2018 Point-Intercept Plant Surveys

At Long Lake, Long Lake-Katherine Abbott Pond, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake

Prepared for
Valley Branch Watershed District

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4300 MarketPointe Drive, Suite 200
Minneapolis, MN 55435
952.832.2600
www.barr.com

Executive Summary

As authorized by the Managers, a subcontractor for Barr conducted point-intercept aquatic plant surveys at Long Lake, Long Lake-Katherine Abbott Pond, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake in 2018. A summary of results is as follows:

- None of these lakes are considered impaired (i.e., not supporting aquatic life due to stress from excessive nutrients).
- Three of the lakes were treated with herbicide to contain invasive Eurasian watermilfoil (EWM), and all had a favorable response. Two of the lakes and Long-Lake Katherine Abbott Pond were not treated, but still showed decreases in EWM extent.
- There was a reduced frequency of invasive curly-leaf pondweed in all lakes. This result was primarily due to the timing of the survey, which took place after the plant's natural senescence.
- Several other aquatic invasive species are present in the lakes: reed canary grass, purple loosestrife, narrow-leaved cattail, hybrid cattail, and yellow iris. None were problematic.

This report outlines survey methods and more extensive results. Tables and figures follow the discussion. Locations of the surveyed lakes are shown in Figure 1.

2018 Point-Intercept Plan Surveys at Long Lake, Long Lake-Katherine Abbott Pond, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake

November 2018

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Table 1 summarizes the results of the 2018 aquatic plant surveys of six VBWD lakes. The following data are presented:

- **Number of species**—the number of different plant species that were either collected on the rake or observed in the lake (e.g., water lilies or cattail beds not collected on the rake but observed). This number includes both invasive and native species.
- **Number of native species**—the number of native plant species that were either collected on the rake or observed in the lake.
- **Number of native species collected on rake**—only native plants collected on the rake were used for this statistic.
- **Number of invasive species**—the number of invasive plant species that were either collected on the rake or observed in the lake.
- **Maximum depth of plant growth**—the maximum depth that plants were found in the lake.
- **Frequency of occurrence**—the frequency with which plants were found in water shallower than the maximum depth of plant growth.
- **Average rake fullness**—the density of plant growth, as measured by rake fullness on a scale of 1 to 4, where:
    - 1 = less than 1/3 of the rake head full of plants.
    - 2 = from 1/3 to 2/3 of the rake head full of plants.
    - 3 = more than 2/3 of the rake head full of plants.
    - 4 = rake head is full, with plants overtopping.
- **Simpson Diversity Index Value**—index used to measure plant diversity, which assesses the overall health of the lake's plant communities. The index, with scores ranging from 0 to 1, considers both the number of species present and the evenness of species distribution. The scores represent the probability that two individual plants randomly selected from the lake will belong to different species. A high score indicates a more diverse plant community—a higher probability that two randomly selected plants will represent different species.

Table 2 summarizes invasive species data from the six VBWD lakes surveyed in 2018. The table shows the frequency of occurrence for species collected on the rake and includes species that were observed (Present = P), but not collected on the rake.

Tables 3, 4, 8, 12, 16, 20, and 24 summarize Eurasian watermilfoil (EWM) extent for the period of record for Long Lake, Long Lake-Katherine Abbott Pond, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and for Silver Lake (2017 and 2018 only). EWM extent is shown as acres of EWM in the lake and as a percent of the plant-growth area.

Tables 5, 9, 13, 17, 21, and 25 summarize Simpson Diversity Index values for the period of record in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake.

Tables 6, 10, 14, 18, 22, and 26 summarize MNDNR Lake Eutrophication Plant IBI values for the period of record in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake.

Tables 7, 11, 15, 19, 23, and 27 show species frequency for the period of record in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake.

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Figure 1 shows locations of Long Lake, Long Lake-Katherine Abbott Pond, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake.

Figures 2 through 8 show 2018 EWM extent in Long Lake, Long Lake-Katherine Abbott Pond, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake.

Figure 9 shows the 2006–2018 Eurasian watermilfoil frequency of occurrence in the vegetated depth range of plants in Silver Lake.

1.0 Assessing Lake Health

Barr used two tools in assessing the health of the lakes. The first is called the Lake Plant Eutrophication IBI, used to measure the response of a lake plant community to eutrophication (excess nutrients). This tool is important because the Minnesota Pollution Control Agency (MPCA) will use it in the future to identify impaired lakes.[1] The other tool, used to assess plant diversity, is called the Simpson Diversity Index. Both tools are described in greater detail below.

1.1 Lake Plant Eutrophication IBI

The Minnesota Department of Natural Resources (MNDNR) developed the Lake Plant Eutrophication IBI to assist the MPCA with determining lake impairment based on the plant community. The Lake Plant Eutrophication IBI includes two metrics to assess the viability of aquatic life. The first metric is taxa richness—the estimated number of taxa (species) in a lake. The second metric is floristic quality index (FQI). This metric distinguishes the quality of the plant community, which is a reflection of the quantity of nutrients in the lake. Barr analyzed the 2018 survey results to determine taxa richness and FQI scores and compared them with MNDNR impairment thresholds (a minimum of 12 taxa [species] and an FQI score of at least 18.6) to determine whether the lakes were impaired.

1.2 Plant Diversity—Simpson Diversity Index

The Simpson Diversity Index considers both the number of species present and the evenness of species distribution. The values, from 0 to 1, represent the probability that two individual plants randomly selected from the lake will belong to different species. Increasing values indicate increasing probability that two randomly selected plants will represent different species. Barr analyzed the 2018 survey results to determine Simpson Diversity Index values.

[1] Minnesota Department of Natural Resources. 2016. Lake Plant Eutrophication IBI, June 23, 2016: *An Assessment of Aquatic Plant Community Response to Anthropogenic Eutrophication.*

2.0 2018 Sample Methods

Barr's subcontractor, Matt Berg, of Endangered Resource Services, LLC, conducted point-intercept plant surveys in six VBWD lakes and Long Lake-Katherine Abbott Pond on July 29 and July 30, 2018. Survey locations are shown in Figure 1. Berg located equally spaced preset points in the field with a global positioning system (GPS) and took measurements at each point. His measurements included the following:

1. Individual species present
2. Overall density of plants, as measured by rake method
3. Density of individual species, as measured by rake method
4. Water depth
5. Dominant sediment type

Barr's subcontractor, Endangered Resource Services, LLC, used a rake (pictured above) to collect plants for the plant surveys. Rake fullness is a measure of plant density.

3.0 Results

3.1 Long Lake and Long Lake-Katherine Abbott Pond

3.1.1 Eurasian Watermilfoil (EWM) Treatment History in Long Lake

EWM (*Myriophyllum spicatum*) has been documented in Long Lake since May of 2007. By 2010, EWM extent had increased to 52 acres, nearly all of the area of the lake where plants grew.[2] Beginning in 2011 and continuing through 2016, Friends of Long Lake completed five herbicide treatments to reduce EWM extent in the lake. The treatments were successful and after the 2016 treatment, EWM extent had been reduced to 0.3 acres. Each of the five treatments involved application of sufficient 2,4-D to attain and sustain a whole-lake concentration that was lethal to EWM. This approach consistently reduced EWM in all areas of the lake except for the area immediately adjacent to the lake's inlet. Barr hypothesized that dilution from the lake's inflow prevented the herbicide concentration in this area from being sustained long enough to kill the EWM.

In 2018, Eurasian watermilfoil in Long Lake, pictured above, expanded to an extent of 35 acres.

In 2017, the Friends of Long Lake became aware of a new herbicide that could potentially kill EWM quickly and attain control of the last remaining EWM adjacent to the lake's inlet (despite the rapid dilution in that area). The group decided to treat the EWM by the lake's inlet when the new herbicide became available which, unfortunately, was not until 2018. Meanwhile, a 2017 plant survey of Long Lake-Katherine Abbott Pond revealed that EWM was prevalent in the pond and that the pond was a source of EWM in Long Lake. Additions of EWM to Long Lake from Long Lake-Katherine Abbott Pond and the spread within the lake caused EWM extent to increase from 0.3 acres in June of 2016 to 20 acres in May of 2018.

The Friends of Long Lake considered using the new herbicide, Procellacor, to treat all of the EWM in Long Lake during 2018. However, the herbicide was expensive and its use for all 20 acres of EWM was cost-prohibitive. The group applied for an MNDNR permit to again treat the lake—including Long Lake-Katherine Abbott Pond—with 2,4-D. They hoped the 2018 treatment would reduce EWM to such a small area that use of the new herbicide to treat remaining areas would be affordable in 2019. However, the MNDNR did not approve the permit application and, instead, suggested the use of Fluoridone for the 2018 treatment. Although Fluoridone has successfully been used to treat a few other lakes, the cost for Long Lake treatment was cost-prohibitive (approximately four times more expensive than 2,4-D). Hence, no treatment occurred in 2018. EWM continued to spread to an extent of 35 acres, documented in July (Table 3 and Figure 2).

[2] The area of Long Lake containing plants in 2010 was 53.71 acres. EWM extent was 52.31 acres which was 97 percent of the plant-growth area of the lake.

3.1.2 Long Lake-Katherine Abbott Pond

Pictured above, canopied coontail in Long Lake-Katherine Abbott Pond.

A plant survey of Long Lake-Katherine Abbott Pond during June of 2017 documented EWM in 98 percent of the pond, while a survey in May of 2018 documented EWM in 71 percent of the pond. Although no treatment occurred in 2018, EWM was not observed in the pond during July. Instead, a native plant, coontail (*Ceratophyllum demersum*), dominated most areas of the pond. The surveys indicate that EWM can and does become prevalent throughout the pond, but can also be naturally reduced so as not to be observed. Although the mechanisms for its rise and fall are not known, the pond should be considered a potential source of EWM for Long Lake and should be surveyed with Long Lake. Future Long Lake herbicide treatments should include Long Lake-Katherine Abbott Pond whenever EWM is present to prevent the pond from infesting the lake with EWM.

3.1.3 Long Lake MNDNR Plant IBI

The 2018 Long Lake plant community meets the criteria of the MNDNR Plant IBI and is not impaired. A total of 15 species were observed in Long Lake, 25 percent more than the impairment threshold of 12 species. In 2018, the lake's FQI of 19.9 was 7 percent more than the impairment threshold of 18.6. Historical data indicate Long Lake met the MNDNR Plant IBI criteria from 2010 through 2018 except for low FQI values in 2013 and 2014 (Table 6).

3.1.4 Plant Diversity in Long Lake

Bearded stonewort, pictured above, was first observed in Long Lake in 2017.

The initial 2011 herbicide treatment reduced EWM extent and improved plant diversity in Long Lake. Subsequent herbicide treatments have sustained the lake's improved plant diversity. Long Lake diversity index values increased from 0.40 before the initial 2011 treatment to 0.80 after the treatment. The values indicate that prior to the 2011 herbicide treatment there was a 40 percent probability that two individual plants randomly selected from the lake would belong to different species and an 80 percent probability after the 2011 herbicide treatment. From 2011 to 2018, diversity fluctuated between 0.77 and 0.85 and was 0.80 in 2018. Data indicate the improved plant diversity after the initial herbicide treatment has been sustained.

3.1.5 Bearded Stonewort *(Lychnothamnus barbatus)* in Long Lake

Barr's subcontractor observed bearded stonewort *(Lychnothamnus barbatus)*, a good plant, in Long Lake in 2017 (Table 7). This species was not seen in North America until 2012 and few populations have been documented in the world. Barr's subcontractor observed bearded

stonewort in Westwood Lake (Hennepin County) in 2015, the first sighting of bearded stonewort in Minnesota. In 2016, Barr's subcontractor observed bearded stonewort in neighboring Crane Lake (Hennepin County), the second sighting in Minnesota. Long Lake is the third lake in Minnesota and the first lake in Ramsey County with bearded stonewort. The plant was spreading along the southeastern shoreline in 2018 and had increased in frequency from 1 percent in 2017 to 2 percent in 2018.

3.1.6 Significant Changes in Long Lake Plant Frequency

The Long Lake plant community was relatively stable between 2017 and 2018, but a few significant changes in plant frequency occurred. EWM, coontail, common watermeal (*Wolffia columbiana*), and aquatic moss significantly increased in frequency. Filamentous algae, curly-leaf pondweed (*Potamogeton crispus*, CLP), and white water crowfoot (*Ranunculus aquatilis)* significantly decreased in frequency. A similar decline in white water crowfoot occurred in Lake DeMontreville and Lake Elmo in 2018. We assume the change was from natural causes since neither Long Lake nor Lake Elmo was treated with herbicide in 2018. The significant increase in EWM verified the need for continued herbicide treatment to contain its spread. The significant decline in CLP during 2018 was due to natural senescence which occurs annually in late June. The 2017 survey occurred prior to CLP senescence while the 2018 survey occurred after CLP senescence. The significant decline in filamentous algae was a positive change for the lake.

3.1.7 Other AIS in Long Lake

Although EWM is the AIS of primary concern in Long Lake, CLP is also present. As in previous years, CLP was not problematic in 2018. CLP was observed at a frequency of 15 percent in May, prior to seasonal senescence, and at a frequency of 7 percent in July, after seasonal senescence.

3.2 Lake DeMontreville

3.2.1 EWM Treatment History

EWM was first observed in Lake DeMontreville in 2007 and was treated with 2,4-D in 2009. After the 2009 herbicide treatment, it was not observed again until 2011. EWM remained at low levels during 2011, but its extent increased by an order of magnitude between June of 2012 and June of 2013. The Lake DeMontreville Olson Association (LDO) has annually funded herbicide treatments to attain seasonal relief from EWM since 2014. 2,4-D was used for the 2014 through 2017 treatments and diquat was used for the 2018 treatment, which included 16 acres. The 2018 VBWD plant survey indicates diquat was effective in controlling EWM within the treated areas. However, as expected, EWM outside of the treated areas continued to thrive after the 2018 treatment (Figure 4).

3.2.2 Changes in Post Treatment EWM Extent

The Lake DeMontreville post-treatment EWM extent has gradually declined during the 2014 through 2018 period at a rate of about 1 or 2 acres per year (from 19 acres after the 2014 treatment to 13 acres after the 2018 treatment). The results indicate a multi-year impact was attained by the seasonal relief treatments. The 2018 treatment reduced EWM extent from 14 acres in June of 2017 to 13 acres in July of 2018.

3.2.3 MNDNR IBI

The 2018 Lake DeMontreville plant community meets the criteria of the MNDNR Lake Plant Eutrophication IBI and is not impaired. A total of 20 plant species were observed in 2018, which is 67 percent greater than the impairment threshold of 12 species. The lake's 2018 FQI score of 25.7 was 38 percent higher than the impairment threshold of 18.6. The Lake DeMontreville plant community has consistently met the criteria of the MNDNR Lake Plant Eutrophication IBI from 2012 through 2018 (Table 10).

3.2.4 Plant Diversity

VBWD point-intercept plant surveys have documented good plant diversity in Lake DeMontreville from 2012 through 2018. Simpson Diversity Index values during this period have fluctuated between 0.86 and 0.90, and a value of 0.87 was documented in 2018.

3.2.5 Significant Changes in Plant Frequency

Although significant changes in plant frequency occurred for several species in 2018, the changes are likely due to annual fluctuations in the Lake DeMontreville plant community and are not considered harmful. Significant year-over-year increases in the frequency of small pondweed (*Potamogeton pusillus)* and forked duckweed (*Lemna trisulca)* occurred in 2018, but remained within the range observed during the 2012 through 2017 period. Similarly, significant year-over-year decreases in frequency of common waterweed (*Elodea canadensis)* and southern naiad (*Najas guadalupensis)* occurred in 2018, but the frequencies remained within the range observed during the 2012 through 2017 period. White water crowfoot was observed at low frequencies prior to 2018, but not at all in 2018. Because similar declines occurred in Long Lake and Lake Elmo, untreated lakes, the decline in Lake DeMontreville is believed due to natural causes. In 2018, CLP was not observed, representing a significant decline due to natural senescence, which occurs annually in late June. The 2017 plant survey occurred prior to CLP senescence while the 2018 survey occurred after CLP senescence. Filamentous algae declined significantly in 2018, a positive change for the lake.

3.2.6 Other AIS

Although EWM is the AIS of primary concern in Lake DeMontreville, reed canary grass (*Phalaris arundinacea*) and hybrid cattail (*Typha x glauca*) were both observed in 2018. A single sighting of reed canary grass occurred in the southwest corner of the lake and a single sighting of hybrid cattail in the northwest corner of the lake. Because the infestations were small and no change occurred between 2017 and 2018, they are not considered problematic.

3.3 Lake Olson

3.3.1 EWM Treatment History and Changes in Post-Treatment EWM Extent

EWM was first observed in Lake Olson during 2012. Between 2012 and 2013, EWM extent doubled from 2 to 4 acres. Over the years, the LDO has conducted several treatments. The first was a small-scale 2,4-D treatment in 2014 which was unsuccessful, with EWM extent increasing to 24 acres by June of that year. Despite an additional small-scale 2,4-D treatment in 2015, EWM extent increased to 28 acres by June

2015. Small-scale 2,4-D treatments in 2016 and 2017 reduced EWM extent to 21 acres by June 2017. Switching to a different herbicide, diquat, in 2018, reduced EWM extent by two-thirds. After treating 8.5 acres with diquat, EWM extent was reduced to 7 acres in July 2018 (Table 12 and Figure 5). The EWM remaining was primarily outside of the treated areas. The results indicate diquat was effective in controlling EWM within the treated areas.

3.3.2 MNDNR IBI

The 2018 Lake Olson plant community meets the criteria of the MNDNR Lake Plant Eutrophication IBI and is not impaired. A total of 21 plant species were observed in 2018, which is 75 percent greater than the impairment threshold of 12 species. The 2018 FQI score of 26.6 was 43 percent higher than the impairment threshold of 18.6 (Table 14). The Lake Olson plant community has consistently met the criteria of the MNDNR Lake Plant Eutrophication IBI during the 2012 through 2018 period.

3.3.3 Plant Diversity

Increasing EWM extent from 2012 through 2016 resulted in decreasing plant diversity. Simpson Diversity Index values declined from 0.92 in 2012 to 0.85 in 2016. Herbicide treatments since 2016 have reduced EWM extent in the lake and improved diversity. Simpson Diversity Index values increased from 0.85 in 2016 to 0.87 in 2018 (Table 13).

3.3.4 Significant Changes in Plant Frequency

Significant changes in several Lake Olson plant species occurred in 2018. The successful 2018 EWM herbicide treatment caused a significant decline in EWM frequency. A significant decline in CLP occurred in 2018 such that CLP was not observed. The CLP decline was due to natural senescence, which occurs annually in late June. The 2017 plant survey occurred prior to CLP senescence while the 2018 survey occurred after CLP senescence. Two native species had significant frequency declines while three native species had significant frequency increases in 2018: common waterweed and Illinois pondweed (*Potamogeton illinoensis*) significantly declined in frequency while wild celery (*Vallisneria americana*), forked duckweed, and small pondweed significantly increased in frequency. The increase in wild celery frequency was likely due to the later plant survey, since this species tends to thrive later in the growing season. Although significant frequency changes occurred in 2018, common waterweed, forked duckweed, and small pondweed frequencies remained within the range of frequencies observed since 2012. Illinois pondweed was not observed in 2018 compared with previous frequencies of 8 to 23 percent, including a frequency of 17 percent in 2017.

3.3.5 Other AIS

Although EWM is the AIS of primary concern in Lake Olson, four additional AIS were observed during 2018. Several yellow iris (*Iris pseudacorus*) plants were observed at a single location in the southwest corner of the lake. The contractor removed the seedheads from each plant. A few purple loosestrife (*Lythrum salicaria*) plants and hybrid cattail were observed at the same location as the yellow iris. The contractor removed the purple loosestrife plants, and the small infestation of hybrid cattail at this single location is not considered problematic. Reed canary grass has annually been observed since point-intercept surveys began in 2012. Since the reed canary grass infestation is small and hasn't spread during

the past few years, it is not considered problematic. Changes in the area of infestation should be monitored to determine if or when management may be needed.

3.4 Lake Jane

3.4.1 History of EWM and Treatment

The first sighting of EWM occurred in 2012 when a few scattered plants, about 0.1 acres, were observed near the east shore. From 2012 through 2015, EWM extent increased to 44 acres. In May of 2015, the Lake Jane Association treated 7.9 acres with 2,4-D and EWM extent was reduced to 31 acres. No treatment occurred in 2016 and EWM extent increased to 69 acres. In 2017, the Lake Jane Association treated 11.1 acres with 2,4-D and EWM extent was reduced to 26 acres. In 2018, the Lake Jane Association treated 12 acres with Procellacor EC (Florpyrauxifen-benzyl) and EWM extent was reduced to 9 acres (Table 16 and Figure 6).

3.4.2 Changes in Post Treatment EWM Extent

The 2018 post-treatment EWM extent was substantially lower than EWM extent observed after 2015 and 2017 treatments—9 acres following the 2018 treatment compared with 31 acres after the 2015 treatment and 26 acres after the 2017 treatment (Table 16). All of the EWM observed after the 2018 treatment was outside of the treatment area. The data indicate the 2018 Procellacor EC treatment was effective at controlling EWM.

3.4.3 MNDNR IBI

The 2018 Lake Jane plant community meets the criteria of the MNDNR Lake Plant Eutrophication IBI and is not impaired. A total of 28 plant species were observed in 2018, which is 133 percent greater than the impairment threshold of 12 species. The 2018 FQI score of 31.9 was 72 percent higher than the impairment threshold of 18.6 (Table 18). The Lake Jane plant community has consistently met the criteria of the MNDNR Lake Plant Eutrophication IBI during the 2012 through 2018 period.

3.4.4 Plant Diversity

Lake Jane plant diversity has been good throughout the 2012 through 2018 monitoring period. Simpson diversity index values have fluctuated between 0.89 and 0.92 during this period, and a value of 0.89 was observed in both 2017 and 2018.

3.4.5 Significant Changes in Plant Frequency

The Lake Jane plant community was relatively stable in 2018. However, significant changes occurred in two aquatic invasive species (EWM and CLP) and two native species. The successful herbicide treatment resulted in a significant decrease in EWM frequency. CLP frequency significantly declined due to natural senescence, which occurs annually in late June. The 2017 survey occurred prior to CLP senescence while the 2018 survey occurred after CLP senescence. In 2018, Illinois pondweed significantly declined while southern naiad significantly increased in frequency.

3.4.6 Other AIS

Although EWM is the AIS of primary concern in Lake Jane, four additional AIS were observed during 2018. CLP, purple loosestrife, and reed canary grass have annually been present in Lake Jane since point-intercept monitoring began in 2012, but have not been problematic. As noted earlier, CLP declined in 2018 due to natural senescence prior to the plant survey. Purple loosestrife has annually been observed at a single location, although the location has changed from near the boat landing (2012 through 2016) to the southwest corner of the lake (2017 and 2018). Reed canary grass has annually been observed at a single location, but the location has varied from year-to-year. It was observed in the southwest corner of the lake in 2017 and northeast corner of the lake in 2018. Narrow-leaved cattail (*Typha angustifolia*) has been present at one location on the southeast side of lake from 2015 through 2018 and is not problematic.

3.5 Lake Elmo

3.5.1 History of EWM and EWM Removal

Natural fluctuations in Lake Elmo EWM extent have resulted in substantial changes over time. Lake Elmo EWM extent declined from 2012 through 2014 (from 71 acres to 51 acres), increased from 2014 to 2016 (from 51 acres to 80 acres), and declined from 2016 through 2018 (from 80 acres to 30 acres).

The Lake Elmo Association conducted three small-scale EWM removal projects from 2015 through 2017. A dive team removed less than an acre of EWM in 2015. In 2016, about 10 acres of EWM at the north end of the lake were removed by mechanical harvesting. In 2017, about 4 acres of EWM on the east and northeast side of the lake were removed by mechanical harvesting. In 2018, equipment problems with the mechanical harvester prevented removal.

3.5.2 Hybrid Milfoil

In 2018, the Minnesota Aquatic Invasive Species Research Center (MAISRC) collected milfoil samples from Lake Elmo and determined that hybrid milfoil is widespread in the lake. Hybrid milfoil is a cross between the native milfoil (*Myriophyllum sibiricum*) and EWM. Hybrid milfoil has been shown to be more aggressive and more resistant to herbicide treatment than EWM. It generally requires a higher dose of herbicide to attain control. Hybrid milfoil reproduces by both fragments and seeds and its seeds are generally viable.

3.5.3 MNDNR IBI

The 2018 Lake Elmo plant community met the criteria of the MNDNR Lake Plant Eutrophication IBI and is not impaired. A total of 24 plant species were observed in 2018, which is 100 percent greater than the impairment threshold of 12 species. The 2018 FQI score of 25.3 was 36 percent higher than the impairment threshold of 18.6 (Table 22). The Lake Elmo plant community has consistently met the criteria of MNDNR Lake Plant Eutrophication IBI during the 2012 through 2018 period.

3.5.4 Plant Diversity

Lake Elmo plant diversity has been good throughout the 2012 through 2018 monitoring period. Simpson diversity index values have fluctuated between 0.88 and 0.91 during this period and a value of 0.89 was observed in 2018.

3.5.5 Significant Changes in Plant Frequency

The Lake Elmo plant community was relatively stable in 2018 and only one species changed significantly in frequency. A significant decrease in white water crowfoot occurred—with none observed in 2018. White water crowfoot frequency had ranged from 1 to 9 percent from 2012 to 2017 and was 9 percent in 2017. Similar declines occurred in Long Lake and Lake DeMontreville during 2018. The declines in the three lakes appear to be due to natural causes.

3.5.6 Other AIS

Narrow-leaved cattail, an invasive species, has been observed in Lake Elmo since monitoring began in 2012. The cattail community is located along the western and southern shores of the lake and has remained stable over the monitoring period. It is not problematic.

3.6 Silver Lake

3.6.1 History of EWM and Treatment

EWM has been present in Silver Lake since 1992. The Silver Lake Improvement Association (SLIA) has conducted herbicide treatments to control EWM nearly annually since 1995. Most have been small-scale treatments to attain seasonal relief. However, large-scale treatments to attain long-term reduction occurred in 2007 and 2008. Treatments were not needed again until 2012. Small-scale treatments to attain seasonal relief occurred from 2012 through 2015 and in 2017.

3.6.2 Change of EWM Extent in 2018 despite No Treatment/Removal

Despite no EWM treatment or removal in 2018, Silver Lake EWM extent declined by an order of magnitude, from 30 acres in 2017 to 0.3 acres in 2018. The cause of the decline is unknown. As noted previously, a substantial decline in EWM extent also occurred in Lake Elmo during 2018 despite no treatment or removal.

3.6.3 History of CLP and Treatment

CLP presence in Silver Lake has been documented since 2006. The SLIA has conducted herbicide treatments to control CLP since 2007. Large-scale treatments to attain long-term CLP reduction occurred from 2007 through 2009. Treatments were not needed again until 2013. Small-scale treatments to attain seasonal relief occurred in 2013, 2016, and 2017. Although no herbicide treatment occurred in 2018, CLP was not observed. The 2018 decline in CLP was due to natural senescence, which occurs annually in late June. The 2017 survey occurred prior to CLP senescence while the 2018 survey occurred after CLP senescence.

3.6.4 MNDNR IBI

The 2018 Silver Lake plant community meets the criteria of the MNDNR Lake Plant Eutrophication IBI and is not impaired. A total of 17 plant species were observed in 2018, which is 42 percent greater than the impairment threshold of 12 species. The 2018 FQI score of 22.3 was 20 percent higher than the impairment threshold of 18.6 (Table 26).

The Silver Lake plant community has generally failed to meet the MNDNR Lake Plant Eutrophication IBI since 2007. During 2007 and 2008 CLP and EWM treatments, herbicide was reportedly applied at excessive concentrations and significant damage to the native plant community resulted. The data indicate the plant community met IBI criteria in 2006 and in June of 2007, but did not meet IBI criteria from August 2007 through 2012. Over time, the plant community has improved such that the Silver Lake IBI metrics (number of species and FQI) met the IBI criteria about half the time from 2013 through 2016 and met the criteria during both 2017 and 2018.

3.6.5 Plant Diversity

Plant diversity in Silver Lake has fluctuated widely during the monitoring period. Causes of the fluctuations include damage to the plant community from the 2007 and 2008 herbicide treatments and subsequent water-quality degradation and positive impacts from recent improvements to the lake's water quality. Simpson diversity index values have fluctuated between 0.61 and 0.83 during the 2006 through 2018 monitoring period.

Coontail, pictured above, increased in both density and frequency (from 26 percent in 2017 to 64 percent in 2018). Increased coontail positively impacts the water quality of Silver Lake.

Increasing frequency and density of coontail in 2018 reduced plant diversity in Silver Lake. Coontail increased in frequency from 26 percent in 2017 to 64 percent in 2018. Coontail density increased from an average rake fullness of 1.67 in 2017 to 1.97 in 2018. These changes resulted in a decrease in the Simpson Diversity Index value from 0.82 in 2017 to 0.67 in 2018. As noted previously, no herbicide treatment occurred in 2018. Hence, the changes in the plant community were due to natural causes.

3.6.6 Significant Changes in Plant Frequency

In 2018, two invasive species, EWM and CLP, had significant decreases in frequency. EWM frequency declined from 31 percent in 2017 to 1 percent in 2018. CLP was not observed in 2018. Because no herbicide treatment occurred, the changes are due to natural causes. CLP frequency declined due to natural senescence, which occurs annually in late June. The 2017 survey occurred prior to CLP senescence, while the 2018 survey occurred after CLP senescence.

In 2018, two native species, coontail and water star-grass (*Heteranthera dubia*) had significant increases in frequency. Because coontail obtains all of its nutrients from the water column, increases in this plant result

in increased removal of nutrients from the lake—which positively impacts the lake's water quality. Coontail also helps improve water quality by emitting allelochemicals into the water that inhibit algal growth.[3][4]

3.6.7 Other AIS

Prior to 2017, EWM and CLP were the only invasive species observed in Silver Lake. Three additional AIS are currently present in the lake. Reed canary grass and narrow-leaved cattail were first observed at one location in the northeast area of the lake during 2017 and were again observed at the same location in 2018. Purple loosestrife was first observed at one location in the southwest corner of the lake in 2018. The current infestations of reed canary grass, narrow-leaved cattail, and purple loosestrife are not problematic.

[3] Wium-Andersen, S., U. Anthoni, and G. Houen. 1983. *Elemental Sulphur, A Possible Allelopathic Compound from Ceratophyllum demersum*. Phytochemistry, Vol. 22, No. 11. P. 2613.

[4] Korner, Sabine and Andreas Nicklisch. 2002. Allelopathic Growth Inhibition of Selected Phytoplankton Species by Submerged Macrophytes. J. Phycol. 38, pp. 862-871.

4.0 Summary

The MNDNR developed a Lake Plant Eutrophication IBI to measure the response of a lake plant community to eutrophication (excessive nutrients). The MPCA will use this IBI to identify lakes that are impaired (i.e., not supporting aquatic life due to stress from excessive nutrients). In 2018, Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake met the criteria of the MNDNR Lake Plant Eutrophication IBI and are not impaired.

In 2018, lake associations treated Lake DeMontreville, Lake Olson, and Lake Jane with herbicide to contain EWM, an invasive species present in the lakes. All three lakes had a favorable response to the treatments, but the degree of EWM reduction varied among lakes:

- **Lake Jane**—The Procellacor EC treatment of 12 acres reduced EWM extent from 26 acres in June of 2017 to 9 acres in July of 2018.
- **Lake Olson**—The diquat treatment of 8.5 acres reduced EWM extent from 21 acres in June of 2017 to 7 acres in July of 2018.
- **Lake DeMontreville**—The diquat treatment of 16 acres reduced EWM extent from 14 acres in June of 2017 to 13 acres in July of 2018.

Long Lake, Lake Elmo, and Silver Lake are infested with EWM, but were not treated with herbicide in 2018. EWM extent significantly changed in each lake, but the direction of change varied.

- **Long Lake**—EWM extent increased from 6 acres in June of 2017 to 20 acres in May of 2018 to 35 acres in July of 2018.
- **Long Lake**-Katherine Abbott Pond—EWM extent decreased from 3 acres in June of 2017 to 2 acres in May of 2018 to not observed in July of 2018.
- **Lake Elmo**—EWM extent decreased from 57 acres in June of 2017 to 30 acres in July of 2018.

EWM in Long Lake, pictured above, increased in extent from 6 acres in June of 2017 to 35 acres in July of 2018.

- **Silver Lake**—EWM extent decreased from 30 acres in June of 2017 to 0.3 acres in July of 2018.

In 2017, CLP was present in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake. In 2018, there was reduced CLP frequency in all six lakes and CLP was not observed in Lake DeMontreville, Lake Olson, Lake Elmo, and Silver Lake. The reduction in CLP frequency was due to natural senescence which occurs annually in late June. The 2017 survey occurred prior to CLP senescence while the 2018 survey occurred in July, after CLP senescence. This is because the later end to the 2018 winter delayed herbicide treatments until the end of June. In 2017, winter ended earlier and herbicide treatments occurred in May or early June. Therefore, a late June plant survey assessed 2017 treatment results and also was early enough to assess CLP prior to its senescence.

Although EWM is the AIS of primary concern in all six lakes, several other AIS were present in 2018, although none were problematic.

- **Reed canary grass** was present in Lake Jane, Lake Olson, Lake DeMontreville, and Silver Lake.
- **Purple loosestrife** was present in Lake Jane, Lake Olson, and Silver Lake. Barr's subcontractor removed the purple loosestrife plants observed in Lake Olson because only a few plants were present.
- **Narrow-leaved cattail** was present in Lake Elmo and Lake Jane.
- **Hybrid cattail** was present in Lake Olson and Lake DeMontreville.
- **Yellow iris** was present in Lake Olson. Barr's subcontractor removed the seedhead from each plant to prevent reproduction and further spread of the infestation. If yellow iris plants are sighted in the future, the seedheads should be removed to prevent reproduction and further spread.

Tables

Description of Tables

Table 1 summarizes the results of the 2018 aquatic plant surveys of six VBWD lakes. The following data are presented:

- **Number of species**—the number of different plant species that were either collected on the rake or observed in the lake (e.g., water lilies or cattail beds not collected on the rake but observed). This number includes both invasive and native species.
- **Number of native species**—the number of native plant species that were either collected on the rake or observed in the lake.
- **Number of native species collected on rake**—only native plants collected on the rake were used for this statistic.
- **Number of invasive species**—the number of invasive plant species that were either collected on the rake or observed in the lake.
- **Maximum depth of plant growth**—the maximum depth that plants were found in the lake.
- **Frequency of occurrence**—the frequency with which plants were found in water shallower than the maximum depth of plant growth.
- **Average rake fullness**—the density of plant growth, as measured by rake fullness on a scale of 1 to 4, where:
    - 1 = less than 1/3 of the rake head full of plants.
    - 2 = from 1/3 to 2/3 of the rake head full of plants.
    - 3 = more than 2/3 of the rake head full of plants.
    - 4 = rake head is full, with plants overtopping.
- **Simpson Diversity Index Value**—index used to measure plant diversity, which assesses the overall health of the lake's plant communities. The index, with scores ranging from 0 to 1, considers both the number of species present and the evenness of species distribution. The scores represent the probability that two individual plants randomly selected from the lake will belong to different species. A high score indicates a more diverse plant community—a higher probability that two randomly selected plants will represent different species.

Table 2 summarizes invasive species data from the six VBWD lakes surveyed in 2018. The table shows the frequency of occurrence for species collected on the rake and includes species that were observed (Present = P), but not collected on the rake.

Tables 3, 4, 8, 12, 16, 20, and 24 summarize Eurasian watermilfoil (EWM) extent for the period of record for Long Lake, Long Lake-Katherine Abbott Pond, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and 2017 and 2018 for Silver Lake. EWM extent is shown as acres of EWM in the lake and as a percent of the plant-growth area.

Tables 5, 9, 13, 17, 21, and 25 summarize Simpson Diversity Index values for the period of record in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake.

Tables 6, 10, 14, 18, 22, and 26 summarize MNDNR Lake Eutrophication Plant IBI values for the period of record in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake.

Tables 7, 11, 15, 19, 23, and 27 show species frequency for the period of record in Long Lake, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake.

Table 1 Valley Branch Watershed District: Lake Plant Survey Summary Statistics (July 2018)

Lake	Number of Species*	Number of Native Species*	Number of Native Species Collected on Rake*	Number of Invasive Species	Maximum Depth of Plant Growth (feet)	Frequency of Occurrence (%)	Average Rake Fullness	Simpson Diversity Index Value
Jane	32	27	25	5	22	92	2.01	0.89
Elmo	28	26	17	2	22	88	2.38	0.89
Olson	27	22	18	5	20	95	1.81	0.87
DeMontreville	23	20	18	3	22	88	2.08	0.87
Silver	21	17	13	4	10	74	2.54	0.67
Long	16	14	11	2	23	74	2.38	0.80

*Filamentous algae, aquatic moss, and liverworts were not included in number of species.

Table 2 2018 Valley Branch Watershed District: July Invasive Species Summary
Frequency of Occurrence at Sites Shallower than Maximum Depth of Plant Growth (Percent or Observed*)

Lake	*Myriophyllum spicatum* (Eurasian watermilfoil)	*Potamogeton crispus* (curly-leaf pondweed)	*Phalaris arundinacea* (reed canary grass)	*Lythrum salicaria* (purple loosestrife)	*Typha angustifolia* (narrow-leaved cattail)	*Typha glauca* (hybrid cattail)	*Iris pseudacorus* (Yellow iris)
Elmo	25	--	--	--	16	--	--
Jane	9	1	P	P	P	--	--
Olson	10		P	P		P	P
DeMontreville	12	--	P	--	--	P	--
Silver	1	--	P	P	1	--	--
Long	58	7	--	--	--	--	--

*Observed in the lake but not collected on the rake (Present = P).

Table 3 Long Lake acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM (DOW 82.011800)

Sample Date	EWM Extent: Acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/15/2010	52.31	53.71	97.39%
8/1/2011	4.89	22.67	21.56%
4/29/2012	2.44	31.47	7.74%
6/18/2012	7.24	21.06	34.39%
5/16/2013 (Partial Survey)	14.28	--	--
6/24/2013	7.88	50.43	15.62%
5/24/2014	9.75	39.94	24.41%
6/25/2014	4.77	47.68	10.00%
5/9/2015	5.5	52.81	10.41%
6/22/2015	0.40	54.72	0.73%
5/1/2016	3.78	50.34	7.51%
6/27/2016	0.33	51.94	0.64%
6/27/2017	5.58	50.24	11.10%
5/20/2018	20.36	46.97	43.33
7/29/2018	34.71	53.51	64.87

Table 4 Long Lake – Katherine Abbott Pond acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM

Sample Date	EWM Extent: Acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/27/2017	2.88	2.93	98.32
5/20/2018	2.08	2.93	70.80
7/29/2018	0	2.93	0

Table 5 Simpson Diversity Index Values for Long Lake, Washington County, MN (DOW 82.011800)

Year	Month	Day	Diversity
2010	June	15	0.40
2011	August	1	0.80
2012	June	18	0.85
2013	June	24	0.81
2014	June	25	0.83
2015	June	22	0.77
2016	June	27	0.78
2017	June	27	0.84
2018	July	29	0.80

Table 6 MNDNR Plant IBI: Long Lake, Washington County, MN (DOW 82.011800)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Long Lake Species Richness**	Percent Difference between MNDNR Criterion and Long Lake Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Long Lake FQI**	Percent Difference between MNDNR Criterion and Long Lake FQI	Does Long Lake Meet MNDNR Plant IBI Criteria?
2010	June	15	≥12	14	17	≥18.6	21.3	15	Yes
2011	August	1	≥12	13	8	≥18.6	18.9	2	Yes
2012	June	18	≥12	13	8	≥18.6	18.9	2	Yes
2013	June	24	≥12	12	0	≥18.6	17.6	-5	No
2014	June	25	≥12	12	0	≥18.6	17.0	-9	No
2015	June	22	≥12	16	33	≥18.6	20.0	8	Yes
2016	June	27	≥12	17	42	≥18.6	21.8	17	Yes
2017	June	27	≥12	16	33	≥18.6	21.8	17	Yes
2018	July	29	≥12	15	25	≥18.6	19.9	7	Yes

*Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

**Limited to species selected by MNDNR for FQI computations. Does not include filamentous algae, aquatic moss, liverworts, and several emergent species.

Table 7 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Long Lake, Washington County, MN (DOW 82.011800)

Year	Month	Day	*Myriophyllum sibiricum*	*Myriophyllum spicatum*	*Ceratophyllum demersum*	*Ranunculus aquatilis*	*Utricularia vulgaris*	*Elodea canadensis*	*Heteranthera dubia*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton foliosus*	*Potamogeton nodosus*	*Potamogeton pusillus*	*Potamogeton sp.*	*Potamogeton nodosus*	*Stuckenia pectinata*	*Najas flexilis*	*Nitella spp.*	*Lychnothamnus bgarbatus*	*Chara spp.*	*Lemna minor*	*Lemna trisulca*	*Spirodela polyrhiza*	Wolffia columbiana	Filamentous Algae	Aquatic Moss	*Balboschoenus fluviatilis*	*Eleocharis acicularis*	*Phalaris arundinacea*	*Schoenoplectus acutus*	*Sparganium eurycarpum*	*Typha glauca*	*Typha sp.*	*Salix spp.*
			Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Free-float	Free-float	Free-float	Free-float	Algae	Mosses	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Upland
			Dicot	**Dicot**	**Dicot**	**Dicot**	**Dicot**	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot				Monocot	Monocot	Monocot	Monocot			Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	**Eudicot**
			Native	**Non-Native**	Native	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native		Native	Native	Native	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Hybrid		**Non-Native**
2010	06	15	1	92					8		6				P			2				2	2	1					P	1	2	P		1	1
2011	08	1		29	5		P		2		2			2				16			8	P	11			15	3	P	5	P	2				
2012	06	18		29	9				21		41			5				26	2		17	2	5			16		2	2	2	2		2		
2013	06	24		19	5				3		25			5				7			11	2	1			20		1	1	P	1		P		
2014	06	25		10	10			2	2		11			14				1			20		2			17		1	2	P	1		P		
2015	06	22		1	6			26	1		6			8		P	P	1	1		26	1			1	25		P	1	P	P		P		
2016	06	27		1	10	3		31	2		10			4		1		1	1		29	1	1	P		37		P	1	P	P		P		
2017	06	27		14	13	3		28	2	1	17	P		1		2			5	1	31	2	2	2	2	20				P					
2018	07	29		58	28			22	1		7	P		7		3			6	2	31	3		1	3	10	3		P		P				

*P = Present—Observed but not collected on the sampling rake

Table 8 Lake DeMontreville acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM (DOW 82.010100)

Sample Date	EWM Extent: acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/18/2012	5.39	137.07	3.93%
6/24/2013	50.88	144.45	35.22%
5/24/2014	53.08	143.93	36.88%
6/28/2014	26.75	146.94	18.20%
5/10/2015	58.01	149.40	38.83%
6/21/2015	20.60	157.29	13.10%
5/1/2016	38.28	156.25	24.50%
6/26/2016	19.04	147.06	12.95%
5/21/2017	44.27	144.49	30.64
6/25/2017	14.15	146.42	9.66
7/30/2018	12.74	154.91	8.23

Table 9 Simpson Diversity Index Values for Lake DeMontreville, Washington County, MN (DOW 82.010100)

Year	Month	Day	Diversity
2012	June	18	0.89
2013	June	24	0.90
2014	June	28	0.90
2015	June	21	0.90
2016	June	26	0.86
2017	June	25	0.87
2018	July	30	0.87

Table 10 MNDNR Plant IBI: Lake DeMontreville, Washington County, MN (DOW 82.010100)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Lake DeMontreville Species Richness**	Percent Difference between MNDNR Criterion and Lake DeMontreville Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Lake DeMontreville FQI**	Percent Difference between MNDNR Criterion and Lake DeMontreville FQI	Does Lake DeMontreville Meet MNDNR Plant IBI Criteria?
2012	June	18	≥12	22	83	≥18.6	26.4	42	Yes
2013	June	24	≥12	24	100	≥18.6	27.6	48	Yes
2014	June	28	≥12	22	83	≥18.6	27.9	50	Yes
2015	June	21	≥12	24	100	≥18.6	28.6	54	Yes
2016	June	26	≥12	19	58	≥18.6	24.6	32	Yes
2017	June	25	≥12	22	83	≥18.6	25.5	37	Yes
2018	July	30	≥12	20	67	≥18.6	25.7	38	Yes

*Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

**Limited to species selected by MNDNR for FQI computations. Does not include filamentous algae, aquatic moss, liverworts, and several emergent species.

Table 11 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Lake DeMontreville, Washington County, MN (DOW 82.010100)

Year	Month	Day	*Ceratophyllum demersum*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilis*	*Elodea canadensis*	*Heteranthera dubia*	*Isoetes echinospora*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton friesii*	*Potamogeton illinoensis*	*Potamogeton pusillus*	*Potamogeton robbinsii*	*Potamogeton zosteriformis*	*Stuckenia pectinata*	*Najas flexilis*	*Najas s guadalupensis*	*Vallisneria americana*	*Chara sp.*	*Nitella sp.*	*Lemna minor*	*Lemna trisulca*	*Spirodela polyrhiza*	*Wolffia columbiana*	*Nymphaea odorata*	*Polygonum amphibium*	Filamentous Algae	Aquatic moss	*Eleocharis acicularis*	*Eleocharis palustris*	*Lythrum salicaria*	*Iris Pseudacorus*	*Phalaris arundinacea*	*Sagittaria graminea*	*Schoenoplectus acutus*	*Schoenoplectus tabernaemontani*	*Typha angustifolia*	*Typha latifolia*	*Typha glauca*
			Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Free-float	Free-float	Free-float	Free-float	Float-leaf	Float-leaf	Algae	Mosses	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent
			Dicot	**Dicot**	**Dicot**	**Dicot**	Monocot	Monocot		Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot			Monocot	Monocot	Monocot	Monocot	**Dicot**	**Dicot**			Monocot	Monocot		Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot
			Native	**Non-Native**	Native	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	**Non-Native**	**Non-Native**	**Non-Native**	Native	Native	**Non-Native**	Native	Native	**Non-Native**
2012	06	18	38	4	5	4	8	5		4	49		9	41	12	50		2		4	6	11		22		1	3		6	1	1	P	P		1			P	P	P	1
2013	06	24	50	33	12	5	22	7		3	42	1	7	30	26	48	2	2		2	5	3	1	28	1		4	P	33			P		P	P				P	P	1
2014	06	28	61	19	13	3	32	7		3	10	1	7	25	19	39		4	1	7	10	3		17			3	P	14	3	1	P			1						1
2015	06	21	61	17	1	5	30	2	1	6	31		6	18	17	45		6	8	12	13	6		15			3	P	27	6	2	P		P	P		P		P	P	1
2016	06	26	70	16		3	68	4			2		6	5	4	12		4	18	14	30	11		14			5	1	39	1			P		P		P	P			1
2017	06	25	53	14		5	64	1		1	17		3	13	4	2			17	18	35	10	3	5	3	2	3	P	31	6		P			P		P				P
2018	07	30	49	12			24	1		1			3	24	5	3	P	1	8	21	45	4	3	23		3	4	P	16	2					P	1					P

*P = Present—Observed but not collected on the sampling rake

Table 12 Lake Olson acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM (DOW 82.010300)

Sample Date	EWM Extent: Acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/18/2012	2.17	88.03	2.46%
6/24/2013	3.55	89.01	3.99%
5/24/2014	22.96	87.11	26.36%
6/28/2014	23.96	89.02	26.92%
5/9/2015	31.77	89.26	35.59%
6/21/2015	28.13	87.02	32.33%
5/1/2016	53.49	89.26	59.93%
6/26/2016	17.56	89.26	19.67%
5/21/2017	43.61	89.26	48.86
6/25/2017	21.03	88.80	23.68
7/30/2018	6.58	89.26	7.38

Table 13 Simpson Diversity Index Values for Lake Olson, Washington County, MN (DOW 82.010300)

Year	Month	Day	Diversity
2012	June	18	0.92
2013	June	24	0.91
2014	June	28	0.90
2015	June	21	0.90
2016	June	26	0.85
2017	June	25	0.86
2018	July	30	0.87

Table 14 MNDNR Plant IBI: Lake Olson, Washington County, MN (DOW 82.010300)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Lake Olson Species Richness**	Percent Difference between MNDNR Criterion and Lake Olson Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Lake Olson FQI**	Percent Difference between MNDNR Criterion and Lake Olson FQI	Does Lake Olson Meet MNDNR Plant IBI Criteria?
2012	June	18	≥12	21	75	≥18.6	25.6	38	Yes
2013	June	24	≥12	21	75	≥18.6	25.3	36	Yes
2014	June	28	≥12	23	92	≥18.6	27.1	46	Yes
2015	June	21	≥12	25	108	≥18.6	29.2	57	Yes
2016	June	26	≥12	23	92	≥18.6	27.1	46	Yes
2017	June	25	≥12	24	100	≥18.6	27.8	49	Yes
2018	July	30	≥12	21	75	≥18.6	26.6	43	Yes

*Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

**Limited to species selected by MNDNR for FQI computations. Does not include filamentous algae, aquatic moss, liverworts, and several emergent species.

Table 15 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Lake Olson, Washington County, MN (DOW 82.010300)

Year	Month	Day	*Ceratophyllum demersum*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilis*	*Elodea canadensis*	*Heteranthera dubia*	*Isoetes echinospora*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton illinoensis*	*Potamogeton nodosus*	*Potamogeton pusillus*	*Potamogeton robbinsii*	*Potamogeton zosteriformis*	*Najas flexilis*	*Najas guadalupensis*	*Stuckenia pectinata*	*Vallisneria americana*	Chara sp.	*Nitella sp*	*Lemna trisulca*	*Nymphaea odorata*	*Polygonum amphibium*	Filamentous algae	Aquatic moss	*Calamagrostis canadensis*	*Eleocharis acicularis*	*Eleocharis palustris*	*Iris virginica*	*Iris pseudacorus*	*Lythrum salicaria*	*Phalaris arundinacea*	*Sagittaria cristata*	Sagittaria graminea	Schoenoplectus acutus	Schoenoplectus Tabernaemontani	Typha angustifolia	Typha glauca
			Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Free-float	Float-leaf	Float-leaf	Algae	Mosses	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent
			Dicot	**Dicot**	**Dicot**	**Dicot**	**Dicot**	Monocot		Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot		Monocot	**Dicot**	**Dicot**			Monocot	Monocot	Monocot	Monocot	Monocot	**Dicot**	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot
			Native	**Non-Native**	Native	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	**Non-Native**	**Non-Native**	**Non-Native**	Native	Native	Native	Native	**Non-Native**	**Non-Native**	**Non-Native**
2012	06	18	27	3	12	4	11	16		10	28	23		30	10	19	3			2	25	12	15	1	P	7	18		4	1				1				1	P	
2013	06	24	38	5	10	3	11	12		7	43	17		25	7	21	13		P		10	6	20	1		8	14		3	1				P				1	P	
2014	06	28	57	28	8	2	23	24	1	1	3	13		22	10	17	11	2	P	3	25	4	19	1		19	13		1	1				P				P	P	
2015	06	21	37	28	2	P	23	6		3	5	13	1	6	21	15	8	4	P	5	38	7	11	1		9	15		4	1	P			P	P			P	P	
2016	06	26	50	19		3	67	4			1	8	P	3	8	6	8	4	1	6	53	9	8	1	P	23	13	P	5	P				P		2		P	P	
2017	06	27	58	25		2	58	1		2	5	17	P	2	10	3	2	14	1	10	55	9	3	1	P	18	8	P	2			P		P		2	P	P		
2018	07	30	48	10			30	1		1			P	10	8	4	3	15	1	22	53	6	12	1	P	9	8	P	3			P	P	P		1	P			P

*P = Present—Observed but not collected on the sampling rake

Table 16 Lake Jane acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM (DOW 82.010400)

Sample Date	EWM Extent: Acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/18/2012	0.10	118.54	0.08%
6/28/2013	1.68	121.82	1.38%
6/27/2014	24.08	112.61	21.38%
5/9/2015	44.16	125.08	35.31%
6/21/2015	31.01	126.77	24.46%
6/27/2016	68.71	131.23	52.36%
6/27/2017	26.26	126.40	20.77
7/29/2018	9.07	128.01	7.09

Table 17 Simpson Diversity Index Values for Lake Jane, Washington County, MN (DOW 82.010400)

Year	Month	Day	Diversity
2012	June	18	0.92
2013	June	28	0.91
2014	June	27	0.92
2015	June	21	0.92
2016	June	27	0.90
2017	June	27	0.89
2018	July	29	0.89

Table 18 MNDNR Plant IBI: Lake Jane, Washington County, MN (DOW 82.010400)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Lake Jane Species Richness**	Percent Difference between MNDNR Criterion and Lake Jane Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Lake Jane FQI**	Percent Difference between MNDNR Criterion and Lake Jane FQI	Does Lake Jane Meet MNDNR Plant IBI Criteria?
2012	June	18	≥12	28	133	≥18.6	31.6	70	Yes
2013	June	28	≥12	31	158	≥18.6	33.1	78	Yes
2014	June	27	≥12	29	142	≥18.6	32.3	74	Yes
2015	June	21	≥12	26	117	≥18.6	30.8	66	Yes
2016	June	27	≥12	27	125	≥18.6	30.8	66	Yes
2017	June	27	≥12	27	125	≥18.6	30.8	66	Yes
2018	July	29	≥12	28	133	≥18.6	31.9	72	Yes

*Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

**Limited to species selected by MNDNR for FQI computations. Does not include filamentous algae, aquatic moss, liverworts, and several emergent species.

Table 19 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Lake Jane, Washington County, MN (DOW 82.010400)

Year	Month	Day	*Ceratophyllum demersum*	*Bidens beckii*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilus*	*Elodea canadensis*	*Heteranthera dubia*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton friesii*	*Potamogeton illinoensis*	*Potamogeton nodosus*	*Potamogeton pusillus*	*Potamogeton praelongus*	*Potamogeton robbinsii*	*Potamogeton zosteriformis*	*Stuckenia pectinata*	*Najas flexilis*	*Najas guadalupensis*	*Vallisneria americana*	*Zannichellia palustris*	*Isoetes echinospora*	Chara sp.	*Nitella sp*	*Brasenia schreberi*	*Nymphaea odorata*	*Polygonum amphibium*	*Lemna minor*	*Lemna trisulca*	*Riccia fluitans*	*Wolffia columbiana*	Isoetes echinospora	Aquatic moss	Filamentous algae	*Carex pellita*	*Eleocharis acicularis*	*Eleocharis erythropoda*	*Iris virginica*	*Juncus articus variation balticus*	*Juncus canadensis*	*Juncus efflusus*	*Juncus pelocarpus*	*Juncus pilocarpus f. submersus*	*Lythrum salicaria*	*Phalaris arundinacea*	*Sagittaria cristata*	*Schoenplectus tabernaemontani*	*Typha angustifolia*	*Typha X glauca*	*Polygonum amphibium*
			Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Float-leaf	Float-leaf	Float-leaf	Free-float	Free-float	Free-float	Free-float	Quillwort	Mosses	Algae	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent
			Dicot	**Dicot**	**Dicot**	**Dicot**	**Dicot**	**Dicot**	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot				**Dicot**	**Dicot**	**Dicot**	Monocot	Monocot		Monocot			Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	**Dicot**	Monocot	Monocot	Monocot	Monocot	Monocot	**Dicot**
			Native	Native	**Non-Native**	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	**Non-Native**	**Non-Native**	**Non-Native**	Native	Native	**Non-Native**	Native
2012	06	18	33		P	22	15	32	7	21	16	1	24		8	14	62	16	1	8	6	6			16		1	6	P	2	1		1			2		4				P	2		P	P	2	P	P	P	
2013	06	28	24		2	21	9	17	3	15	12		30		6	21	66	10	1	8	5	2	2	1	15	1	1	2		1	1	P	1			5		7	1		1				2	P	P	3	1	P		
2014	06	27	25		19	20	5	27	7	6	8	2	30	2	7	16	57	14	P	5	13	6	1	1	22		2	2			1				1	2	1	1	1		1	1	P			P	P	4	P		P	
2015	06	21	23	1	23	9	2	30		7	11	2	19	7	7	14	53	12	2	4	17	4			17	2	1	3			7				1	16		3								P	P	3	P	P		
2016	06	27	14		41	3	1	46	P	7	18		18	9	1	9	54	5	1	2	37	5	2	1	18	3		5	P							10	1	5	1	P	P	P				P	1	1	P	P		
2017	06	27	17		24		1	62	1	2	17		22	8		3	33	2	P	3	20	11			16	7	1	3			3			1		2		2	1		1	1			P	P	P	1	P	P		P
2018	07	29	14		9		1	59	3	7	1		10	2	1	6	36	1		9	34	17			18	2	1	2		1	10			1	1	4		2	1						1	P	P	2	P	P		P

*P = Present—Observed but not collected on the sampling rake

Table 20 Lake Elmo acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM (DOW 82.010600)

Sample Date	EWM Extent: acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/18–19/2012	71.09	112.68	63.09
6/28/2013	52.69	109.61	48.07
6/27/2014	50.58	112.42	44.99
6/21/2015	67.52	113.53	59.47
4/30/2016	58.77	123.62	47.54%
6/27/2016	78.58	123.31	63.73%
7/29/2016*	80.15	126.60	63.31%
6/27/2017	57.32	120.19	47.69
7/30/2018	30.12	116.26	25.91

*July 29, 2016, data collected by the Lake Elmo Association

Table 21 Simpson Diversity Index Values for Lake Elmo, Washington County, MN (DOW 82.010600)

Year	Month	Day	Diversity
2012	June	18–19	0.91
2013	June	28	0.89
2014	June	27	0.88
2015	June	21	0.88
2016	June	27	0.89
2016	July	29	0.88
2017	June	27	0.91
2018	July	30	0.89

July 29, 2016, data collected by the Lake Elmo Association

Table 22 MNDNR Plant IBI: Lake Elmo, Washington County, MN (DOW 82.010600)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Lake Elmo Species Richness**	Percent Difference between MNDNR Criterion and Lake Elmo Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Lake Elmo FQI**	Percent Difference between MNDNR Criterion and Lake Elmo FQI	Does Lake Elmo Meet MNDNR Plant IBI Criteria?
2012	June	18–19	≥12	31	158	≥18.6	31.1	67	Yes
2013	June	28	≥12	28	133	≥18.6	28.0	51	Yes
2014	June	27	≥12	25	108	≥18.6	25.4	37	Yes
2015	June	21	≥12	26	117	≥18.6	26.9	45	Yes
2016	June	27	≥12	26	117	≥18.6	26.9	45	Yes
2016	July	29	≥12	26	117	≥18.6	26.5	42	Yes
2017	June	27	≥12	29	142	≥18.6	29.2	57	Yes
2018	July	30	≥12	24	100	≥18.6	25.3	36	Yes

* Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

**Limited to species selected by MNDNR for FQI computations. Does not include filamentous algae, aquatic moss, liverworts, and several emergent species.

Table 23 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Lake Elmo, Washington County, MN (DOW 82.010600)

Year	Month	Day	*Ceratophyllum demersum*	*Elodea canadensis*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilus*	*Utricularia vulgaris*	*Heteranthera dubia*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton foliosus*	*Potamogeton friesii*	*Potamogeton illinoensis*	*Potamogeton natans*	*Potamogeton praelongus*	*Potamogeton pusillus*	*Potamogeton richardsonii*	*Potamogeton strictifolius*	*Potamogeton zosteriformis*	*Najas flexilis*	*Najas guadalupensis*	*Stuckenia pectinata*	Chara sp.	*Nitella sp*	*Nymphaea odorata*	*Polygonum amphibium*	*Lemna minor*	*Lemna trisulca*	*Spirodela polyrhiza*	Wolffia columbiana	Filamentous algae	*Riccia fluitans*	*Ricciocarpus natans*	*Carex comosa*	*Carex pellita*	*Carex scoparia*	*Eleocharis acicularis*	*Eleocharis erythropoda*	*Eleocharis palustris*	*Equisetum fluviatile*	*Iris virginica*	*Juncus canadensis*	*Phalaris arundinacea*	*Phragmites australis*	*Polygonum amphibium*	*Schoenoplectus acutus*	*Schoenoplectus pungens*	*Schoenoplectus*	*Sparganium eurycarpum*	*Typha angustifolia*	*Typha glauca*
			Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Float-leaf	Float-leaf	Free-float	Free-float	Free-float	Free-float	Algae	Liverwort	Liverwort	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent
			Dicot	**Dicot**	**Dicot**	**Dicot**	**Dicot**	**Dicot**	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot			**Dicot**	**Dicot**	Monocot	Monocot	Monocot	Monocot				Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	**Dicot**	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot
			Native	Native	**Non-Native**	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	**Non-Native**
2012	06	18-19	29	8	44	1	7	1		P	3	P	P	13	12		1	P	1	7	1	28	5	37	1	12	P	1				5			P			3	1	3	P			4			4	P	5	P	17	
2013	06	28	26	3	37	P	4	1			P		1	7	9		P	P		3	1	21	1	33	1	13		4				8		P	P	1	1		1	P	P	1		1	1		3	P	4	P	16	
2014	06	27	43	5	34		1	P			P		P	4	9			P		4	4	18	1	31		9	P	1		1		14			P	1	P		1	P	P			3	P		5	P	3			16
2015	06	21	41	3	45	P	3	1	1	P	P			4	13		1			7		12	3	35		13	P	5		7		11	3						3	P	P	P		P	P		3	P	3		17	
2016	06	27	43	8	43		6	P	3	P	1			9	10		1			6	P	23	1	34		18	P	4	1	3		8		1						P	P			1	P		5	P	P		15	1
2016	07	29	40	8	39		3	P	3	P	P			11	10	P				4	1	28	3	29		11	P	3		1		3							1	P	P				P		5	P	3		1	15
2017	06	27	42	6	32		9	3	1	P	3			13	10	1	P			4		29	6	21	1	14		4	4	5	4	4	P					1			P				P	P	3	P	P		13	1
2018	07	30	43	5	25			P	P	3				9	12	P				9		35	8	14		16	P	1	3	3		5			1			P	1		P		1		P	P	4	P	P		16	

*P = Present—Observed but not collected on the sampling rake

July 29, 2016, data collected by the Lake Elmo Association

Table 24 Silver Lake acres of EWM, acres of Plant Growth, and percentage of Plant-Growth Area with EWM (DOW 62.000100)

Sample Date	EWM Extent: acres of EWM	Acres of Plant Growth	Percentage of Plant-Growth Area with EWM
6/25/2017	30.43	69.78	43.61
7/29/2018	0.32	68.99	0.46

Table 25 Simpson Diversity Index Values for Silver Lake, Ramsey County, MN (DOW 62.000100)

Year	Month	Day	Diversity
2006	June	7	0.83
2006	July	26	0.79
2007	June	11	0.79
2007	August	13	0.66
2011	August	1	0.77
2012	July	20	0.61
2013	August	13	0.81
2014	August	5	0.79
2015	August	20	0.77
2016	August	9	0.80
2017	June	25	0.82
2018	July	29	0.67

Table 26 MNDNR Plant IBI: Silver Lake, Ramsey County, MN (DOW 62.000100)

Year	Month	Day	MNDNR Species Richness Plant IBI Criterion*	Silver Lake Species Richness**	Percent Difference between MNDNR Criterion and Silver Lake Species Richness	MNDNR Floristic Quality Index (FQI) Plant IBI Criterion*	Silver Lake FQI**	Percent Difference between MNDNR Criterion and Silver Lake FQI	Does Silver Lake Meet MNDNR Plant IBI Criteria?
2006	June	7	≥12	19	58	≥18.6	25.7	38	Yes
2006	July	26	≥12	15	25	≥18.6	22.0	18	Yes
2007	June	11	≥12	13	8	≥18.6	19.4	4	Yes
2007	August	13	≥12	12	0	≥18.6	18.5	-1	No
2008	June	23	≥12	9	-25	≥18.6	16.7	-10	No
2008	August	24	≥12	7	-42	≥18.6	15.1	-19	No
2009	June	2	≥12	10	-17	≥18.6	16.1	-13	No
2009	August	9	≥12	8	-33	≥18.6	13.8	-26	No
2010	June	16	≥12	7	-42	≥18.6	12.1	-35	No
2010	August	6	≥12	9	-25	≥18.6	14.0	-25	No
2011	August	1	≥12	11	-8	≥18.6	16.6	-11	No
2012	July	20	≥12	8	-33	≥18.6	14.1	-24	No
2013	August	13	≥12	13	8	≥18.6	18.6	0	Yes
2014	August	5	≥12	11	-8	≥18.6	15.7	-16	No
2015	August	20	≥12	14	17	≥18.6	19.0	2	Yes
2016	August	9	≥12	11	-8	≥18.6	16.0	-14	No
2017	June	25	≥12	20	67	≥18.6	23.9	29	Yes
2018	July	29	≥12	17	42	≥18.6	22.3	20	Yes

* Criteria for North Central Hardwoods—2B Deeper Water Lakes (≥ 15' Max Depth)

**Limited to species selected by MNDNR for FQI computations. Does not include filamentous algae, aquatic moss, liverworts, and several emergent species

Table 27 Percent Frequencies of Occurrence in Vegetated Depth Range of Plants in Silver Lake, Washington County, MN (DOW 62.000100)

Year	Month	Day	Surveyor	*Ceratophyllum demersum*	*Elodea canadensis*	*Myriophyllum spicatum*	*Myriophyllum sibericum*	*Ranunculus aquatilus*	*Ranunculus sp.*	*Heteranthera dubia*	*Potamogeton amplifolius*	*Potamogeton crispus*	*Potamogeton foliosus*	*Potamogeton praelongus*	*Potamogeton pusillus*	*Potamogeton nodosus*	*Potamogeton richardsonii*	*Potamogeton robbinsii*	*Potamogeton sp.*	*Potamogeton zosteriformis*	*Najas flexilis*	*Najas sp.*	*Stuckenia pectinata*	Chara sp.	*Nitella*	*Chara and Nitella*	*Nymphaea odorata*	*Lemna minor*	*Lemna trisulca*	*Spirodela polyrhiza*	Wolffia columbiana	Aquatic moss	Filamentous algae	*Eleocharis acicularis*	*Eleocharis sp.*	*Iris virginica*	*Lythrum salicaria*	*Phalaris arundinacea*	*Schoenplectus tabernaemontani*	*Typha angustifolia*	*Typha sp.*
				Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Submersed	Float-leaf	Free-float	Free-float	Free-float	Free-float	Free-float	Mosses	Algae	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent	Emergent
				Dicot	**Dicot**	**Dicot**	**Dicot**	**Dicot**	**Dicot**	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot	Monocot				**Dicot**	Monocot	Monocot	Monocot	Monocot											
				Native	Native	**Non-Native**	Native	Native	Native	Native	Native	**Non-Native**	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	Native	**Non-Native**	**Non-Native**	Native	**Non-Native**	Native	
2006	06	7	VBWD	97	49	70	3		6	12	12	21		1			1	1	1	22	25			1	2		3		14						1						
2006	07	26	VBWD	97	41	56	10		1	14	10	1						1		1	29			3	1		2		9												
2007	06	11	Fortin	81	56	48	3				6	2							12		11				1		2	1	28												1
2007	08	13	Fortin	96	32	8						1							5		7								34												
2008	6	23	U of M	54	17					1				1							1			4			3		14				1								
2008	8	24	U of M	11	12					2	1			3							1			3			5		5				3								
2009	6	2	U of M	3	29					2		1												26	1		4	1	1				1								1
2009	8	9	U of M	1	44	1				6				1							1			40			8	1					3								1
2010	6	16	MnDNR		22	6		1			1	62											9	55																
2010	8	6	MnDNR	3	25	16				4	1	1			2								3	34																
2011	8	1	MnDNR	2	13	42	4			3		5	10	2									2	21			6													3
2012	7	20	MnDNR		4	71	9					8	1	1									1	24			3													1
2013	8	13	MnDNR	10	2	11	19					3	2	1							2		2	2	30		7						2							
2014	8	5	MnDNR	22	2	63				1		38			13						4		4		44		5						1							
2015	8	20	MnDNR	39	2	7	1	1		7		2	6							1		5	1			47	8						1							
2016	8	9	MnDNR	46	3	19				4		17		1								8	2			29	8						2							
2017	06	25	VBWD	26	3	31		P		P		32	P	P	1	P				1	1		P	40			5	4	1	3	2		29	2		P		P		1	
2018	07	29	VBWD	64	1	1				4			P		2	1				P	4			30			9	3	2	2	2	1	19	2		P	P	P	P	1	

*P = Present—Observed but not collected on the sampling rake

Figures

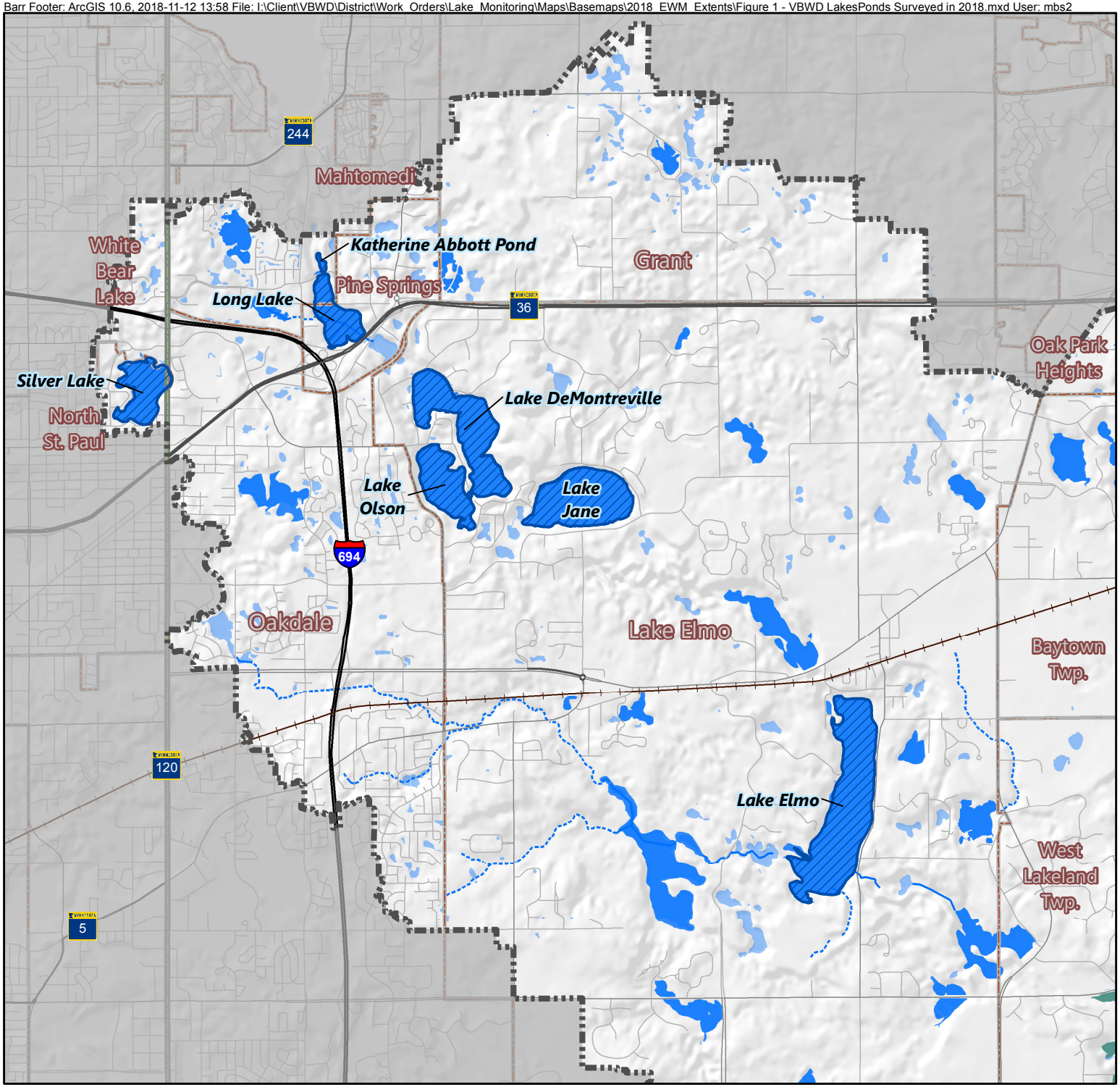
Description of Figures

Figure 1 shows locations of Long Lake, Long Lake-Katherine Abbott Pond, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake.

Figures 2 through 8 show 2018 EWM extent in Long Lake, Long Lake-Katherine Abbott Pond, Lake DeMontreville, Lake Olson, Lake Jane, Lake Elmo, and Silver Lake.

Figure 9 shows the 2006-2018 Eurasian Watermilfoil Frequency of Occurrence in the Vegetated Depth Range of Plants in Silver Lake.

Barr Footer: ArcGIS 10.6, 2018-11-12 13:58 File: I:\Client\VBWD\District\Work_Orders\Lake_Monitoring\Maps\Basemaps\2018_EWM_Extents\Figure 1 - VBWD LakesPonds Surveyed in 2018.mxd User: mbs2



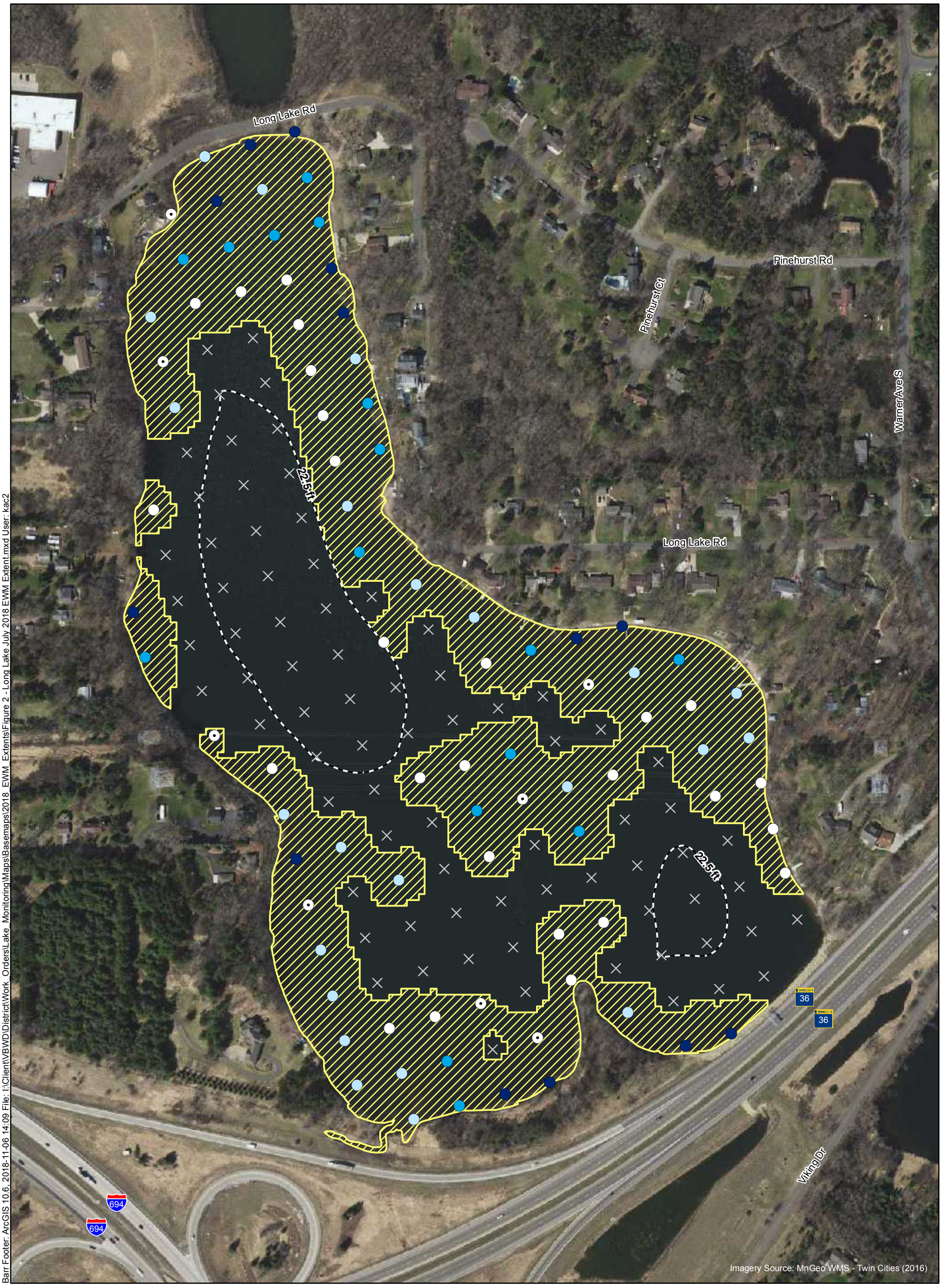
Lake/Pond Surveyed in 2018
Major Waterbody
Stormwater Pond
District Legal Boundary
Municipal Boundary
County Boundary

N

Miles
0 1 2

Figure 1

VBWD LAKES/PONDS SURVEYED IN 2018
Washington County
Valley Branch Watershed District



Barr Footer: ArcGIS 10.6, 2018-11-06 14:09 File: I:\Client\VBWD\District\Work_Orders\Lake_Monitoring\Maps\Basemaps\2018_EWM_Extents\Figure 2 - Long Lake July 2018 EWM Extent.mxd User: kac2

EWM Survey Results

- Not Observed
- Visual Only (None on Rake)
- Density = 1
- Density = 2
- Density = 3
- Density = 4

- Approximate Extent of EWM
- Maximum Depth of Plant Growth

N

Feet

0 125 250 500

Figure 2

LONG LAKE EURASIAN WATERMILFOIL EXTENT, JULY 2018
Long Lake (82011800)
Washington County
Valley Branch Watershed District

EWM Survey Results

- Not Observed
- Visual Only (None on Rake)
- Density = 1
- Density = 2
- Density = 3
- Density = 4

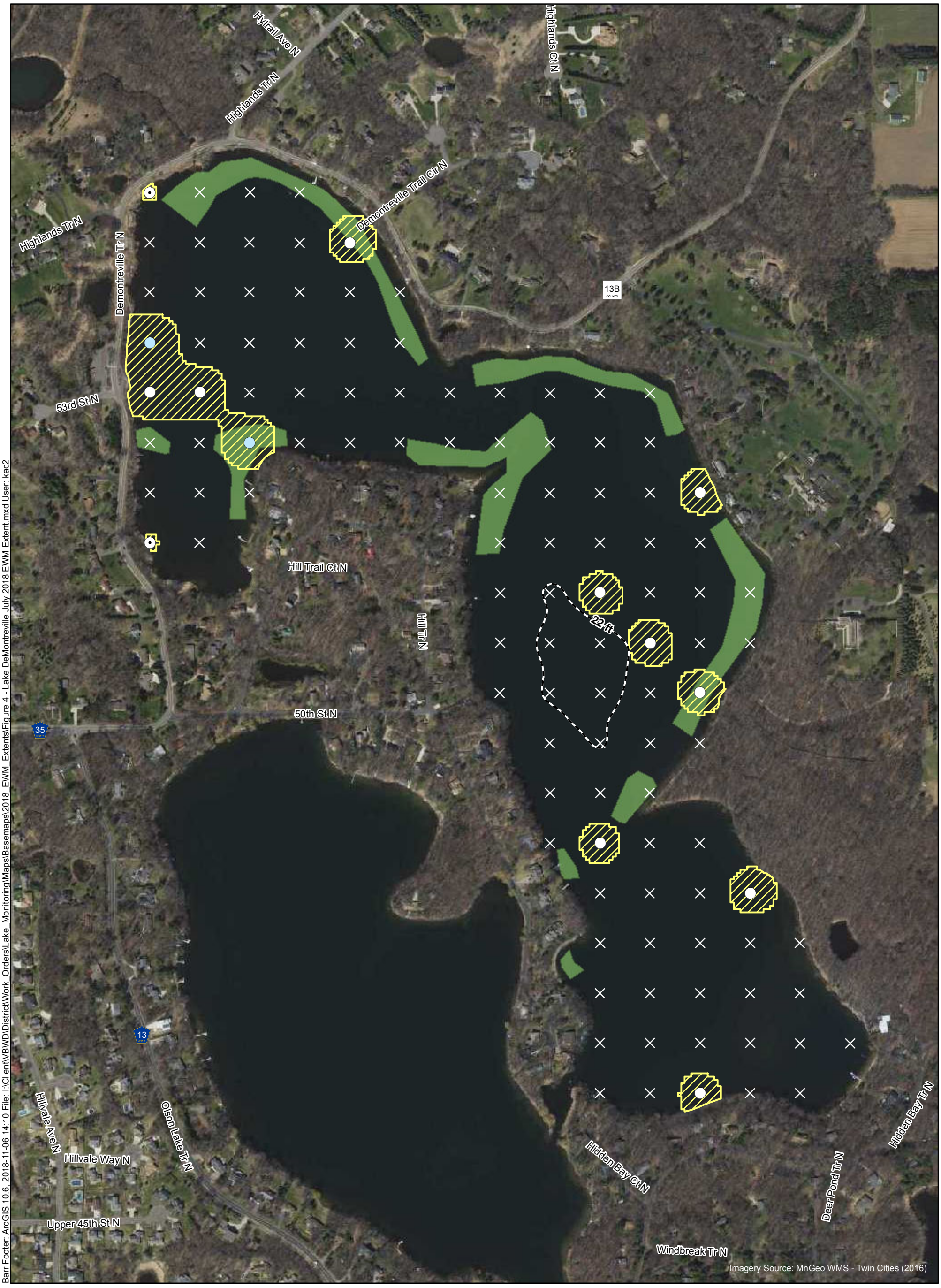
Approximate Extent of EWM

N

Feet
0 30 60 120

Figure 3

LONG LAKE-KATHERINE ABBOTT POND EURASIAN WATERMILFOIL EXTENT, JULY 2018
Long Lake-Katherine Abbott Pond
Washington County
Valley Branch Watershed District



Barr Footer: ArcGIS 10.6, 2018-11-06 14:10 File: I:\Client\VBWD\District\Work_Orders\Lake_Monitoring\Maps\Basemaps\2018_EWM_Extents\Figure 4 - Lake DeMontreville July 2018 EWM Extent.mxd User: kac2

EWM Survey Results

- Not Observed
- Visual Only (None on Rake)
- Density = 1
- Density = 2
- Density = 3
- Density = 4

- Approximate Extent of EWM
- Maximum Depth of Plant Growth
- EWM Treatment Area (Spring 2018)

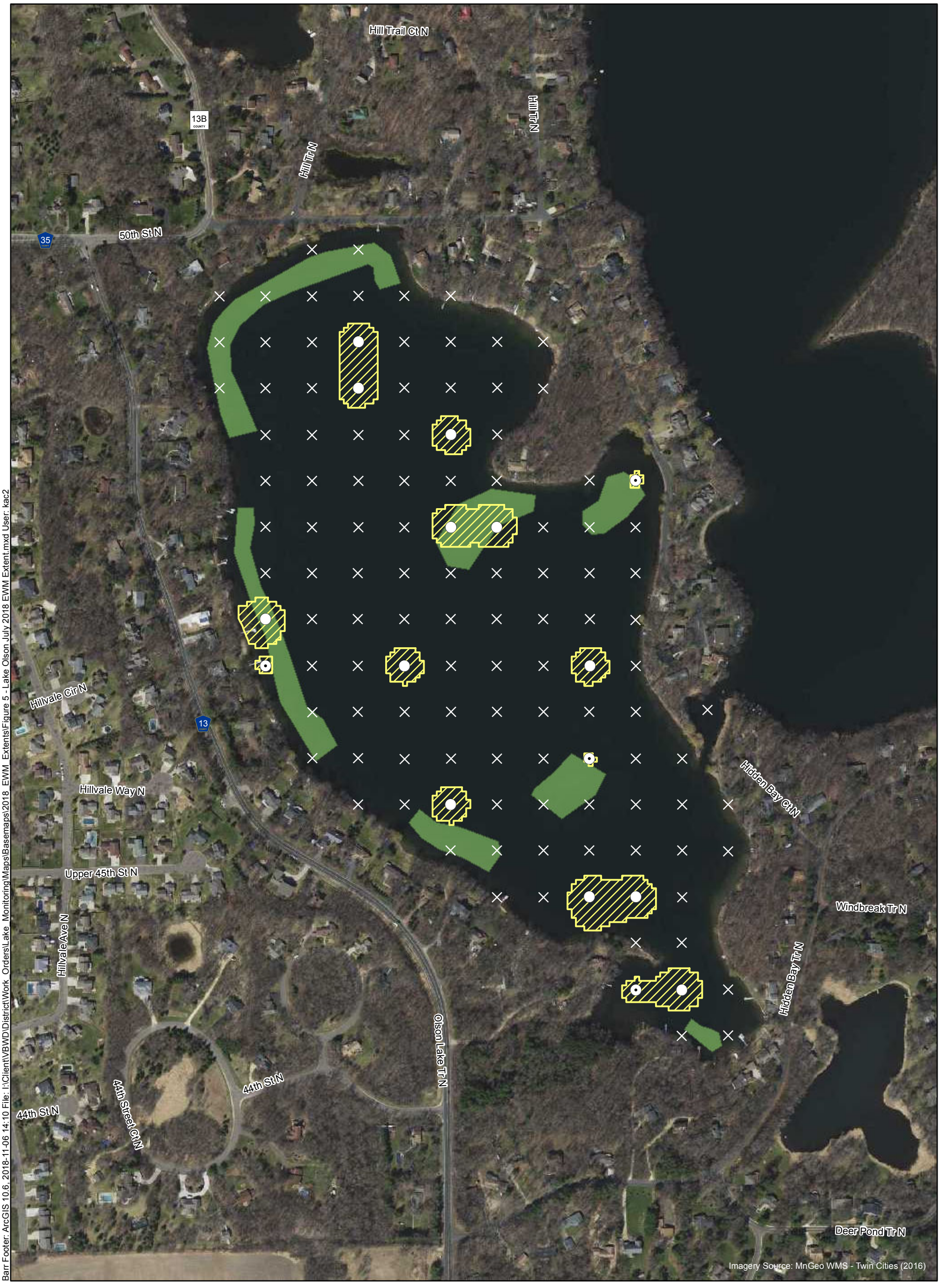
N

Feet

0 225 450 900

Figure 4

LAKE DEMONTREVILLE
EURASIAN WATERMILFOIL
EXTENT, JULY 2018
Lake DeMontreville (82010100)
Washington County
Valley Branch Watershed District



Barr Footer: ArcGIS 10.6, 2018-11-06 14:10 File: I:\Client\VBWD\DistrictWork_Orders\Lake_Monitoring\Maps\Basemaps\2018_EWM_Extents\Figure 5 - Lake Olson July 2018 EWM Extent.mxd User: kac2

EWM Survey Results

- Not Observed
- Visual Only (None on Rake)
- Density = 1
- Density = 2
- Density = 3
- Density = 4

- Approximate Extent of EWM
- EWM Treatment Area (Spring 2018)

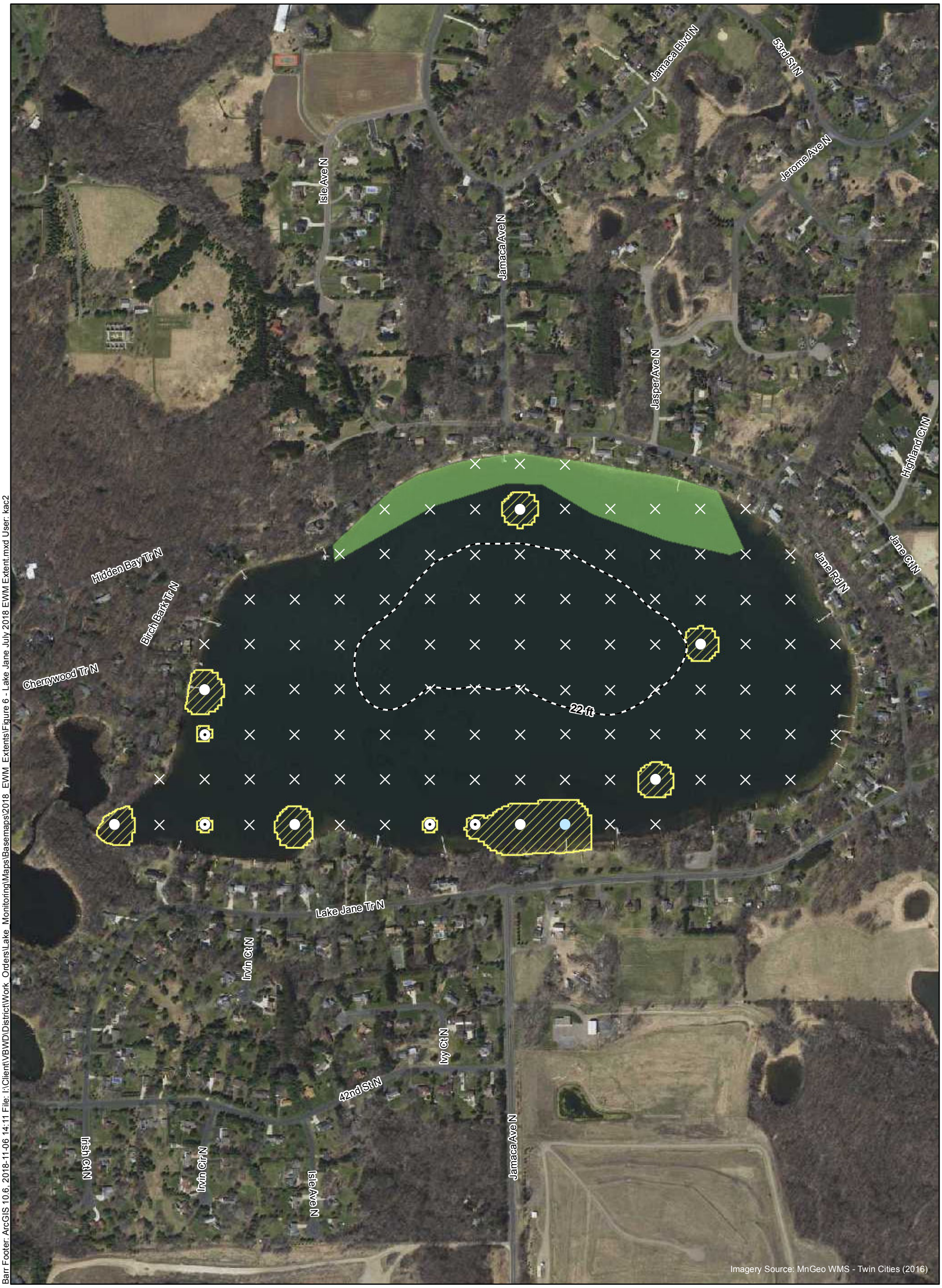
N

Feet

0 175 350 700

Figure 5

LAKE OLSON EURASIAN WATERMILFOIL EXTENT, JULY 2018
Lake Olson (82010300)
Washington County
Valley Branch Watershed District



Barr Footer: ArcGIS 10.6, 2018-11-06 14:11 File: I:\Client\VBWD\DistrictWork_Orders\Lake_Monitoring\Maps\Basemaps\2018_EWM_Extents\Figure 6 - Lake Jane July 2018 EWM Extent.mxd User: kac2

EWM Survey Results

- Not Observed
- Visual Only (None on Rake)
- Density = 1
- Density = 2
- Density = 3
- Density = 4

- Approximate Extent of EWM
- Maximum Depth of Plant Growth
- EWM Treatment Area (Spring 2018)

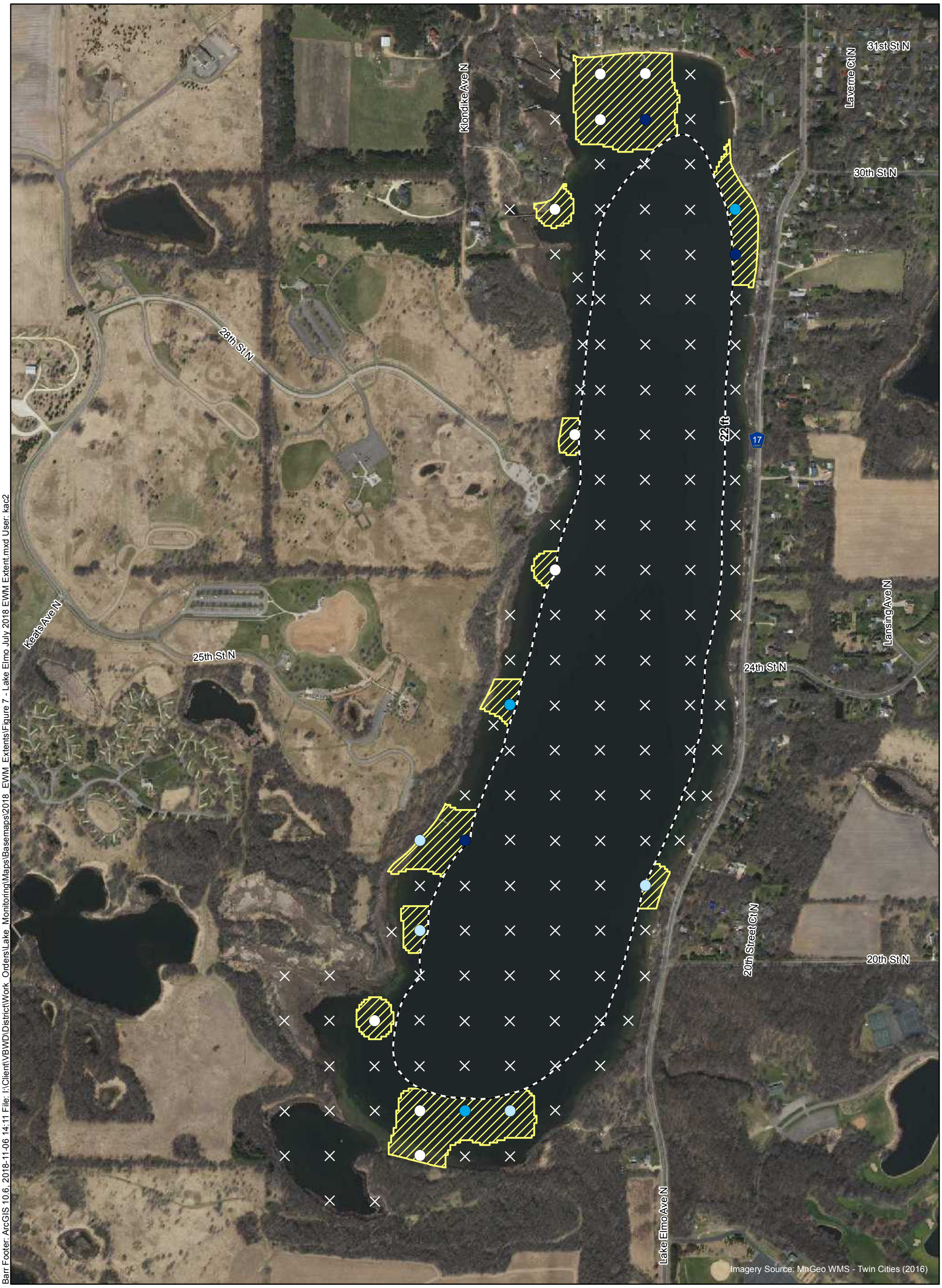
N

Feet

0 250 500 1,000

Figure 6

LAKE JANE EURASIAN WATERMILFOIL EXTENT, JULY 2018
Lake Jane (82010400)
Washington County
Valley Branch Watershed District



Barr Footer: ArcGIS 10.6, 2018-11-06 14:11 File: I:\Client\VBWD\District\Work_Orders\Lake_Monitoring\Maps\Basemaps\2018_EWM_Extents\Figure 7 - Lake Elmo July 2018 EWM Extent.mxd User: kac2

EWM Survey Results

- Not Observed
- Visual Only (None on Rake)
- Density = 1
- Density = 2
- Density = 3
- Density = 4

Approximate Extent of EWM

Maximum Depth of Plant Growth

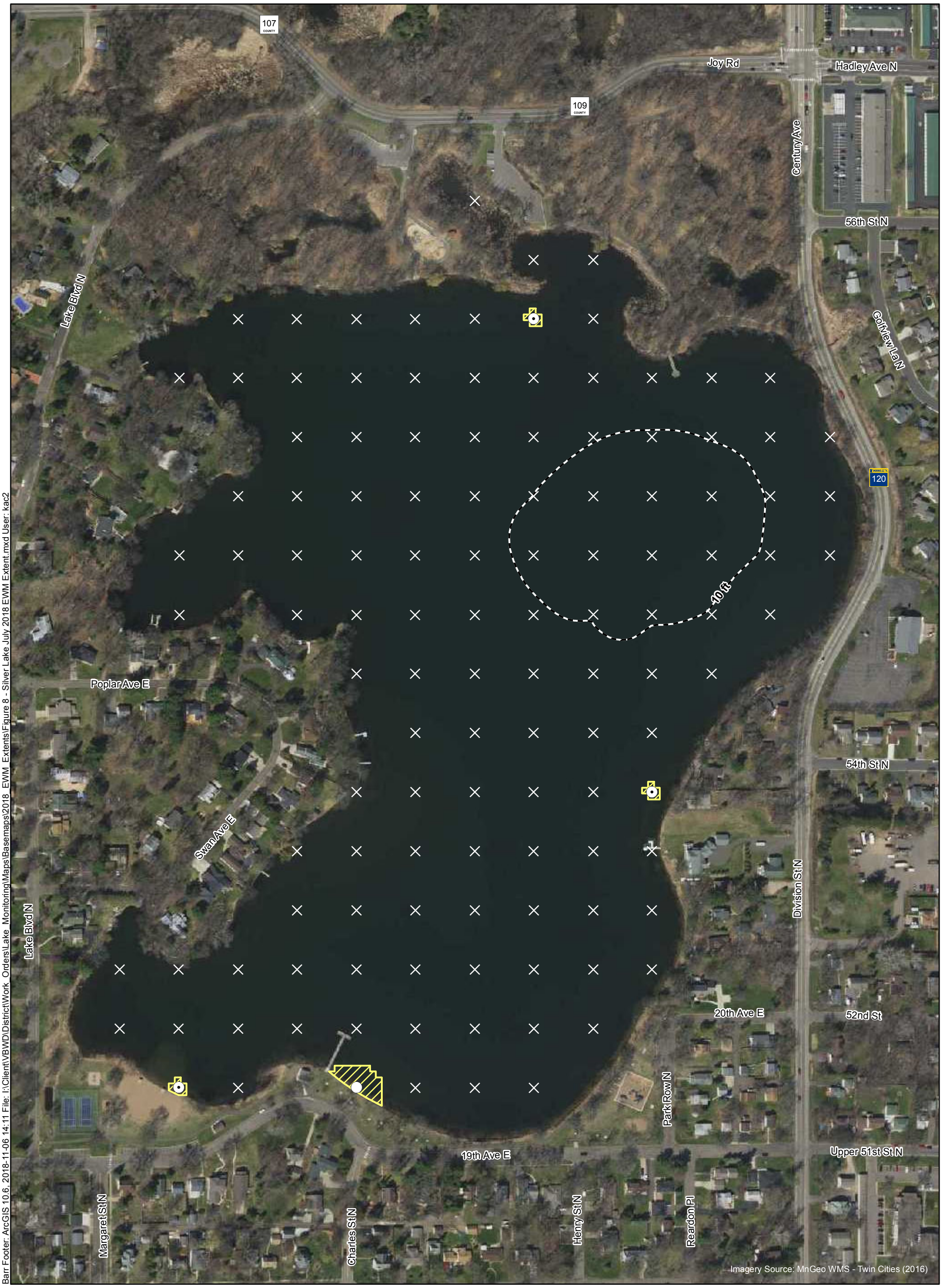
N

Feet

0 300 600 1,200

Figure 7

LAKE ELMO EURASIAN WATERMILFOIL EXTENT, JULY 2018
Lake Elmo (82010600)
Washington County
Valley Branch Watershed District



Barr Footer: ArcGIS 10.6, 2018-11-06 14:11 File: I:\Client\VBWD\District\Work_Orders\Lake_Monitoring\Maps\Basemaps\2018_EWM_Extents\Figure 8 - Silver Lake July 2018 EWM Extent.mxd User: kac2

EWM Survey Results

- Not Observed
- Visual Only (None on Rake)
- Density = 1
- Density = 2
- Density = 3
- Density = 4

Approximate Extent of EWM

Maximum Depth of Plant Growth

N

Feet

0 125 250 500

Figure 8

SILVER LAKE EURASIAN WATERMILFOIL EXTENT, JULY 2018
Silver Lake (62000100)
Ramsey County
Valley Branch Watershed District

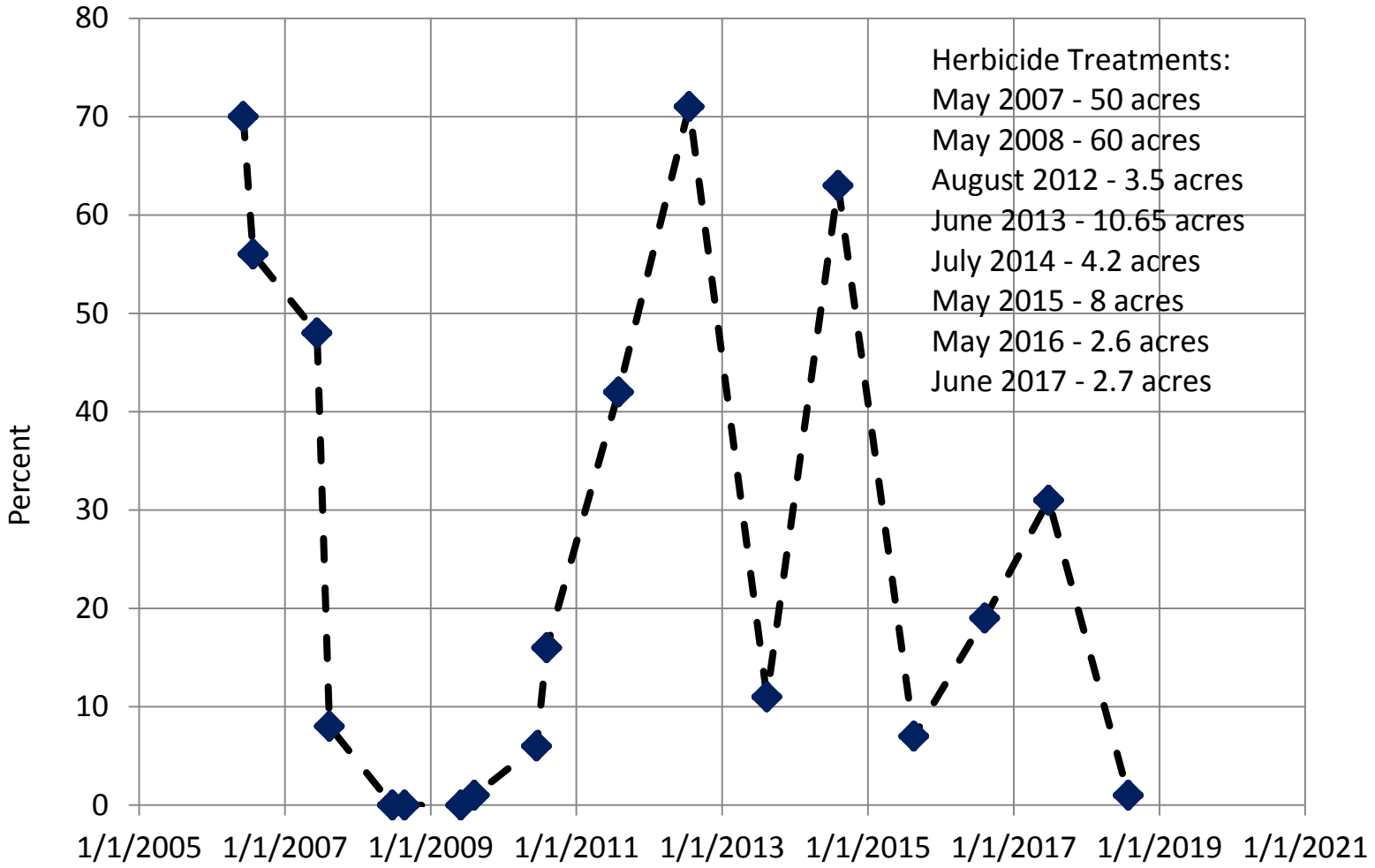


Figure 9
2006-2018 EURASIAN WATERMILFOIL FREQUENCY OF OCCURRENCE IN VEGETATED DEPTH RANGE OF PLANTS
Silver Lake (62000100)
Ramsey County
Valley Branch Watershed District