with the herbicide after application is within the treatment design volume and that the target whole lake concentration is attained. Treatment efficacy would be compromised if the herbicide were applied prior to basin stratification or applied when the thermocline depth was greater than 20 feet. To determine thermocline depth, temperature measurements will occur beginning two weeks after ice-out and continuing through the day of herbicide treatment. Initially temperature measurements will be made on Mondays, Wednesdays, and Fridays. When the thermocline reaches 15 feet, temperature measurements will be made daily until and including the day of treatment. The water temperatures will be measured at 1

meter intervals from the surface to bottom of Rabbit Island Bay. If unforeseen circumstances prevent the Rabbit Island Bay herbicide treatment from occurring when the thermocline is 20 feet or less, no herbicide treatment will occur in 2017.

1.1.4 Norwegian Bay

The Norwegian Bay 2,4-D treatment is a whole bay treatment. The bay totals 37.9 acres (Figure 2 and Table 1). A 2,4-D dose of 0.8 ppm will be applied to the entire bay. Hence, the expected whole bay concentration after treatment is 0.8 ppm (Figure 1 and Table 1). The Norwegian Bay herbicide treatment will be completed in a single day. Herbicide treatment will occur when the average water column temperature is 60 degrees Fahrenheit or less. It is expected that the average water column temperature will be at least 55 degrees Fahrenheit at the time of herbicide treatment. However, if Wisconsin Department of Natural Resources (WDNR) staff determines the EWM is ready for treatment when the average water column temperature is less than 55 degrees Fahrenheit and recommends that treatment proceed, the treatment will proceed per the recommendation of WDNR staff. Treating Norwegian Bay when the average water column temperature is 60 degrees Fahrenheit or less protects the native plant species from harm. Native plant species typically begin growing after the average water column temperature reaches 60 degrees Fahrenheit. Experience in Beaver Dam Lake during 2015 indicated applying a lethal dose of herbicide at or shortly prior to the start of the native plant growing season exposed infant plants to a lethal dose of herbicide and harmed the natives. The 2017 herbicide treatment plan protects natives by applying the herbicide when the average water column temperature is 60 degrees Fahrenheit or less. Water temperature measurements will occur beginning two weeks after ice-out and continuing through the day of herbicide treatment. Initially, water temperature measurements will be made on Mondays, Wednesdays, and Fridays. When the average water column temperature reaches 55 degrees Fahrenheit, water temperatures will be measured daily until and including the day of herbicide treatment. The daily water temperatures will be measured at 1 meter intervals from the surface to bottom of Norwegian Bay. If unforeseen circumstances prevent the Norwegian Bay treatment from occurring when the average water column temperature is 60 degrees Fahrenheit or less, no herbicide treatment will occur in 2017.

1.1.5 Cemetery Bay

The Cemetery Bay 2,4-D treatment is a whole bay treatment. The bay totals 53.2 acres (Figure 2 and Table 1). A 2,4-D dose of 0.8 ppm will be applied to the entire bay. Hence, the expected whole bay concentration after treatment is 0.8 ppm (Figure 1 and Table 1). The Cemetery Bay herbicide treatment will be completed in a single day. Herbicide treatment will occur when the average water column temperature is 60 degrees Fahrenheit or less. It is expected that the average water column temperature

will be at least 55 degrees Fahrenheit at the time of herbicide treatment. However, if Wisconsin Department of Natural Resources (WDNR) staff determines the EWM is ready for treatment when the average water column temperature is less than 55 degrees Fahrenheit and recommends that treatment proceed, the treatment will proceed per the recommendation of WDNR staff. Treating Cemetery Bay when the average water column temperature is 60 degrees Fahrenheit or less protects the native plant species from harm. Native plant species typically begin growing after the average water column temperature reaches 60 degrees Fahrenheit. Experience in Beaver Dam Lake during 2015 indicated applying a lethal dose of herbicide at or shortly prior to the start of the native plant growing season exposed infant plants to a lethal dose of herbicide and harmed the natives. The 2017 herbicide treatment plan protects natives by applying the herbicide when the average water column temperature is 60 degrees Fahrenheit or less. Water temperature measurements will occur beginning two weeks after ice-out and continuing through the day of herbicide treatment. Initially, water temperature measurements will be made on Mondays, Wednesdays, and Fridays. When the average water column temperature reaches 55 degrees Fahrenheit, water temperatures will be measured daily until and including the day of herbicide treatment. The daily water temperatures will be measured at 1 meter intervals from the surface to bottom of Cemetery Bay. If unforeseen circumstances prevent the Cemetery Bay treatment from occurring when the average water column temperature is 60 degrees Fahrenheit or less, no herbicide treatment will occur in 2017.

1.2 Manual EWM Removal

Based upon the 2016 fall plant survey, two areas of the lake will use manual removal to manage EWM in 2017 – East Lake and City Bay.

In City Bay, manual removal will occur in three 0.5 acre areas shown on Figure 3. In addition, EWM plants along the western shore and to the east of Area 2 will be manually removed (Figure 3). Although DASH can be tried for manual removal, it is anticipated that the soft muck bottom in City Bay might make DASH difficult. When organic muck is stirred up, the area tends to go to zero visibility quickly, making DASH removal difficult. Rake removal works well in soft muck bottom areas. Hence, rake removal will probably be used to remove EWM in City Bay.

In East Lake, manual removal will occur in the two areas shown in Figure 4. In addition, EWM plants observed between the two areas will be removed. The EWM manual removal area in East Lake is about 2 acres. EWM in East Lake will be removed by DASH.

Manual removal of EWM shown in Figures 3 and 4 will occur in June before EWM begins fragmenting.

The 2017 herbicide treatment in Rabbit Island Bay, Norwegian Bay, and Cemetery Bay is expected to suppress the EWM infestation to very low levels, but some EWM will likely survive. Removal of surviving EWM throughout the growing season will be important to keep EWM suppressed to very low levels. EWM spreads explosively in Beaver Dam Lake and a handful of plants become hundreds of plants in just a few months. To keep EWM at very low levels, EWM observed in Beaver Dam Lake will be manually removed whenever feasible during 2017

2.0 2017 Monitoring Programs

The 2017 monitoring programs consist of 2,4-D herbicide residue monitoring after the herbicide treatment and aquatic plant surveys during July and October.

2.1 2,4-D Residue Monitoring

In 2017, 2,4-D herbicide residue monitoring will occur in 9 representative locations to determine whether the target dose was attained as well as the rate of herbicide decline due to dilution, mixing, and natural degradation. Monitoring locations are shown in Figures 1 and 2. Samples will be collected at mid-depth from each location during the monitoring period. Specific sample collection times for the treatment areas are shown in Table 1. It should be noted that: (1) if the sample collection time for 1 and 4 hours after treatment occurs after dark, the sample will not be collected; (2) if weather conditions make sample collection unsafe during any of the scheduled sample collection times, samples will not be collected.

Table 2 2017 2,4-D Residue Monitoring Plan

Treatment Area	Sample Site ID	Sample Collection Time (Hours After Treatment	Sample Collection Time (Days After Treatment)
West Lake	1A, 2A, and 3A	1 and 4	1, 2, 3, 4
Rabbit Island Bay	5A and 5 Center	1 and 4	1, 2, 3, 5, 7, 12, 19, and 26
Norwegian Bay	6A and 6B	1 and 4	1, 2, 3, 5, 7, 12, 19, and 26
Cemetery Bay	7A and 7B	1 and 4	1, 2, 3, 5, 7, 12, 19, and 26

2.2 2017 Aquatic Plant Monitoring Programs

The 2017 aquatic plant monitoring programs will include a July survey of all plant species and an October survey of aquatic invasive species (EWM and CLP). Details of the aquatic plant monitoring programs follow.

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engineering and environmental consultants

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Memorandum

To: Beaver Dam Lake Management District (Board of Commissioners)

From: Barr Engineering Co. (Meg Rattei)

Subject: Proposed 2018 Eurasian Watermilfoil (EWM) Management Program, Monitoring Programs, and Navigation Channel Inspection

Date: February 2, 2018

Project: 49030011.18

c: Jim Bartlett (Lake Restoration, Inc.), Alex Smith (WDNR), Mark Sundeen (WDNR), Scott Provost (WDNR), Scott Van Egeren, and John Skogerboe (Research Scientist)

The purpose of this memorandum is to present:

1. 2018 EWM Management Program
2. 2018 Monitoring Programs
3. 2018 Navigation Channel Inspection and Treatment Program

1.0 2018 EWM Management Program

The proposed 2018 EWM management program is a combination of herbicide treatment and manual removal of EWM. Herbicides used for herbicide treatment include 2,4-D and diquat. Manual removal will include Diver Assisted Suction Harvesting (DASH) wherever feasible and rake removal in shallow areas in which the soft bottom would make it difficult to remove EWM by DASH.

Based upon the results of the 2017 fall plant survey, the following EWM management is planned for 2018: (1) 2,4-D whole bay treatment of Norwegian Bay and City Bay, (2) Diquat spot treatments in Rabbit Island Bay and West Lake (3) DASH removal of EWM in West Lake, Williams Bay, and East Lake, and (4) Rake removal in Library Lake. The 2,4-D treatment areas total 161.30 acres. The diquat treatment areas total 10.31 acres. DASH removal areas total 6.42 acres. Rake removal areas total 0.70 acres. Table 1 summarizes the proposed 2018 Beaver Dam Lake EWM management program and Figures 1 and 2 show the EWM management areas.

Cemetery Bay does not require EWM management in 2018 because EWM was not observed during the fall plant survey.

Table 1 Proposed 2018 Beaver Dam Lake EWM Herbicide Treatment Program

Location	EWM Extent (ac)	EWM Management Method	EWM Management Area	Name of Herbicide	Herbicide Dose Applied to Treatment Area	Expected Whole Bay/Lake Concentration (ppm)
West Lake	21.05	Herbicide Treatment	21.20	2,4-D	4 ppm	--
		Herbicide Treatment	9.11	Diquat	2 gallons per acre	--
		DASH	5.34	--	--	--
Williams Bay	0.26	DASH	0.38	--	--	--
Rabbit Island Bay	0.83	Herbicide Treatment	1.20	Diquat	2 gallons per acre	--
Library Lake	0.43	Rake Removal	0.70	--	--	--
Norwegian Bay	6.19	Herbicide Treatment	37.90	2,4-D	1.2	1.2
East Lake	0.48	DASH	0.70	--	--	--
City Bay	5.13	Herbicide Treatment	102.20	2,4-D	1.2	1.2
Cemetery Bay	0.00	None	--	--	--	--

Treatment Area #1
7.92 acres
Average Depth: 7.4 ft
2,4-D Dose: 4 ppm

Treatment Area #2
0.52 acres
Average Depth: 4.5 ft
DASH

Treatment Area #4
0.36 acres
Average Depth: 11.0 ft
DASH

Treatment Area #5
0.38 acres
Average Depth: 3.0 ft
DASH

Treatment Area #6
1.02 acres
Average Depth: 9.0 ft
DASH

Treatment Area #7
1.01 acres
Average Depth: 9.0 ft
DASH

Treatment Area #3
1.16 acres
Average Depth: 12.0 ft
DASH

Treatment Area #8
0.26 acres
Average Depth: 4.0 ft
DASH

Treatment Area #9
0.94 acres
Average Depth: 14.0 ft
Diquat Dose: 2 gal/acre

Treatment Area #10
0.45 acres
Average Depth: 8.0 ft
DASH

Treatment Area #11
3.23 acres
Average Depth: 4.3 ft
2,4-D Dose: 4 ppm

Treatment Area #12
0.18 acres
Average Depth: 5.0 ft
DASH

Treatment Area #13
2.45 acres
Average Depth: 10.8 ft
Diquat Dose: 2 gal/acre

Treatment Area #14
5.05 acres
Average Depth: 9.6 ft
Diquat Dose: 2 gal/acre

Treatment Area #15
0.67 acres
Average Depth: 7.8 ft
Diquat Dose: 2 gal/acre

Treatment Area #16
10.05 acres
Average Depth: 5.8 ft
2,4-D Dose: 4 ppm

Treatment Area #17
0.38 acres
Average Depth: 7.0 ft
DASH

Treatment Area #18
0.5 acres
Average Depth: 3.3 ft
Diquat Dose: 2 gal/acre

Treatment Area #19
0.3 acres
Average Depth: 3.0 ft
Diquat Dose: 2 gal/acre

Treatment Area #20
0.4 acres
Average Depth: 5.0 ft
Diquat Dose: 2 gal/acre

Treatment Area #21
0.5 acres
Average Depth: 2.2 ft
Rake Removal in June

Treatment Area #22
0.1 acres
Average Depth: 3 ft
Rake Removal in June

Treatment Area #23
0.1 acres
Average Depth: 4 ft
Rake Removal in June

N
0 100 200 400
Feet

Proposed 2018 EWM Treatment Areas
EWM Observed
No EWM Present

Treatment Zones
Library Lake (Rake Removal in June)
Rabbit Island Bay (Spot Treatment with Diquat at 2 gal/acre)
West Lake (Spot Treatment with Diquat at 2 gal/acre, Spot Treatment with 2,4-D at 4 ppm or DASH)
Williams Bay (DASH)

N
0 750 1,500 3,000
Feet

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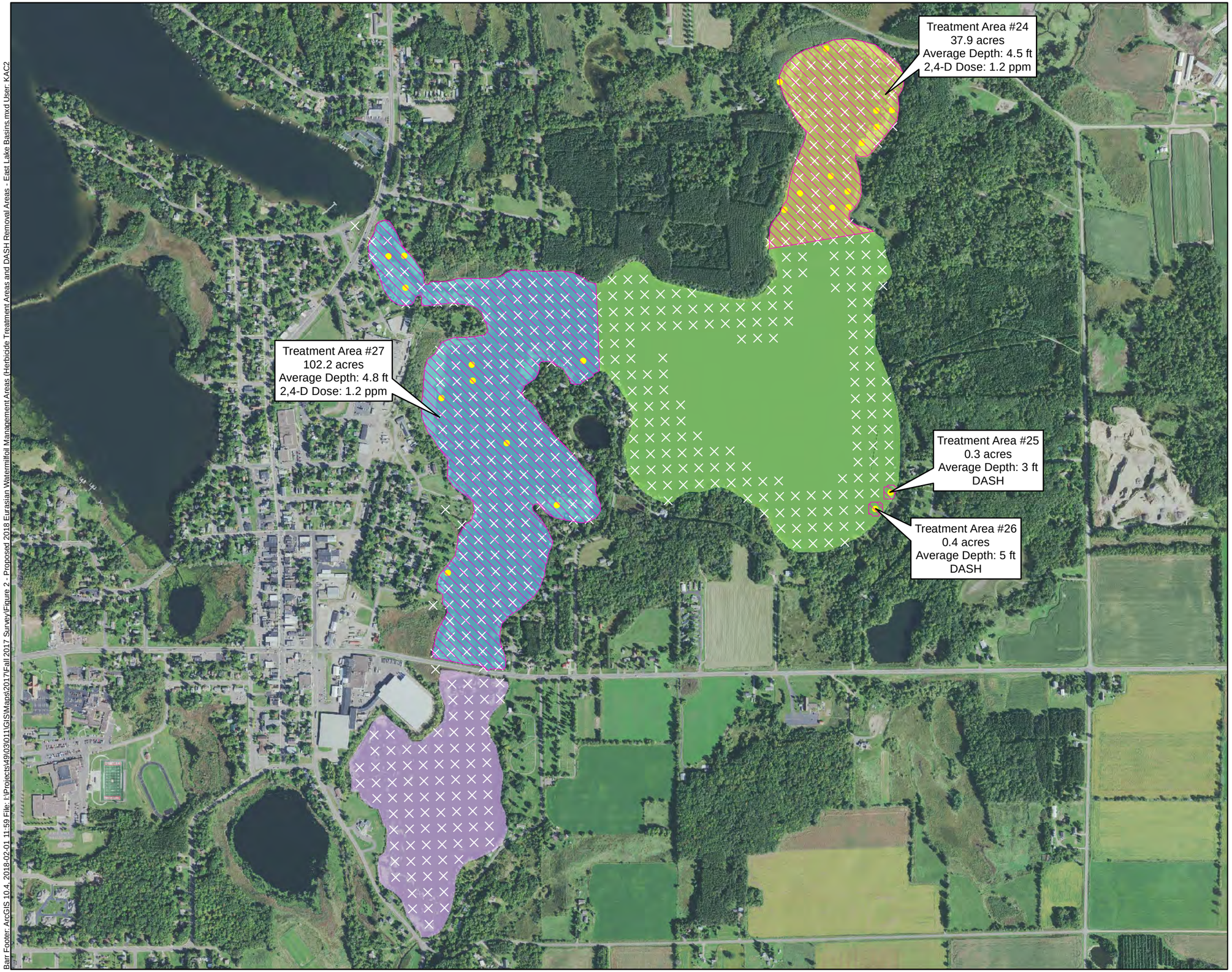
Figure 1

PROPOSED 2018 EURASIAN WATERMILFOIL MANAGEMENT AREAS (HERBICIDE TREATMENT AREAS, DASH REMOVAL AREAS, AND RAKE REMOVAL AREAS): WEST LAKE BASINS
Beaver Dam and Library Lake
Barron County, WI

J-71

Barr Footer: ArcGIS 10.4, 2018-02-08 15:00 File: I:\Projects\4903\011\GIS\Maps\2017\Fall 2017 Survey\Figure 1 - Proposed 2018 Eurasian Watermilfoil Management Areas (Herbicide Treatment Areas, DASH Removal Areas and Rake Removal Areas - West Lake Basins.mxd User: kac2



Proposed 2018 EWM Treatment Areas

EWM Observed

No EWM Present

Treatment Zones

East Lake (DASH)

City Bay (Whole Bay 2,4-D Concentration - 1.2 ppm)

Cemetery Bay (No Treatment)

Norwegian Bay (Whole Bay 2,4-D Concentration - 1.2 ppm)

N

0 450 900 1,800

Feet

BARR

Figure 2

PROPOSED 2018 EURASIAN WATERMILFOIL MANAGEMENT AREAS (HERBICIDE TREATMENT AREAS AND DASH REMOVAL AREAS): EAST LAKE BASINS
Beaver Dam and Library Lake
Barron County, WI

J-72

Barr Footer: ArcGIS 10.4, 2018-02-01 11:59 File: I:\Projects\49\03\011\GIS\Maps\2017\Fall 2017 Survey\Figure 2 - Proposed 2018 Eurasian Watermilfoil Management Areas (Herbicide Treatment Areas and DASH Removal Areas - East Lake Basins.mxd User: KAC2

The herbicide treatments are expected to suppress the EWM infestation in the treated areas to very low levels, but some EWM will likely survive. Removal of surviving EWM throughout the 2018 growing season will be important to keep EWM suppressed to very low levels. EWM spreads explosively in Beaver Dam Lake and a handful of plants becomes hundreds of plants in just a few months. To keep EWM at very low levels, EWM observed in Beaver Dam Lake will be removed using Diver Assisted Suction Harvesting (DASH) whenever it is observed and DASH removal is feasible. Rake removal will be used to remove EWM in shallow areas in which the soft bottom would make it difficult to remove EWM by DASH.

A detailed discussion of the 2018 EWM management program follows.

1.1 EWM Management in Individual Bays and Basins

1.1.1 Williams Bay

EWM in Williams Bay will be removed by DASH. The DASH removal area is 0.38 acres (treatment area 17 on Figure 1).

1.1.2 West Lake

EWM management in West Lake will be a combination of manual removal by DASH or herbicide treatments with either 2,4-D or diquat.

The West Lake DASH removal areas are comprised of 9 individual areas ranging in size from 0.18 acres to 1.16 acres (treatment areas 2 through 8, 10, and 12 shown on Figure 1) and totaling 5.34 acres.

In 2018, EWM management in West Lake, pictured above, will include manual removal by DASH and spot herbicide treatments with either 2,4-D or diquat.

2,4-D will be used to treat three individual areas in West Lake (treatment areas 1, 11, and 16 shown on Figure 1). The three individual areas range in size from 3.23 acres to 10.05 acres (Figure 1) and total 21.2 acres. The three areas will be treated with a 2,4-D dose of 4 ppm. The treatments will occur within two to three weeks after ice out. For areas 11 and 16, the treatments will occur under no wind conditions when the water is still to minimize mixing with untreated waters. For treatment area 1, it would be helpful if the treatment were timed when there was a slight south breeze.

Diquat will be used to treat four individual areas in West Lake (treatment areas 9, 13, 14, and 15 shown on Figure 1). The four individual areas range in size from 0.67 acres to 5.05 acres (Figure 1) and total 9.11 acres. The four areas will be treated with diquat at a dose of 2 gallons per acre. The treatment will occur within two to three weeks after ice out under no wind conditions when the water is still to minimize mixing with untreated waters.

1.1.3 Rabbit Island Bay

The Rabbit Island Bay herbicide treatment will be a spot treatment of 1.2 acres with diquat at a dose of 2 gallons per acre. Diquat will be used to treat 3 individual areas in Rabbit Island Bay (treatment areas 18 through 20 shown on Figure 1) ranging in size from 0.3 to 0.5 acres. The treatment will occur within two to three weeks after ice out under no wind conditions when the water is still to minimize mixing with untreated waters. Because treatment area 18 is vulnerable to becoming turbid during herbicide application, care should be taken to minimize stirring up the water during herbicide application. Diquat quickly attaches to organic material and is inactivated by turbid conditions.

1.1.4 Library Lake

EWM management in Library Lake will be rake removal of 0.7 acres (Figure 1). The rake removal areas are comprised of 3 individual areas ranging in size from 0.1 acres to 0.5 acres (treatment areas 22 through 24 on Figure 1). The areas are not suitable for DASH because the muck bottom would result in a lot of turbidity, making it difficult to see well enough for DASH removal. The soft muck bottom, however, is ideal for rake removal.

1.1.5 Norwegian Bay

The Norwegian Bay 2,4-D treatment will be a whole bay treatment. The bay totals 37.9 acres (treatment area 24 on Figure 2). A 2,4-D dose of 1.2 ppm will be applied to the entire bay. Past treatments have indicated significant dilution from inflowing waters has rapidly reduced the whole bay 2,4-D concentration after treatment. In 2016, the whole bay concentration of 2,4-D was about 75 percent less than the application rate within 2 to 3 days after treatment. Although the expected whole bay 2,4-D concentration after treatment is 1.2 ppm (Figure 1 and Table 1), 2016 data indicate dilution from inflowing waters could substantially reduce the whole lake 2,4-D concentration within 2 to 3 days after treatment. With the expected dilution, it is estimated that a whole bay concentration of at least 0.3 ppm will be attained and

sustained for at least 4 days after treatment. A 2,4-D concentration of at least 0.3 ppm sustained for at least 4 days has been found to be lethal to EWM.[1]

The Norwegian Bay herbicide treatment will be completed in a single day. Herbicide treatment will occur when the average water column temperature is 60 degrees Fahrenheit or less. It is expected that the average water column temperature will be at least 55 degrees Fahrenheit at the time of herbicide treatment. However, if Wisconsin Department of Natural Resources (WDNR) staff determines the EWM is ready for treatment when the average water column temperature is less than 55 degrees Fahrenheit and recommends that treatment proceed, the treatment will proceed per the recommendation of WDNR staff. Treating Norwegian Bay when the average water column temperature is 60 degrees Fahrenheit or less protects the native plant species from harm. Native plant species typically begin growing after the average water column temperature reaches 60 degrees Fahrenheit. Experience in Beaver Dam Lake during 2015 indicated applying a lethal dose of herbicide at or shortly prior to the start of the native plant growing season exposed infant plants to a lethal dose of herbicide and harmed the natives. The 2018 herbicide treatment plan protects natives by applying the herbicide when the average water column temperature is 60 degrees Fahrenheit or less.

Water temperature measurements will occur beginning 2 weeks after ice-out and continuing through the day of herbicide treatment. Initially, water temperature measurements will be made on Mondays, Wednesdays, and Fridays. When the average water column temperature reaches 55 degrees Fahrenheit, water temperatures will be measured daily until and including the day of herbicide treatment. The daily water temperatures will be measured at 1 meter intervals from the surface to bottom of Norwegian Bay at the location shown in Figure 3. If unforeseen circumstances prevent the whole bay Norwegian Bay herbicide treatment from occurring when the average water column temperature is 60 degrees Fahrenheit or less, the whole bay Norwegian Bay herbicide treatment will not occur in 2018.

1.1.6 City Bay

The City Bay 2,4-D treatment will be a whole bay treatment. The bay totals 102.2 acres (treatment area 27 shown on Figure 2). A 2,4-D dose of 1.2 ppm will be applied to the entire bay. Dilution from East Lake and West Lake is expected to reduce the whole lake concentration of 2,4-D after treatment to less than 1.2 ppm after treatment. In 2015, dilution from West Lake reduced the 2,4-D concentration of the northern most herbicide residue monitoring location by about 25 percent 2 days after treatment. Despite

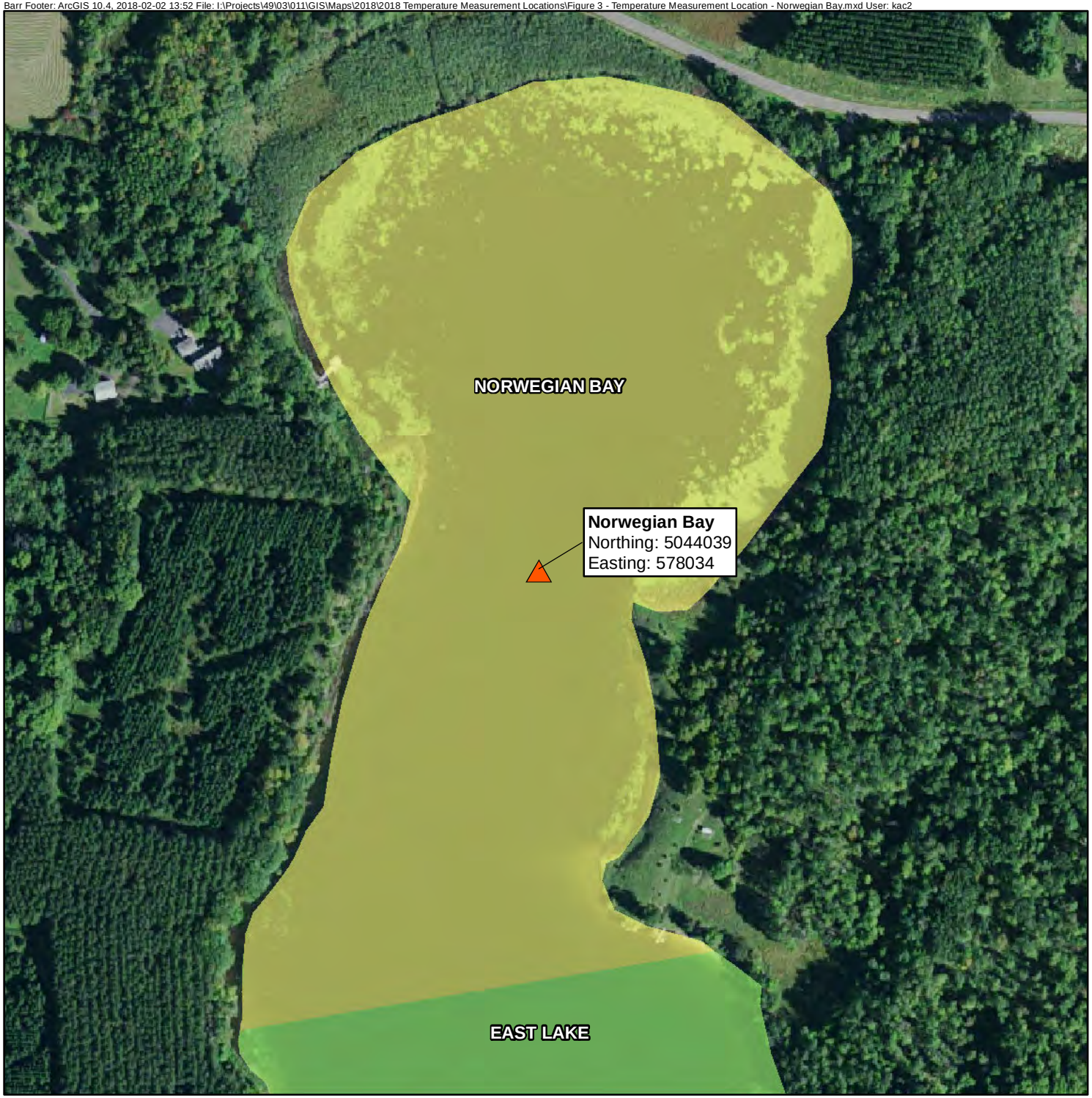
[1] Green, W.R. and H.E. Westerdahl. 1990. "Response of Eurasian watermilfoil to 2,4-D concentrations and exposure times." *J. Aquat. Plant Manage*. 28:27-32

dilution, it is hoped that a 2,4-D concentration of 0.6 ppm to 0.8 ppm can be attained and sustained for at least 4 days after treatment.

The City Bay herbicide treatment will be completed in a single day. Herbicide treatment will occur when the average water column temperature is 60 degrees Fahrenheit or less. It is expected that the average water column temperature will be at least 55 degrees Fahrenheit at the time of herbicide treatment. However, if Wisconsin Department of Natural Resources (WDNR) staff determines the EWM is ready for treatment when the average water column temperature is less than 55 degrees Fahrenheit and recommends that treatment proceed, the treatment will proceed per the recommendation of WDNR staff. Treating City Bay when the average water column temperature is 60 degrees Fahrenheit or less protects the native plant species from harm. Native plant species typically begin growing after the average water column temperature reaches 60 degrees Fahrenheit. Experience in Beaver Dam Lake during 2015 indicated applying a lethal dose of herbicide at or shortly prior to the start of the native plant growing season exposed infant plants to a lethal dose of herbicide and harmed the natives. The 2018 herbicide treatment plan protects natives by applying the herbicide when the average water column temperature is 60 degrees Fahrenheit or less.

Water temperature measurements will occur beginning 2 weeks after ice-out and continuing through the day of herbicide treatment. Initially, water temperature measurements will be made on Mondays, Wednesdays, and Fridays. When the average water column temperature reaches 55 degrees Fahrenheit, water temperatures will be measured daily until and including the day of herbicide treatment. The daily water temperatures will be measured at 1 meter intervals from the surface to bottom of City Bay at the location shown in Figure 4. If unforeseen circumstances prevent the whole bay herbicide treatment of City Bay from occurring when the average water column temperature is 60 degrees Fahrenheit or less, the whole bay herbicide treatment of City Bay will not occur in 2018.

Barr Footer: ArcGIS 10.4, 2018-02-02 13:52 File: I:\Projects\49\03\011\GIS\Maps\2018\2018 Temperature Measurement Locations\Figure 3 - Temperature Measurement Location - Norwegian Bay.mxd User: kac2



Temperature Measurement Location

Treatment Zones

East Lake

Norwegian Bay

Coordinates are listed in UTM NAD83 Zone 15N (meters)

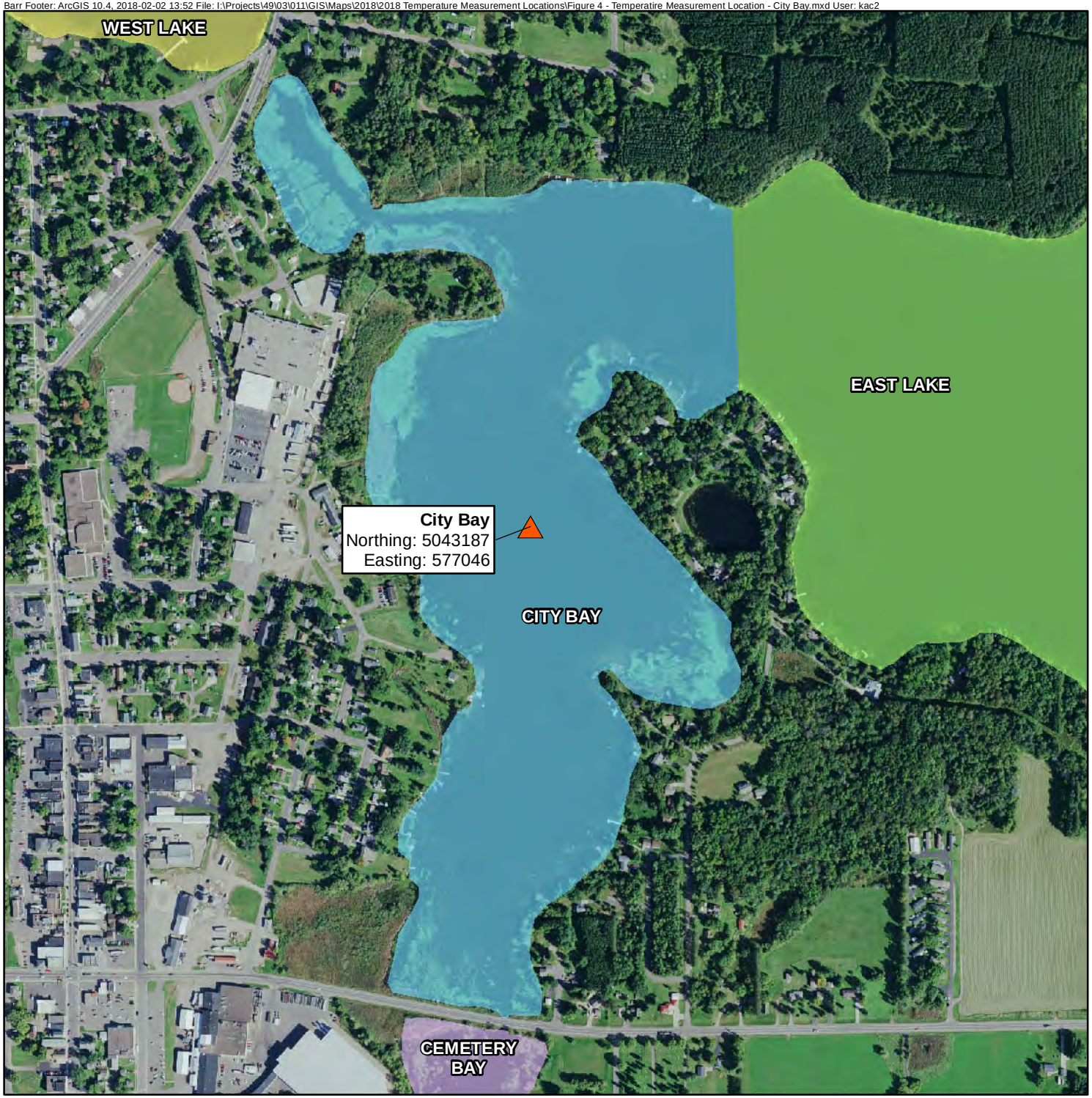
N

Feet
0 300 600

Figure 3

2018 TEMPERATURE MEASUREMENT LOCATION: NORWEGIAN BAY
Beaver Dam and Library Lake
Barron County, WI

Barr Footer: ArcGIS 10.4, 2018-02-02 13:52 File: I:\Projects\49\03\011\GIS\Maps\2018\2018 Temperature Measurement Locations\Figure 4 - Temperatire Measurement Location - City Bay.mxd User: kac2



Temperature Measurement Location

Treatment Zones

- Cemetery Bay
- City Bay
- East Lake
- West Lake

Coordinates are listed in UTM NAD83 Zone 15N (meters)

N

Feet
0 650 1,300

Figure 4

2018 TEMPERATURE MEASUREMENT LOCATION: CITY BAY
Beaver Dam and Library Lake
Barron County, WI

1.1.7 East Lake

EWM in East Lake will be removal by DASH. The DASH removal areas are two individual areas ranging in size from 0.3 to 0.4 acres and totaling 0.7 acres (treatment areas 25 and 26 shown on Figure 2).

1.1.8 Cemetery Bay

EWM was not observed in Cemetery Bay during the July and October 2017 plant surveys. Hence, herbicide treatment will **not** occur in 2018.

1.2 Manual EWM Removal

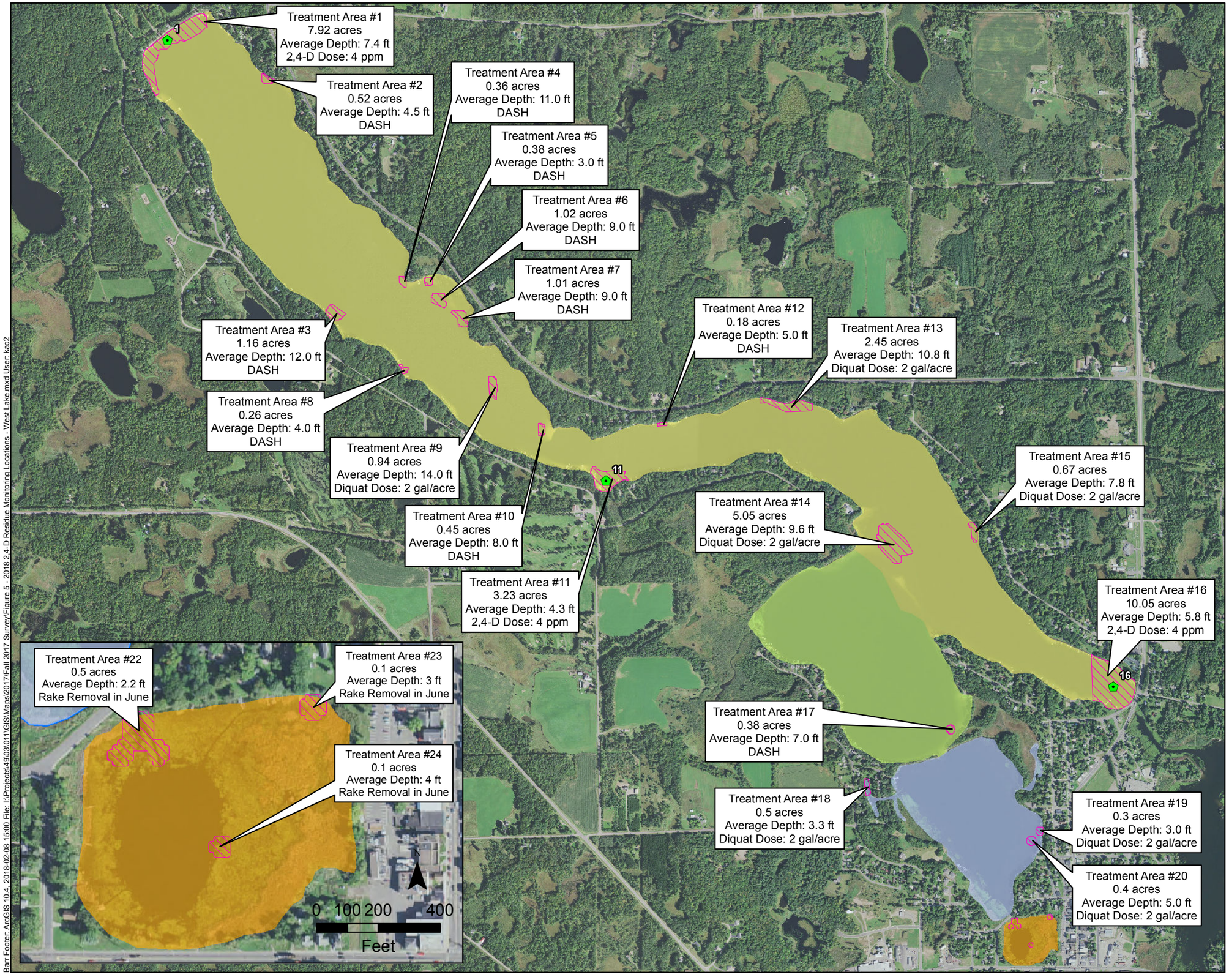
The 2018 herbicide treatment and early season DASH/rake removal are expected to suppress the EWM infestation to very low levels, but some EWM will likely survive. Removal of surviving EWM throughout the growing season will be important to keep EWM suppressed to very low levels. EWM spreads explosively in Beaver Dam Lake and a handful of plants becomes hundreds of plants in just a few months. To keep EWM at very low levels, EWM observed in Beaver Dam Lake will be manually removed whenever feasible during 2018. Removal will begin after the spring EWM management has been completed and EWM is first observed and will continue as needed during the growing season. EWM observed in the July plant survey will be manually removed after completion of the plant survey. Manual removal will include Diver Assisted Suction Harvesting (DASH) wherever feasible and rake removal in shallow areas in which the soft bottom would make it difficult to remove EWM by DASH.

2.0 2018 Monitoring Programs

The 2018 monitoring programs consist of temperature measurements prior to herbicide treatment, 2,4-D herbicide residue monitoring after herbicide treatment, and aquatic plant surveys during July and October. The temperature monitoring program is discussed in Section 1.1 EWM Herbicide treatments. The herbicide residue monitoring and aquatic plant monitoring programs are discussed in the following paragraphs.

2.1 2,4-D Residue Monitoring

In 2018, 2,4-D herbicide residue monitoring will occur in 8 representative locations to determine whether the target dose was attained as well as the rate of herbicide decline due to dilution, mixing, and natural degradation. Monitoring locations are shown in Figures 5 and 6. Samples will be collected at mid-depth from all locations during the monitoring period. Specific sample collection times for the treatment areas are shown in Table 2. It should be noted that: (1) if the sample collection time for 1 and 4 hours after treatment occurs after dark, the sample will not be collected; (2) if weather conditions make sample collection unsafe during any of the scheduled sample collection times, samples will not be collected.



Herbicide Residue Monitoring Locations

Proposed 2018 EWM Treatment Areas

Treatment Zones

- Library Lake
- Rabbit Island Bay
- West Lake
- Williams Bay

N

0 750 1,500 3,000

Feet

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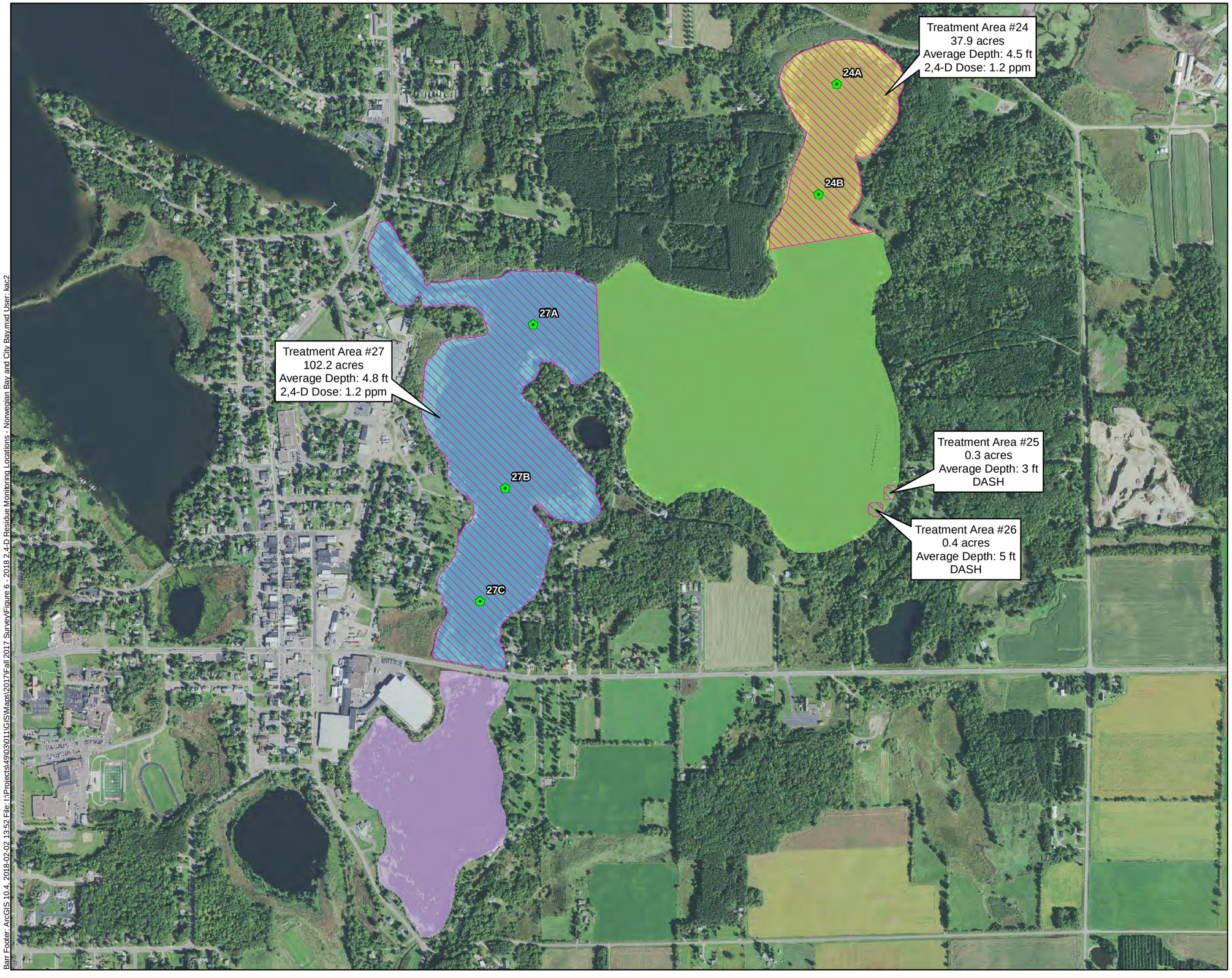
Figure 5

2018 2,4-D RESIDUE MONITORING LOCATIONS: WEST LAKE
Beaver Dam and Library Lake
Barron County, WI

J-80

Barr Footer: ArcGIS 10.4, 2018-02-08 15:00 File: I:\Projects\4903\011\GIS\Maps\2017\Fall 2017 Survey\Figure 5 - 2018 2,4-D Residue Monitoring Locations - West Lake.mxd User: kac2



Herbicide Residue Monitoring Locations

Proposed 2018 EWM Treatment Areas

Treatment Zones

- East Lake
- City Bay
- Cemetery Bay
- Norwegian Bay

N

0 450 900 1,800

Feet

BARR

Figure 6

2018 2,4-D RESIDUE MONITORING LOCATIONS: NORWEGIAN BAY AND CITY BAY

Beaver Dam and Library Lake

Barron County, WI

Barr Footer: ArcGIS 10.4, 2018-02-02 13:52 File: I:\Projects\49\03\011\GIS\Maps\2017\Fall 2017 Survey\Figure 6 - 2018 2,4-D Residue Monitoring Locations - Norwegian Bay and City Bay.mxd User: kac2

Table 2 2018 2,4-D Residue Monitoring Plan

Treatment Area	Sample Site ID	Sample Collection Time (Hours After Treatment	Sample Collection Time (Days After Treatment)
West Lake	1, 11, and 16	1 and 4	1, 2, 3, 5, 7, 12, 19, and 26
Norwegian Bay	25A and 25 B	1 and 4	1, 2, 3, 5, 7, 12, 19, and 26
City Bay	28A, 28B, and 28C	1 and 4	1, 2, 3, 5, 7, 12, 19, and 26

2.2 2018 Aquatic Plant Monitoring Programs

The 2018 aquatic plant monitoring programs will include a July survey of all plant species and an October survey of aquatic invasive species (EWM and CLP). Details of the aquatic plant monitoring programs follow.

2.2.1 July Aquatic Plant Survey – All Species

During July, a point intercept survey of about 1,346 sample points will assess the entire plant community in Beaver Dam Lake. Maps showing the sample locations are found in Appendix E of the Beaver Dam Lake APM Plan (http://www.beaverdamlake.org/apmp). Data will be summarized in tabular format using the WDNR pre-treatment/post-treatment spreadsheet. Maps will be prepared showing location and density of each species identified in the July plant survey. Maps will also be prepared that show bottom substrate, lake depth, littoral zone, native species richness, and total rake fullness. Chi squared analysis will compare 2018 data with 2017 data to identify significant changes in frequency of occurrence of native species. The July monitoring program duplicates monitoring programs completed during 2009 through 2017.

2.2.2 Fall Aquatic Invasive Species Survey

During October, a fall point intercept survey of about 1,346 sample points will assess aquatic invasive species (EWM and CLP) coverage in Beaver Dam Lake. Maps showing the sample locations are found in Appendix E of the Beaver Dam Lake APM Plan (http://www.beaverdamlake.org/apmp). The results of the EWM data collected during the fall aquatic invasive species survey will determine 2019 EWM management areas and will be used to design the 2019 EWM management program. The results of the CLP data collected during the fall aquatic invasive species survey will be evaluated to determine whether any areas would need additional CLP monitoring during June of 2019 when CLP is at its peak growth stage. The fall

aquatic invasive species monitoring program duplicates monitoring programs completed during 2006 through 2017.

3.0 2018 Navigation Channel Inspection

In 2018, an inspection of navigation channels within Beaver Dam Lake will determine whether plant growth impedes navigation. The inspection of navigation channels will occur during the July plant survey and will document any impairment of navigation channels and access corridors by plants. If impairment of navigation channels and access corridors by plants is documented, the Beaver Dam Lake Management District will contact WDNR staff to discuss the issue. If herbicide treatment of plants is warranted to alleviate navigation problems and WDNR staff will permit herbicide treatment of the plants, the Beaver Dam Lake Management District will work with a herbicide applicator to obtain a treatment permit and perform the herbicide treatment.

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Memorandum

To: Beaver Dam Lake Management District (Board of Commissioners)
From: Barr Engineering Co. (Meg Rattei)
Subject: Proposed 2019 Eurasian Watermilfoil (EWM) Management Program, Monitoring Programs, and Navigation Channel Inspection
Date: February 15, 2019
Project: 49030011.19
c: Alex Smith (WDNR), Mark Sundeen (WDNR), and Jim Bartlett (Lake Restoration, Inc.)

The purpose of this memorandum is to present:

1. 2019 EWM Management Program
2. 2019 Monitoring Programs
3. 2019 Navigation Channel Inspection and Treatment Program

1.0 2019 EWM Management Program

The proposed 2019 EWM management program is a combination of herbicide treatment and mechanical removal of EWM. The total area managed for EWM in 2019 is 56.81 acres, which is about 11 percent of the lake's 530-acre littoral area. A total of 48.22 acres will be treated with herbicide and mechanical removal of EWM will occur in 8.59 acres. Herbicides used for herbicide treatment include 2,4-D, diquat, Aquastrike, and ProcellaCor. Mechanical removal will include Diver Assisted Suction Harvesting (DASH) wherever feasible and rake removal in shallow areas in which the soft bottom would make it difficult to remove EWM by DASH. The EWM plan indicates mechanical removal whenever it is not known whether DASH or rake removal will be used.

EWM, pictured above, will be managed by herbicide treatment and mechanical removal in 2019.

Based upon the results of the 2018 fall plant survey, the following EWM management is planned for 2019: (1) a large scale 2,4-D treatment of Library Lake; (2) diquat spot treatments in West Lake, Williams Bay, Rabbit Island Bay, Norwegian Bay, and City Bay; (3) Aquastrike spot treatments in West Lake; (4) ProcellaCOR spot treatment of Hunt Bay which is located in West Lake; and (5) Mechanical EWM removal (either DASH or rake removal) in West Lake, Williams Bay, and Rabbit Island Bay. The 2,4-D treatment area in Library Lake totals 10.00 acres. The diquat treatment areas total 16.03 acres. The Aquastrike treatment areas total 18.2 acres. The Hunt Bay ProcellaCOR treatment area totals 3.99 acres. Mechanical/DASH removal areas total 8.59 acres. Table 1 summarizes the proposed 2019 Beaver Dam Lake EWM management program and Figures 1 through 3 show the EWM management areas.

Cemetery Bay and East Lake do not require EWM management in 2019 because EWM was not observed during the 2018 fall plant survey.

Table 1 Proposed 2019 Beaver Dam Lake EWM Management Program

Location	EWM Extent (ac)	EWM Management Method	EWM Management Area	Name of Herbicide	Herbicide Dose Applied to Treatment Area	Expected Whole Bay/Lake Concentration (ppm)
West Lake	12.35	Herbicide	18.20	Aquastrike	6.5 quarts/acre foot	--
		Herbicide	4.84	Diquat	2 gallons/acre	--
		Herbicide	3.99	ProcellaCOR	4 PDU/acre foot	--
		Mechanical/DASH	6.33	--	--	--
Williams Bay	0.54	Herbicide	2.10	Diquat	2 gallons/acre	--
		DASH	1.45	--	--	--
Rabbit Island Bay	1.32	Mechanical	0.81	--	--	--
		Herbicide	2.76	Diquat	2 gallons/acre	
Library Lake	1.85	Herbicide	10.00	2,4-D	0.44 ppm	0.4 ppm
Norwegian Bay	0.65	Herbicide	2.86	Diquat	2 gallons/acre	--
East Lake	0	--	--	--	--	--
City Bay	1.56	Herbicide	3.47	Diquat	2 gallons/acre	--
Cemetery Bay	0	--	--	--	--	--

The herbicide treatments are expected to suppress the EWM infestation in the treated areas to very low levels, but some EWM will likely survive. Removal of surviving EWM throughout the 2019 growing season will be important to keep EWM suppressed to very low levels. EWM spreads explosively in Beaver Dam Lake and a handful of plants becomes hundreds of plants in just a few months. To keep EWM at very low levels, EWM observed in Beaver Dam Lake will be removed using Diver Assisted Suction Harvesting (DASH) whenever it is observed and DASH removal is feasible. Rake removal will be used to remove EWM in shallow areas in which the soft bottom would make it difficult to remove EWM by DASH.

A detailed discussion of the 2019 EWM management program follows.

Treatment Area #2
1.71 acres
Average Depth: 9.7 ft
Diquat Dose: 2 gal/acre

Treatment Area #3
1.91 acres
Average Depth: 8.6 ft
Diquat Dose: 2 gal/acre

Treatment Area #1
2.36 acres
Average Depth: 16.4 ft
AquaStrike Dose: 6.5 qts/ac ft

Treatment Area #4
1.03 acres
Average Depth: 21.3 ft
DASH

Treatment Area #5
3.99 acres
Average Depth: 6.4 ft
ProcellaCOR Dose: 4 PDU/ac ft

Treatment Area #9
3.30 acres
Average Depth: 16.3 ft
AquaStrike Dose: 6.5 qts/ac ft

Treatment Area #10
2.63 acres
Average Depth: 15.3 ft
AquaStrike Dose: 6.5 qts/ac ft

Treatment Area #6
1.92 acres
Average Depth: 11.6 ft
DASH

Treatment Area #7
1.09 acres
Average Depth: 12.9 ft
DASH

Treatment Area #8
1.22 acres
Average Depth: 4.0 ft
Diquat Dose: 2 gal/acre

Treatment Area #11
9.91 acres
Average Depth: 10.9 ft
AquaStrike Dose: 6.5 qts/ac ft

Treatment Area #12
3.32 acres
Average Depth: 7.1 ft
Mechanical Removal

Treatment Area #13
2.10 acres
Average Depth: 8.8 ft
Diquat Dose: 2 gal/acre

Treatment Area #14
1.45 acres
Average Depth: 7.7 ft
DASH

Treatment Area #15
0.81 acres
Average Depth: 4.4 ft
Mechanical Removal

Treatment Area #16
2.76 acres
Average Depth: 10.6 ft
Diquat Dose: 2 gal/acre

Library Lake Inset Map

Treatment Area #17
10.00 acres
Average Depth: 5.2 ft
2,4-D Dose: 0.44 ppm

17-A

17-B

0 100 200 400
Feet

- Proposed 2019 EWM Treatment Areas
- Herbicide Residue Monitoring Locations
- EWM Observed
- No EWM Present

Treatment Zones

- Library Lake (0.4 ppm 2,4-D)
- Rabbit Island Bay (Spot Treatment with Diquat at 2 gal/acre)
- West Lake (Spot Treatment with Diquat at 2 gal/acre or Spot Treatment with Procellacor at label rate)
- Williams Bay (Spot Treatment with Diquat at 2 gal/acre)

0 750 1,500 3,000
Feet

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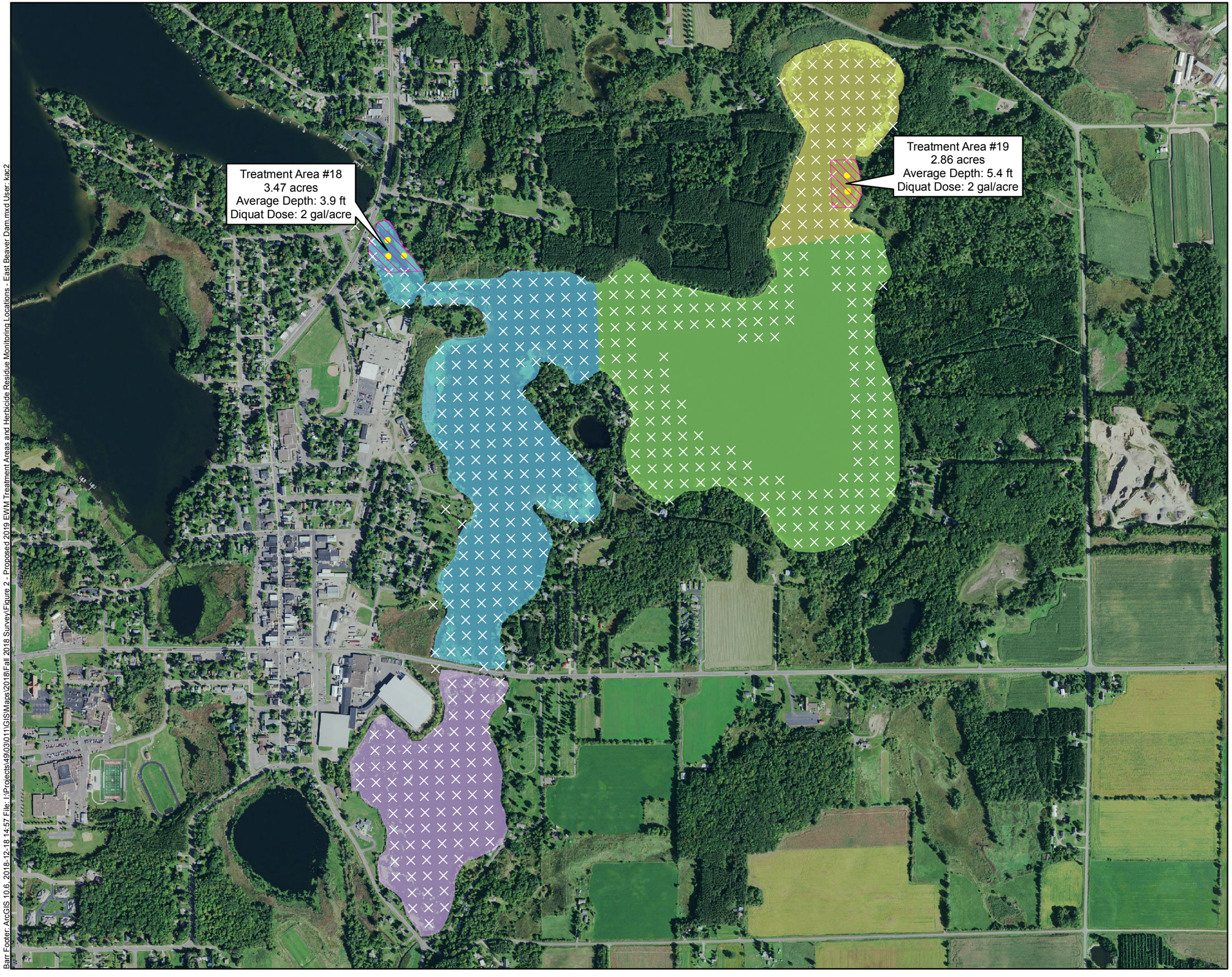
Figure 1

PROPOSED 2019 EURASIAN WATERMILFOIL MANAGEMENT AREAS AND HERBICIDE RESIDUE MONITORING LOCATIONS
Beaver Dam and Library Lake
Barron County, WI

J-86

Barr Footer: ArcGIS 10.6.1, 2019-01-28 11:25 File: I:\Projects\49\03\011\GIS\Maps\2018\Fall 2018 Survey\Figure 1 - Proposed 2019 EWM Management Areas and Herbicide Residue Monitoring Locations - West Beaver Dam and Library Lake.mxd User: KAC2



Proposed 2019 EWM Treatment Areas

EWM Observed

No EWM Present

Treatment Zones

East Lake (No Treatment)

City Bay (Spot Treatment with Diquat at 2 gal/acre)

Cemetery Bay (No Treatment)

Norwegian Bay (Spot Treatment with Diquat at 2 gal/acre)

N

0 450 900 1,800

Feet

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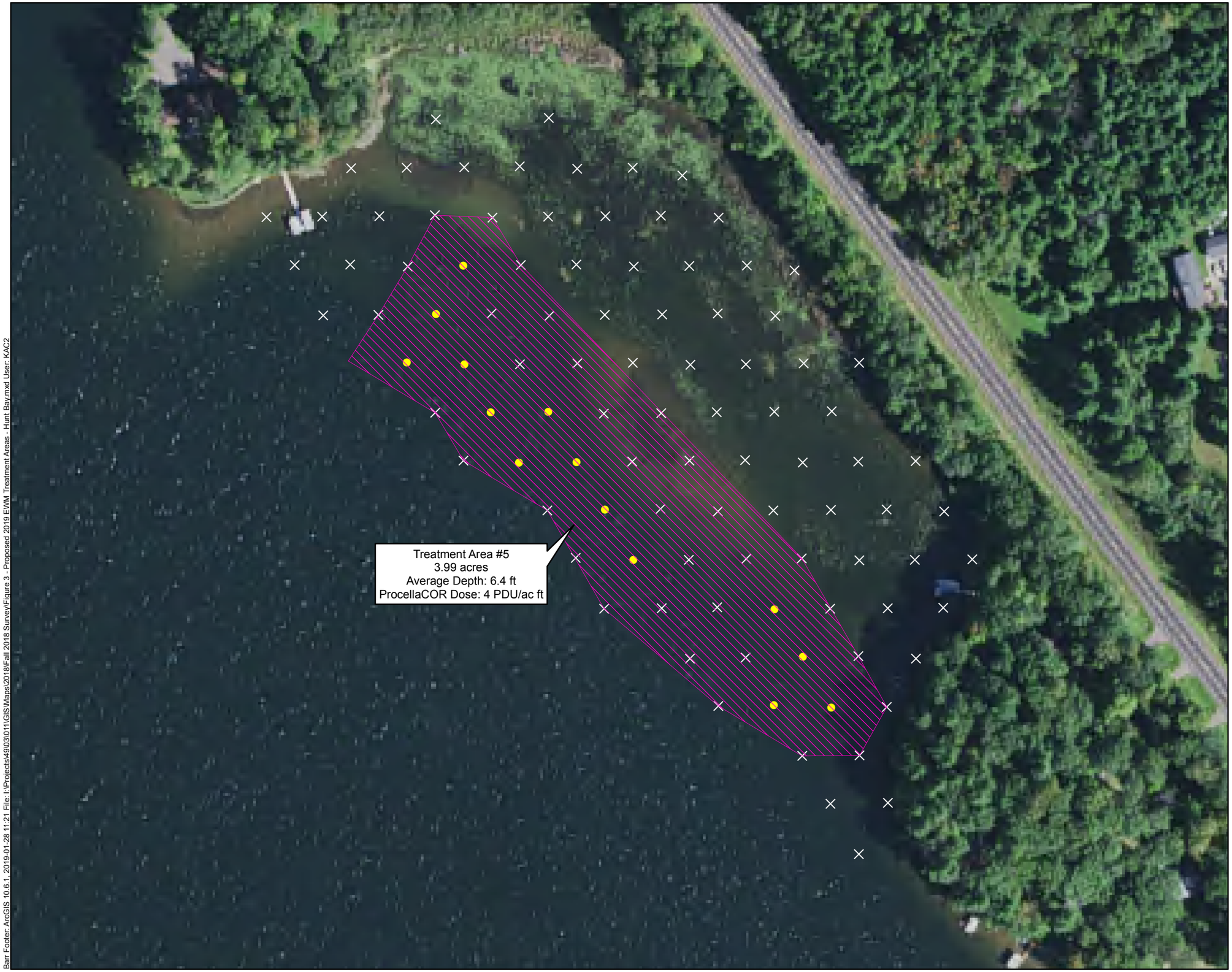
Figure 2

PROPOSED 2019 EURASIAN WATERMILFOIL TREATMENT AREAS
Beaver Dam and Library Lake
Barron County, WI

J-87

Barr Footer: ArcGIS 10.6, 2018-12-18 14:57 File: I:\Projects\49\03\011\GIS\Maps\2018\Fall 2018 Survey\Figure 2 - Proposed 2019 EWM Treatment Areas and Herbicide Residue Monitoring Locations - East Beaver Dam.mxd User: kac2



Proposed 2019 EWM Treatment Areas

August EWM Survey Results

EWM Observed

No EWM Present

N

0 60 120 240

Feet

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Figure 3

PROPOSED 2019 EURASIAN WATERMILFOIL TREATMENT AREAS - HUNT BAY
Beaver Dam and Library Lake
Barron County, WI

J-88

Barr Footer: ArcGIS 10.6.1, 2019-01-28 11:21 File: I:\Projects\49103\011\GIS\Maps\2018\Fall 2018 Survey\Figure 3 - Proposed 2019 EWM Treatment Areas - Hunt Bay.mxd User: KAC2

1.1 EWM Management in Individual Bays and Basins

1.1.1 Williams Bay

Williams Bay EWM management includes herbicide treatment and DASH removal.

The herbicide treatment will be a spot treatment of 2.10 acres with diquat at a dose of 2 gallons per acre. The treatment will occur within 2 to 3 weeks after ice out under no wind conditions when the water is still to minimize mixing with untreated waters. The herbicide treatment area is Treatment Area 13 on Figure 1.

The DASH removal area is 1.45 acres (Treatment Area 14 on Figure 1).

1.1.2 West Lake

In 2019, EWM management in West Lake, pictured above, will include mechanical removal, including DASH, and spot herbicide treatments with either diquat, Aquastrike, or ProcellaCOR.

EWM management in West Lake will be a combination of herbicide treatment and mechanical removal, including DASH.

Diquat will be used to treat three individual areas in West Lake (treatment areas 2, 3, and 8 shown on Figure 1). The three individual areas range in size from 1.22 acres to 1.91 acres and total 4.84 acres. The three areas will be treated with diquat at a dose of 2 gallons per acre. The treatment will occur within 2 to 3 weeks after ice out under no wind conditions when the water is still to minimize mixing with untreated waters.

Aquastrike will be used to treat four individual areas in West Lake (Treatment Areas 1, 9, 10, and 11 on Figure 1). The four areas range in size from 2.36 acres to 9.91 acres and total 18.20 acres. The four areas will be treated with Aquastrike at a dose of 6.5 quarts per acre foot. The treatment will occur within 2 to 3 weeks after ice out under no wind conditions when the water is still to minimize mixing with untreated waters.

ProcellaCOR will be used to treat Hunt Bay, a 3.99-acre treatment area (Treatment Area 5 on Figure 1 and the area shown in Figure 3). Hunt Bay will be treated with ProcellaCOR at a dose of 4 PDU per acre foot. The herbicide application will be a surface application.

The West Lake DASH removal areas are comprised of three individual areas ranging in size from 1.03 to 1.92 acres (treatment areas 4, 6, and 7 on Figure 1) and totaling 4.04 acres.

Mechanical removal will be used to remove EWM in area 12 on Figure 1. Either DASH or rake removal will be used to remove EWM from this 3.32-acre area.

1.1.3 Rabbit Island Bay

Rabbit Island Bay EWM management includes herbicide treatment and mechanical removal.

Herbicide treatment will be a spot treatment of 2.76 acres with diquat at a dose of 2 gallons per acre. The treatment will occur within 2 to 3 weeks after ice out under no wind conditions when the water is still to minimize mixing with untreated waters. The herbicide treatment area is Treatment Area 16 on Figure 1.

Mechanical removal will be used to remove EWM in Treatment Area 15, located in the west canal. Rake removal will likely be used to remove EWM in this 0.81-acre area.

1.1.4 Library Lake

EWM management in Library Lake will be a large scale herbicide treatment. A 10.00-acre area (Treatment Area 17 on Figure 1) will be treated with 2,4-D at a dose of 0.44 ppm. The treatment is expected to result in a whole basin concentration of 0.4 ppm.

The Library Lake herbicide treatment will be completed in a single day. Herbicide treatment will occur when the average water column temperature is 60 degrees Fahrenheit or less. It is expected that the average water column temperature will be at least 55 degrees Fahrenheit at the time of herbicide treatment. However, if Wisconsin Department of Natural Resources (WDNR) staff determines the EWM is ready for treatment when the average water column temperature is less than 55 degrees Fahrenheit and recommends that treatment proceed, the treatment will proceed per the recommendation of WDNR staff. Treating Library Lake when the average water column temperature is 60 degrees Fahrenheit or less protects the native plant species from harm. Native plant species typically begin growing after the average water column temperature reaches 60 degrees Fahrenheit. Experience in Beaver Dam Lake during 2015 indicated applying a lethal dose of herbicide at or shortly prior to the start of the native plant growing season exposed infant plants to a lethal dose of herbicide and harmed the natives. The 2018 herbicide treatment plan protects natives by applying the herbicide when the average water column temperature is 60 degrees Fahrenheit or less.

Daily water temperature measurements will occur beginning 1 week after ice-out and continuing through and including the day of herbicide treatment. The daily water temperatures will be measured at 1 meter intervals from the surface to bottom of Library Lake at Location 17B shown in Figure 1. If unforeseen circumstances prevent the large scale Library Lake herbicide treatment from occurring when the average water column temperature is 60 degrees Fahrenheit or less, the large scale herbicide treatment of Library Lake will not occur in 2019.

1.1.5 Norwegian Bay

Herbicide treatment will be a spot treatment of 2.86 acres with diquat at a dose of 2 gallons per acre. The treatment will occur within 2 to 3 weeks after ice out under no wind conditions when the water is still to minimize mixing with untreated waters. The herbicide treatment area is Treatment Area 19 on Figure 2.

1.1.6 City Bay

Herbicide treatment will be a spot treatment of 3.47 acres with diquat at a dose of 2 gallons per acre. The treatment will occur within 2 to 3 weeks after ice out under no wind conditions when the water is still to minimize mixing with untreated waters. The herbicide treatment area is Treatment Area 18 on Figure 2.

2.0 2019 Monitoring Programs

The 2019 monitoring programs consist of temperature measurements prior to the herbicide treatment of Library Lake, 2,4-D herbicide residue monitoring after the herbicide treatment of Library Lake, and aquatic plant surveys during July and October. The temperature monitoring program of Library Lake is discussed in Section 1.1.4 Library Lake. The herbicide residue monitoring and aquatic plant monitoring programs are discussed in the following paragraphs.

2.1 2,4-D Residue Monitoring

In 2019, 2,4-D herbicide residue monitoring will occur at 2 representative locations in Library Lake to determine whether the target dose was attained as well as the rate of herbicide decline due to dilution, mixing, and natural degradation of the 2,4-D, Monitoring locations 17 A and 17 B are shown in Figure 1. Samples will be collected at mid-depth from both locations during the monitoring period. Specific sample collection times for the treatment areas are shown in Table 2. It should be noted that if weather conditions make sample collection unsafe during any of the scheduled sample collection times, samples will not be collected during those unsafe times.

Table 2 2019 2,4-D Residue Monitoring Plan

Treatment Area	Sample Site ID	Sample Collection Time (Hours After Treatment	Sample Collection Time (Days After Treatment)
Library Lake	17A and 17B	1 and 4	1, 2, 3, 5, 7, 12, 19, and 26

2.2 2019 Aquatic Plant Monitoring Programs

The 2019 aquatic plant monitoring programs will include a July survey of all plant species and an October survey of aquatic invasive species (EWM and CLP). Details of the aquatic plant monitoring programs follow.

2.2.1 July Aquatic Plant Survey – All Species

During July, a point intercept survey of about 1,346 sample points will assess the entire plant community in Beaver Dam Lake. Maps showing the sample locations are found in Appendix E of the Beaver Dam Lake APM Plan (http://www.beaverdamlake.org/apmp). Data will be summarized in tabular format using the WDNR pre-treatment/post-treatment spreadsheet. Maps will be prepared showing location and density of each species identified in the July plant survey. Maps will also be prepared that show bottom substrate, lake depth, littoral zone, native species richness, and total rake fullness. Chi squared analysis will compare 2019 data with 2018 data to identify significant changes in frequency of occurrence of native species. The July monitoring program duplicates monitoring programs completed during 2009 through 2018.

2.2.2 Fall Aquatic Invasive Species Survey

During October, a fall point intercept survey of about 1,346 sample points will assess aquatic invasive species (EWM and CLP) extent in Beaver Dam Lake. Maps showing the sample locations are found in Appendix E of the Beaver Dam Lake APM Plan (http://www.beaverdamlake.org/apmp). The results of the EWM data collected during the fall aquatic invasive species survey will determine 2020 EWM management areas and will be used to design the 2020 EWM management program. The results of the CLP data collected during the fall aquatic invasive species survey will be evaluated to determine whether any areas would need additional CLP monitoring during June of 2020 when CLP is at its peak growth stage. The fall aquatic invasive species monitoring program duplicates monitoring programs completed during 2006 through 2018.

3.0 2019 Navigation Channel Inspection

In 2019, an inspection of navigation channels within Beaver Dam Lake will determine whether plant growth impedes navigation. The inspection of navigation channels will occur during the July plant survey and will document any impairment of navigation channels and access corridors by plants. If impairment of navigation channels and access corridors by plants is documented, the Beaver Dam Lake Management District will contact WDNR staff to discuss the issue. If herbicide treatment of plants is warranted to alleviate navigation problems and WDNR staff will permit herbicide treatment of the plants, the Beaver Dam Lake Management District will work with a herbicide applicator to obtain a treatment permit and perform the herbicide treatment.

Memorandum

To: Beaver Dam Lake Management District (Board of Commissioners)
From: Barr Engineering Co. (Meg Rattei)
Subject: Proposed 2020 Eurasian Watermilfoil (EWM) Management Program, Monitoring Programs, and Navigation Channel Inspection
Date: December 16, 2019
Project: 49030011.20
c: Alex Smith (WDNR) and Jim Bartlett (Lake Restoration, Inc.)

The purpose of this memorandum is to present:

1. 2020 EWM Management Program
2. 2020 Monitoring Programs
3. 2020 Navigation Channel Inspection and Treatment Program

1.0 2020 EWM Management Program

The proposed 2020 EWM management program will treat EWM within Beaver Dam Lake with herbicide. The treated areas total 70.41 acres, which is about 13 percent of the lake's 530-acre littoral area. Herbicides used for treatment will include 2,4-D, diquat, and Aquastrike.

EWM, pictured above, will be managed by herbicide treatment in 2020.

The 2020 herbicide treatment areas are based upon the results of the 2019 fall plant survey and include: (1) a whole bay 2,4-D treatment of Cemetery Bay (2) diquat treatments of the West canal of Rabbit Island Bay and small areas within Norwegian Bay and City Bay; and (3) Aquastrike spot treatment of a small area within West Lake. The 2,4-D treatment area in Cemetery Bay totals 53.37 acres. The diquat treatment areas total 14.85 acres. The Aquastrike treatment area in West Lake totals 2.19 acres. Table 1 summarizes the proposed 2020 Beaver Dam Lake EWM herbicide treatment program and Figure 1 and Figure 2 show the EWM treatment areas.

Williams Bay, Libray Lake, East Lake, Rabbit Island Bay, and the East Canal of Rabbit Island Bay do not require EWM management in 2020 because EWM was not observed in these areas during the 2019 fall plant survey.

Table 1 Proposed 2020 Beaver Dam Lake EWM Management Program

Location	EWM Extent (ac)	EWM Management Method	EWM Management Area (ac)	Name of Herbicide	Herbicide Dose Applied to Treatment Area	Expected Whole Bay/Lake Concentration (ppm)
West lake	NA*	Herbicide	2.19	Aquastrike	6.5 quarts/acre foot	--
Rabbit Island Bay West Canal	0.62	Herbicide	0.81	Diquat	2 gallons/acre	--
City Bay	0.97	Herbicide	7.01	Diquat	2 gallons/acre	--
Norwegian Bay	0.70	Herbicide	7.03	Diquat	2 gallons/acre	--
Cemetery Bay	4.10	Herbicide	53.37	2,4-D	0.8 ppm	0.8 ppm

*The EWM treatment area is based on citizen observation. Because the EWM was not observed during the fall plant survey, EWM extent is not available.

The herbicide treatments are expected to suppress the EWM infestation in the treated areas to very low levels, but some EWM may survive. Removal of surviving EWM throughout the 2020 growing season will be important to keep EWM suppressed to very low levels. EWM spreads explosively in Beaver Dam Lake and a handful of plants becomes hundreds of plants in just a few months. To keep EWM at very low levels, EWM observed in Beaver Dam Lake will be removed using Diver Assisted Suction Harvesting (DASH) whenever it is observed and DASH removal is feasible. Rake removal will be used to remove EWM in shallow areas in which the soft bottom would make it difficult to remove EWM by DASH.

The west canal of Rabbit Island Bay, pictured above, will be treated with diquat in 2020.

A detailed discussion of the 2020 EWM management program follows.

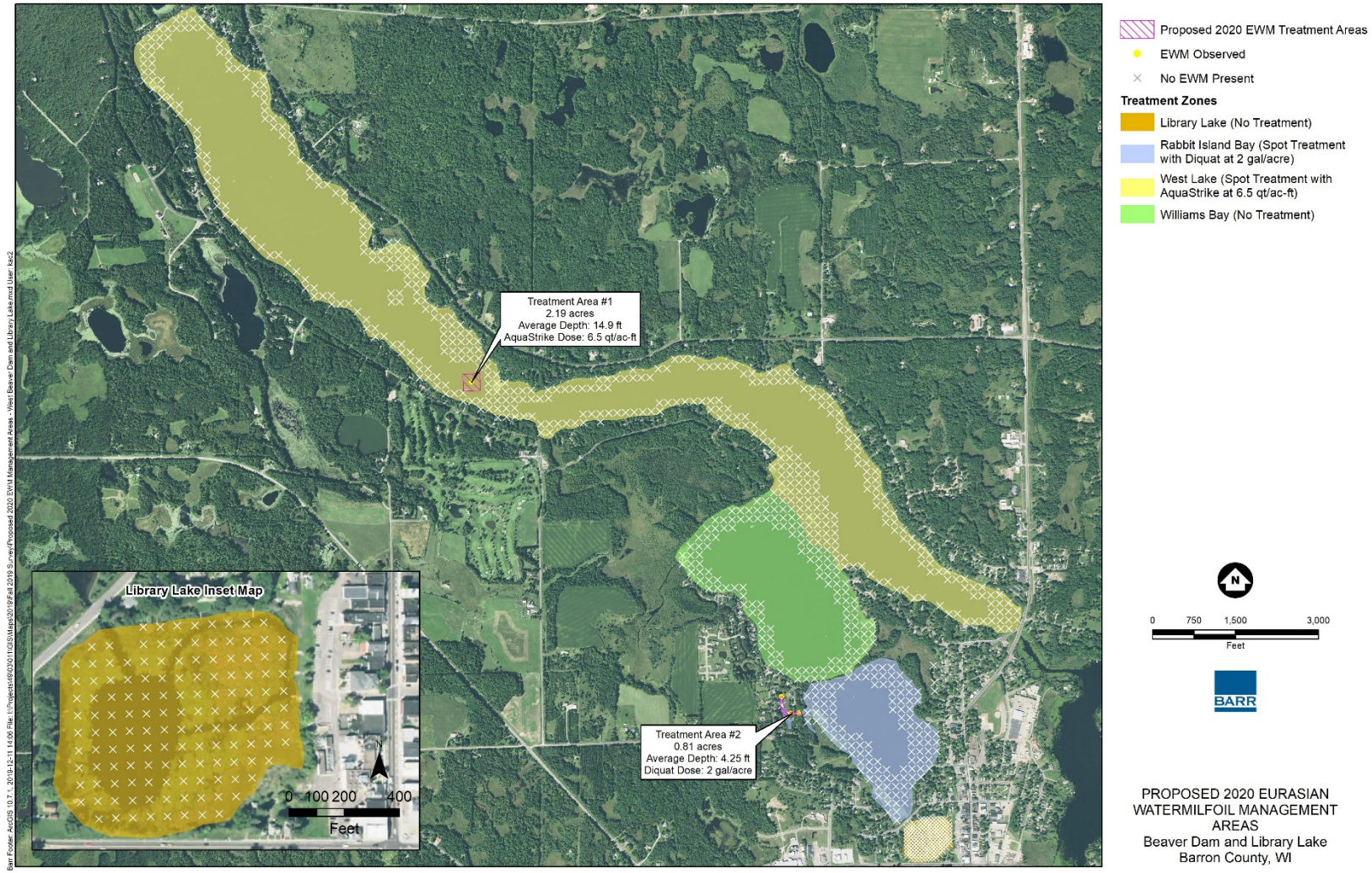

Figure 1 Proposed 2020 Eurasian Watermilfoil Management Areas (Herbicide Treatment Areas): West Lake Basins

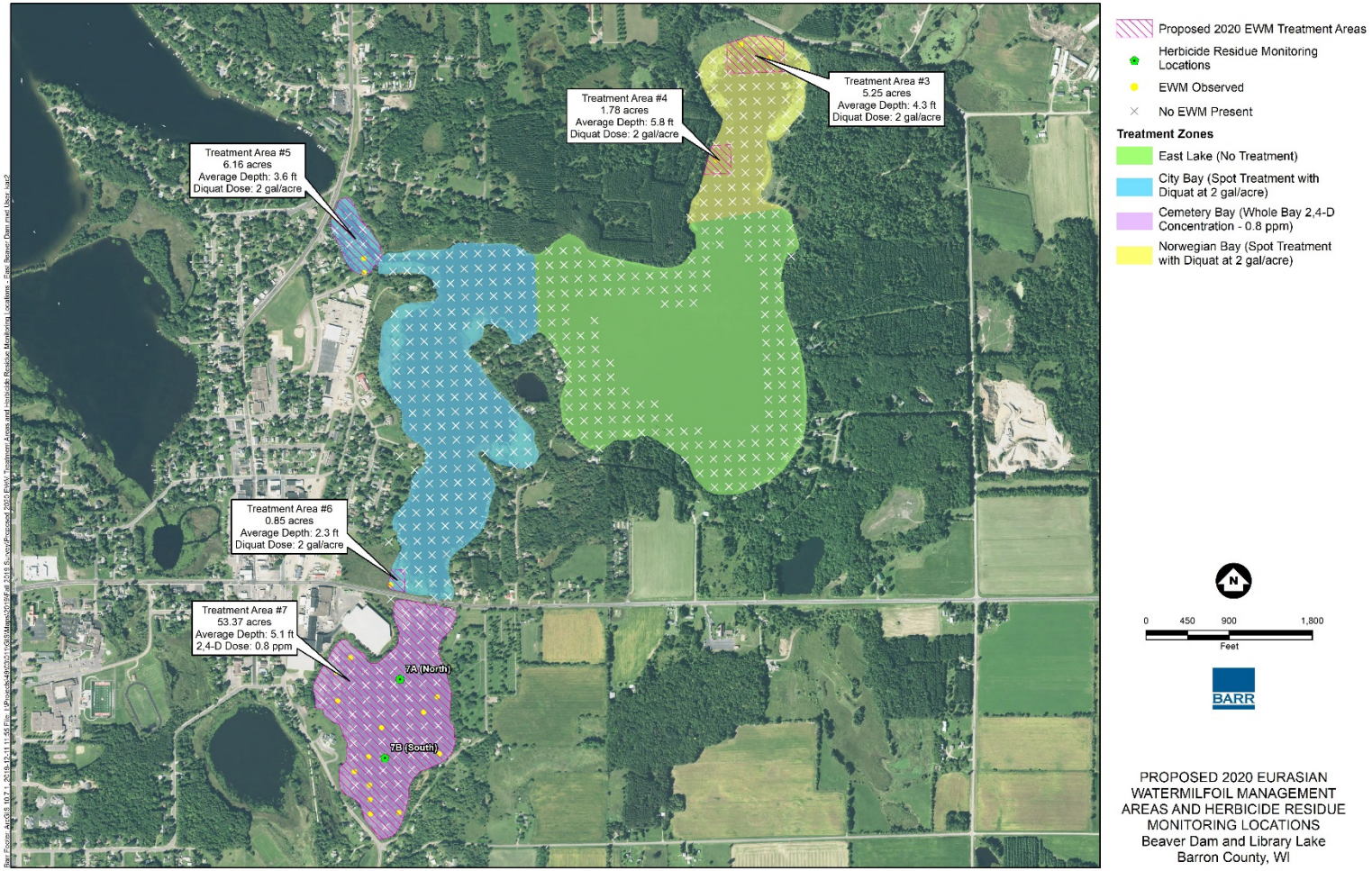

Figure 2 **Proposed 2020 Eurasian Watermilfoil EWM Management Areas (HerbicideTreatment Areas): East Lake Basins**

2.0 EWM Management in Individual Bays and Basins

2.1.1 West Lake

Herbicide treatment will be a spot treatment of 2.19 acres with Aquastrike at a dose of 6.5 quarts per acre foot (Treatment Area 1 on Figure 1). Because Treatment Area 1 is based on a citizen observation, it is recommended that additional details be gathered prior to treatment. Hence, it is recommended that Endangered Resource Services, LLC perform a delineation of the treatment area in spring of 2020 to determine the treatment area boundary and average water depth. The treatment area boundary shown in Figure 1 is an estimation based on a citizen observation. Average water depth shown in Figure 1 is based on extrapolation from nearby sample points. After delineation of the treatment area in spring 2020, the treatment area shown in Figure 1 will be revised as needed. Treatment will then occur within 2 to 3 weeks after ice out under no wind conditions when the water is still to minimize mixing with untreated waters.

In 2020, EWM management in West Lake, pictured above, will consist of herbicide treatment of 2.19 acres with Aquastrike.

2.1.2 Rabbit Island Bay

A 0.81 acre area in the west canal of Rabbit Island Bay (Treatment Area 2 on Figure 1) will be treated with diquat at a dose of 2 gallons per acre. The treatment will occur within 2 to 3 weeks after ice out under no wind conditions.

Because EWM was not observed within Rabbit Island Bay or the east canal of Rabbit Island Bay during the October 2019 plant survey, these areas do not require EWM management in 2020.

2.1.3 Norwegian Bay

Herbicide treatment will be a spot treatment of 7.03 acres (Treatment Areas 3 and 4 on Figure 2) with diquat at a dose of 2 gallons per acre. The treatment will occur within 2 to 3 weeks after ice out under no wind conditions when the water is still to minimize mixing with untreated waters.

2.1.4 City Bay

Herbicide treatment will be a spot treatment of 7.01 acres (Treatment Areas 5 and 6 on Figure 2) with diquat at a dose of 2 gallons per acre. The treatment will occur within 2 to 3 weeks after ice out under no wind conditions when the water is still to minimize mixing with untreated waters.

2.1.5 Cemetery Bay

EWM management in Cemetery Bay will be a whole bay herbicide treatment. The 53.37-acre area (Treatment Area 7 on Figure 2) will be treated with 2,4-D at a dose of 0.8 ppm.

In 2020, EWM management in Cemetery Bay, pictured above, will be a whole bay herbicide treatment.

The Cemetery Bay herbicide treatment will be completed in a single day. Herbicide treatment will occur when the average water column temperature is 60 degrees Fahrenheit or less. It is expected that the average water column temperature will be at least 55 degrees Fahrenheit at the time of herbicide treatment. However, if Wisconsin Department of Natural Resources (WDNR) staff determines the EWM is ready for treatment when the average water column temperature is less than 55 degrees Fahrenheit and recommends that treatment proceed, the treatment will proceed per the recommendation of WDNR staff. Treating Cemetery Bay when the average water column temperature is 60 degrees Fahrenheit or less protects the native plant species from harm. Native plant species typically begin growing after the average water column temperature reaches 60 degrees Fahrenheit.

Daily water temperature measurements will occur beginning 1 week after ice-out and continuing through and including the day of herbicide treatment. The daily water temperatures will be measured at 1 meter intervals from the surface to bottom of Cemetery Bay at the location shown in Figure 3. If unforeseen circumstances prevent the whole bay herbicide treatment from occurring when the average water column temperature is 60 degrees Fahrenheit or less, the large scale herbicide treatment of Cemetery Bay will not occur in 2020.

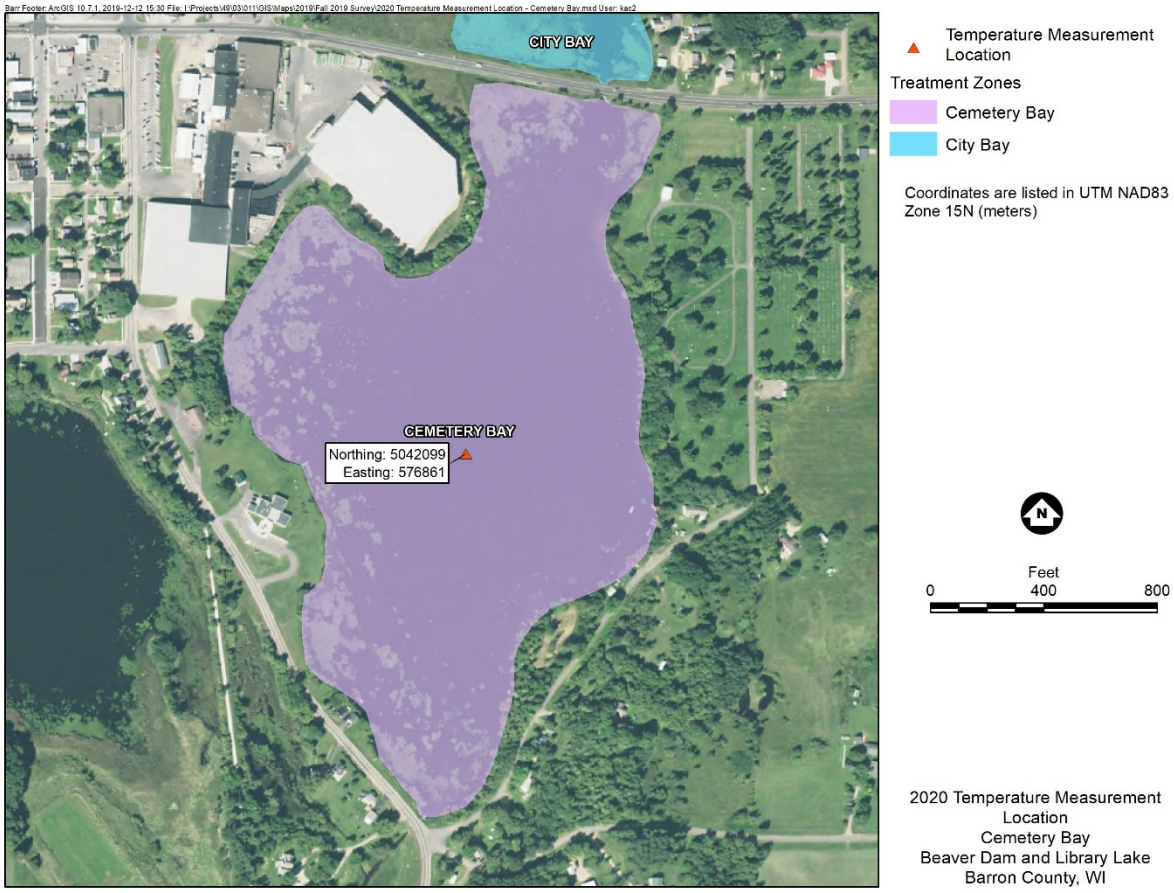

Figure 3 2020 Temperature Measurement Location: Cemetery Bay

3.0 2020 Monitoring Programs

The 2020 monitoring programs consist of temperature measurements prior to the herbicide treatment of Cemetery Bay, 2,4-D herbicide residue monitoring after the herbicide treatment of Cemetery Bay, aquatic plant surveys of Beaver Dam Lake during July and October, and a post-treatment plant survey of Hunt Bay during July. The temperature monitoring program of Cemetery Bay is discussed in Section 2.1.5 Cemetery Bay. The herbicide residue monitoring and aquatic plant monitoring programs are discussed in the following paragraphs.

3.1 2,4-D Residue Monitoring

In 2020, 2,4-D residue monitoring will occur at 2 representative locations in Cemetery Bay to determine whether the target dose was attained as well as the rate of herbicide decline due to dilution, mixing, and natural degradation. Monitoring locations 7A and 7B are shown in Figure 2. Samples will be collected at mid-depth from both locations during the monitoring period. Specific sample collection times for the treatment areas are shown in Table 2. It should be noted that if weather conditions make sample collection unsafe during any of the scheduled sample collection times, samples will not be collected during those unsafe times.

Table 2 2020 2,4-D Residue Monitoring Plan for Cemetery Bay

Treatment Area	Sample Site ID	Sample Collection Time (Hours After Treatment	Sample Collection Time (Days After Treatment)
Cemetery Bay	7A and 7B	1 and 4	1, 2, 3, 5, 7, 12, 19, and 26

3.2 2020 Aquatic Plant Monitoring Programs

The 2020 aquatic plant monitoring programs will include a July survey of all plant species in Beaver Dam Lake, an October survey of aquatic invasive species in Beaver Dam Lake, and a July post-treatment survey of all plant species in Hunt Bay. Details of the aquatic plant monitoring programs follow.

3.2.1 Beaver Dam Lake July Aquatic Plant Survey – All Species

During July, a point intercept survey of about 1,346 sample points will assess the entire plant community in Beaver Dam Lake. Maps showing the sample locations are found in Appendix E of the Beaver Dam Lake APM Plan (http://www.beaverdamlake.org/apmp). Data will be summarized in tabular format using the WDNR pre-treatment/post-treatment spreadsheet. Maps will be prepared showing location and density of each species identified in the July plant survey. Maps will also be prepared that show bottom substrate, lake depth, littoral zone, native species richness, and total rake fullness. Chi squared analysis will compare 2020 data with 2019 data to identify significant changes in frequency of occurrence of native species. The July monitoring program duplicates monitoring programs completed during 2009 through 2019.

3.2.2 Beaver Dam Lake Fall Aquatic Plant Survey – Aquatic Invasive Species (EWM and CLP)

During October, a fall point intercept survey of about 1,346 sample points will assess aquatic invasive species (EWM and CLP) extent in Beaver Dam Lake. Maps showing the sample locations are found in Appendix E of the Beaver Dam Lake APM Plan (http://www.beaverdamlake.org/apmp). The results of the EWM data collected during the fall aquatic invasive species survey will determine 2021 EWM management

areas and will be used to design the 2021 EWM management program. The results of the CLP data collected during the fall aquatic invasive species survey will be evaluated to determine whether any areas would need additional CLP monitoring during June of 2021 when CLP is at its peak growth stage. The fall aquatic invasive species monitoring program duplicates monitoring programs completed during 2006 through 2019.

3.2.3 Hunt Bay Post-Treatment July Aquatic Plant Survey – All Species

During July, a point-intercept survey of 100 sample points will assess the entire plant community in Hunt Bay. The survey will assess the results of the August 2019 treatment of Hunt Bay with ProcellaCOR. Sample locations are shown in Figure 4. Data will be summarized in tabular format using the WDNR pre-treatment/post-treatment spreadsheet. Maps will be prepared showing location and density of each species identified in the July Hunt Bay plant survey. Maps will also be prepared that show Hunt Bay bottom substrate, depth, littoral zone, native species richness, and total rake fullness. Chi squared analysis will compare 2020 Hunt Bay data with 2019 Hunt Bay data to identify significant changes in frequency of occurrence of native species. The 2020 Hunt Bay post-treatment monitoring program duplicates pre-treatment monitoring programs completed during 2018 and 2019.

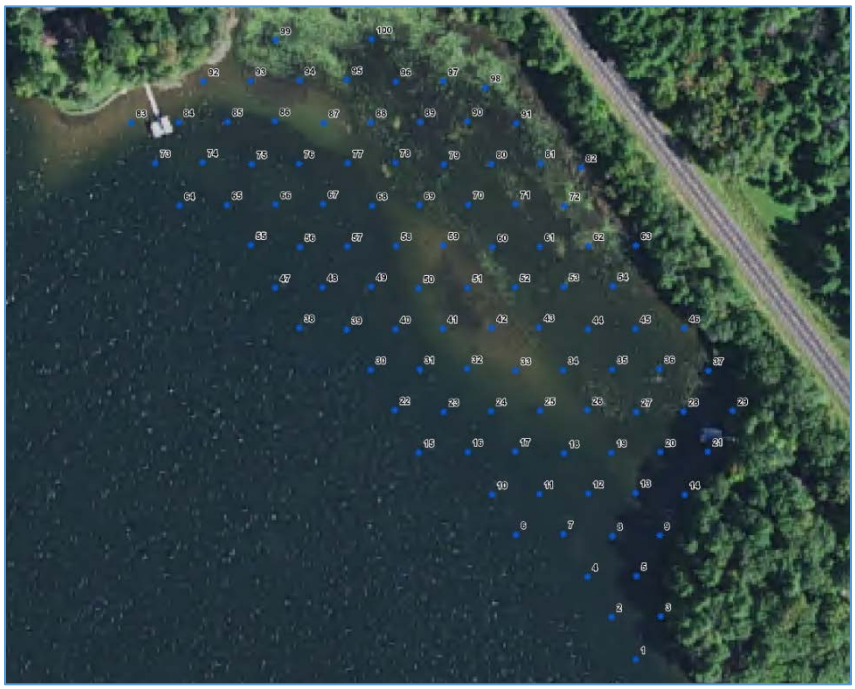

Figure 4 Sample points for 2020 Hunt Bay Point Intercept Plant Survey

4.0 2020 Navigation Channel Inspection

In 2020, an inspection of navigation channels within Beaver Dam Lake will determine whether plant growth impedes navigation. The inspection of navigation channels will occur during the July plant survey and will document any impairment of navigation channels and access corridors by plants. If impairment of navigation channels and access corridors by plants is documented, the Beaver Dam Lake Management District will contact WDNR staff to discuss the issue. If herbicide treatment of plants is warranted to alleviate navigation problems and WDNR staff will permit herbicide treatment of the plants, the Beaver Dam Lake Management District will work with a herbicide applicator to obtain a treatment permit and perform the herbicide treatment.

The 2020 navigation channel inspection will identify navigation impairment such as the navigation impairment in the shallow bay directly south of the City Bay boat landing pictured above.