2018 Aquatic Plant Management Report
Hamilton Reservoir
Holland, Massachusetts

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Town of Holland
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Holland, MA 01521

In accordance with the existing aquatic plant management contract between SŌLitude Lake Management and the Town of Holland - Lake Oversight Committee for Hamilton Reservoir, the following document serves to provide this year's treatment and survey results and the management recommendations for next season.

All management activities were consistent with the Order of Conditions (DEP File #184-129), and the License to Apply Chemicals issued by the MA DEP – Office of Watershed Management (#18035); and with the permit issued by CT DEEP – (AQUA-2017-309).

PRE-MANAGEMENT INSPECTION

On May 29th, a SŌLitude biologist surveyed the Hamilton Reservoir littoral zone. The objective of the survey was to document the density and distribution of variable watermilfoil (*Myriophyllum heterophyllum*) and fanwort (*Cabomba caroliniana*), making note of nuisance and native plant species. As in the past, techniques that were employed to locate and identify the submersed vegetation included the use of a "throw-rake", Aqua-Vu underwater system, and visual surface observations. The areas where watermilfoil was found were mapped and estimates of cover were recorded. Watermilfoil at this time was observed at sparse to moderate abundances. Fanwort remained isolated in the cove west of the boat launch at trace to sparse Densities. Treatment areas were decided upon based off results from the 2017 post-management inspection and the 2018 pre-management inspection (**Figure 1 & 2**).

Watermilfoil density and distribution has seemingly remained constant compared to conditions observed in previous years; in total the overall watermilfoil infestation occupied approximately 65-acres this season as compared to 62-acres in 2017. The native vegetation assemblage was dominated by slender waternymph (*Najas flexilis)*, watershield (*Brasenia schreberi)*, ribbon-leaf pondweed (*Potamogeton epihydrus)*, and common bladderwort (*Utricularia vulgaris)*.

WATERMILFOIL TREATMENT

A single herbicide treatment with Reward (active ingredient: diquat) was applied by Solitude's licensed applicators on June 14th. Approximately 82 gallons of Reward was dispersed in both the northern and southern basins at pre-determined treatment areas. As in the past, notification was given to the Town, the Association and all other required parties prior to each treatment. In addition to this notification, the shorelines of the reservoir were thoroughly posted by the HRA with printed signs, warning of the pending treatment and any use or re-entry restrictions.

MID-SEASON INSPECTION

On July 24th, a SŌLitude biologist performed a mid-season inspection for tapegrass, floating-leaved species, fanwort, and variable watermilfoil. The objectives of this survey were to record the efficacy of the initial watermilfoil treatment conducted on June 14th, and to document the density and distributions of the above-mentioned species in preparation for possible secondary treatment. At this time, it was noted that excellent control of watermilfoil was achieved as result of the first herbicide application. A single patch of milfoil in trace abundance was observed in the northern basin adjacent to the boat launch, and at a single location in the southern basin in the inlet cove (**Figure 3 & 4**). Tapegrass and floating-leaf species were observed in non-nuisance densities and therefore treatments of these species were deemed unnecessary. During this inspection, the fanwort in the cove adjacent to the boat ramp was still present; therefore, a treatment to prevent further spread of this species was recommended.

FANWORT HERBICIDE TREATMENT

On August 23rd a second herbicide treatment was performed to manage the presence of invasive fanwort (*Cabomba caroliniana*). This treatment was performed utilizing Clipper (flumioxazin) herbicide. This was a localized treatment performed in the cove adjacent to the boat ramp in the northern basin. Approximately 2 acres were treated (**Figure 5**) with Clipper and water use restrictions were only implemented for homes adjacent to the treatment areas.

POST-MANAGEMENT INSPECTION

On September 28th, a SŌLitude Biologist performed a post-management inspection of Hamilton Reservoir. The objectives of this survey were to record the efficacy of the 2018 herbicide treatments, as well as evaluate management techniques for the 2019 season and beyond.

The survey displayed decreased watermilfoil growth in both the North & South Basin. The observed plants largely consisted of low-biomass regrowth, which had re-appeared since the June treatment. Reward is a contact herbicide that has minimal impact on the plant's root structure; therefore, regrowth of this species is to be expected. A healthy assemblage of native species remained well represented throughout the entirety of the littoral zone and were seldom present in sufficient quantities. Dominant native species included slender naiad, common bladderwort, yellow and white waterlily, and watershield. In smaller quantities existed several pondweed species (thin-leaf pondweed, Robbin's pondweed, and ribbon-leaf pondweed).

WATER QUALITY

A single water quality sampling round was conducted on July 24th during the mid-season inspection. Samples were collected at four locations for the specific parameters. Please refer to table 1 & 2 for results. Descriptions for the parameters collected are attached (**Water Quality Parameter Explanations**). Please refer to **Figure 6** for water quality sampling locations.

Table 1: 2018 dissolved oxygen and temperature readings

Depth (Meters)	Dissolved Oxygen (mg/L)				Temperature (°C)			
	North		South		North		South	
	May	Sept.	May	Sept.	May	Sept.	May	Sept.
SW	8.56	7.76	8.11	8.01	22.9	26.9	21.2	26.1
1	8.66	7.32	8.13	7.88	22.4	26.6	20.8	26.0
2	8.72	6.45	8.15	7.62	20.5	25.3	20.5	25.7
3	8.30	6.21	8.21	6.97	19.8	23.1	20.2	25.6
4	5.85	5.77	8.21	6.41	16.6	22.8	20.0	24.3
5	3.75	4.19	8.13	6.13	11.6	22.5	19.9	22.9
6	0.91	1.02	7.97	5.66	9.6	22.4	19.8	22.1
7	--	--	7.75	5.30	--	--	19.6	20.6
8	--	--	7.43	4.28	--	--	19.4	20.5
9	--	--	4.53	2.55	--	--	18.8	20.3

Table 2: July 2018 water quality sampling

Parameter	Units	Detection Levels	Massaconnic Beach	Brandon St. Cove	Aqua Rider's Beach	Boat Ramp
E. Coli	Col/mL	1.0	50	31	67	72
Total Phosphorus	Mg/L	0.010	0.019	0.015	0.021	0.013
Dissolved Phosphorus	Mg/L	0.010	0.013	ND	0.014	ND
True Color	Color Units	5	29	16	40	18
Apparent Color	Color Units	10	50	32	60	29
Ammonia/Nitrogen	Mg/L	0.010	ND	0.080	ND	ND
Total Alkalinity	Mg/L	2.0	14.9	12.3	21.3	11.7
Total Kjeldahl Nitrogen	Mg/L	0.300	0.476	0.533	0.546	0.490
Nitrate/Nitrogen	Mg/L	0.010	ND	ND	ND	ND
Turbidity	NTU	0.20	5.5	2.9	5.2	2.5
pH	pH Units	--	6.8	6.8	6.6	6.8

MANAGEMENT RECOMMENDATIONS FOR 2019

We recommend continuing with the monitoring and management program in place at Hamilton Reservoir. The current program has provided effective seasonal control of invasive variable watermilfoil. Desirable open-water conditions can be achieved via area selective herbicide treatments in 2019, while maintaining valuable vegetative diversity within the ecosystem.

It is also recommended that a proper water quality program be implemented for the 2019 season. It is suggested that water samples be collected at three times during the growing season, May, July, and September to gain a broad understanding of water chemistry throughout the summer months. It is also suggested that three algae samples be tested for identification and enumeration three times during the growing season to determine if nuisance algae and/or cyanobacteria exists in Hamilton Reservoir.

It is also recommended to continue to monitor for invasive fanwort in the area of the boat ramp. Since its initial discovery in the lake in 2017, it has seemingly not expanded into other areas of the lake, however annual monitoring of this species should continue to ensure spread of this species is reduced. Spot-treating with the herbicide Clipper,

followed by post-treatment hand-harvesting, would be the best mode of action to stifle regrowth. A new infestation should be dealt with aggressively, as fanwort is a persistent plant that spreads primarily through fragmentation and rhizomes.

If you have any questions or require any additional information please do not hesitate to contact the office. We look forward to working with you in the 2019 season.

Water Quality Parameter Explanations

pH – The pH measurement scale is from 0 to 14, where zero is extremely acidic, 7 is neutral, and 14 is the most basic. pH is related to the concentration of H^+ (hydrogen ions) in solution and can affect many different aspects of water chemistry. Most lakes in the region exhibit pH of between 6 and 8 SU, but certain geology and some biological processes can shift pH outside of this range.
The pH results remained within the desirable range.

Total Alkalinity – Alkalinity is a measure of the buffering capacity of a waterbody against acid additions such as acid rain and pollution, which can be detrimental to wildlife populations. Total alkalinity measures the presence of carbonates, bicarbonates and hydroxides. Values below 20 mg/l are a signal that the pond may be susceptible to fluctuations in pH.
Alkalinity in Hamilton Reservoir is below 20 mg/L, determining that it is susceptible to fluctuations in pH.

Turbidity- Turbidity is a relative measurement of the amount of suspended material in the water. It is measured through a process involving light diffraction of the pond sample as compared to a series of prepared samples. Turbidity values can range from less than one to thousands of units, however, values in most ponds and lakes rarely rises above 5 NTU.
Turbidity levels at Massaconnic Beach and Aqua Rider's Beach were relatively high. Hamilton Reservoir is fairly shallow; therefore, the benthic layer can be impacted by boat traffic and wind, causing increased turbidity.

Nitrate/Nitrogen – Nitrate is another form of nitrogen found in the water column. Nitrate nitrogen is usually the most prevalent form of inorganic nitrogen in the water and results from such things as natural aerobic bacterial activity and fertilizer use. It is also the form that is most readily available for plant and algae growth. Levels lower than 0.3 mg/L can limit plant and algae growth in conjunction with low phosphorus levels.
Nitrogen levels remained below detectable levels (0.010 mg/L).

Ammonia/Nitrogen – Ammonia is a measure of two constituents, NH_3 and NH_4^+, and is a transitional product in the breakdown of organic nitrogen into nitrate. It is typically short-lived in the pond environment except under conditions of low dissolved oxygen. Waterbodies that have a high pH are susceptible to high ammonia concentrations; the higher the pH, the more ammonia will be present within the water column. High levels of ammonia typically indicate a eutrophic pond, and can be toxic to fish at higher levels. Levels <0.05 mg/L are ideal.
For most of the locations, ammonia remained below detectable levels; however, ammonia levels were above "ideal" levels at Brandon St. Cove. This cove is a high residential area that is relatively narrow and close to the road. There are many factors that could influence the ammonia levels within this area, including potential animal, agricultural, or industrial waste effluent.

Total Kjeldahl nitrogen (TKN) is a measure of the nitrogen contained in organic compounds, such as proteins and amino acids, and as ammonia. It is created from biological growth and decomposition. A concentration of 1.0 mg/l or below is considered desirable.
Total Kjedahl nitrogen remained below desirable levels at each sampling station.

Total/Dissolved Phosphorus – Phosphorus is generally considered the limiting nutrient for plant and algae growth, with concentrations of 0.03 mg/l or more being sufficient to stimulate algae blooms. Water column phosphorus (dissolved phosphorus) does not generally relate to rooted plant growth as they obtain most of their nutrients from the pond sediment. In the hypolimnion, low oxygen levels can promote the release of phosphorus from the bottom sediments, which may build up over the summer due lack of transfer to the upper layer of the lake. Under prolonged layering and highly organic substrates, the build-up can be significant (on the order of 0.5-1.0 mg/l or more) and later cause algae blooms when the lake mixes in the fall.
Detectable levels or phosphorus occurred at all sampling stations; however, all results remained below the threshold of 0.030 mg/L where alga growth could occur.

Total & Fecal Coliform Bacteria – Coliform bacteria are naturally occurring in pond systems as well as resultant from human and animal inputs. While total coliform can be partly attributed to naturally occurring bacteria, fecal coliform is an indicator of the presence of human or animal waste inputs. In general, acceptable values in "swimmable waters" for total coliform is less than 1,000 organisms per 100 ml, while for fecal coliform it is 200 organisms per 100 ml.
E. Coli levels at all sampling stations remained below concerning levels.

Apparent Color – The color of the unfiltered pond water, caused by suspended and dissolved matter is the "apparent color". Apparent color values can change drastically depending on weather conditions and commonly increase with storm events and decreases with drought. There are four approximate categories for apparent color: 0-25 is clear, 25-40 is light tea color, 40-80 is tea color, >80 is dark tea color.
If the true color value is subtracted from the apparent color value, then the "true" color of water remains at the "clear" category of 0-25.

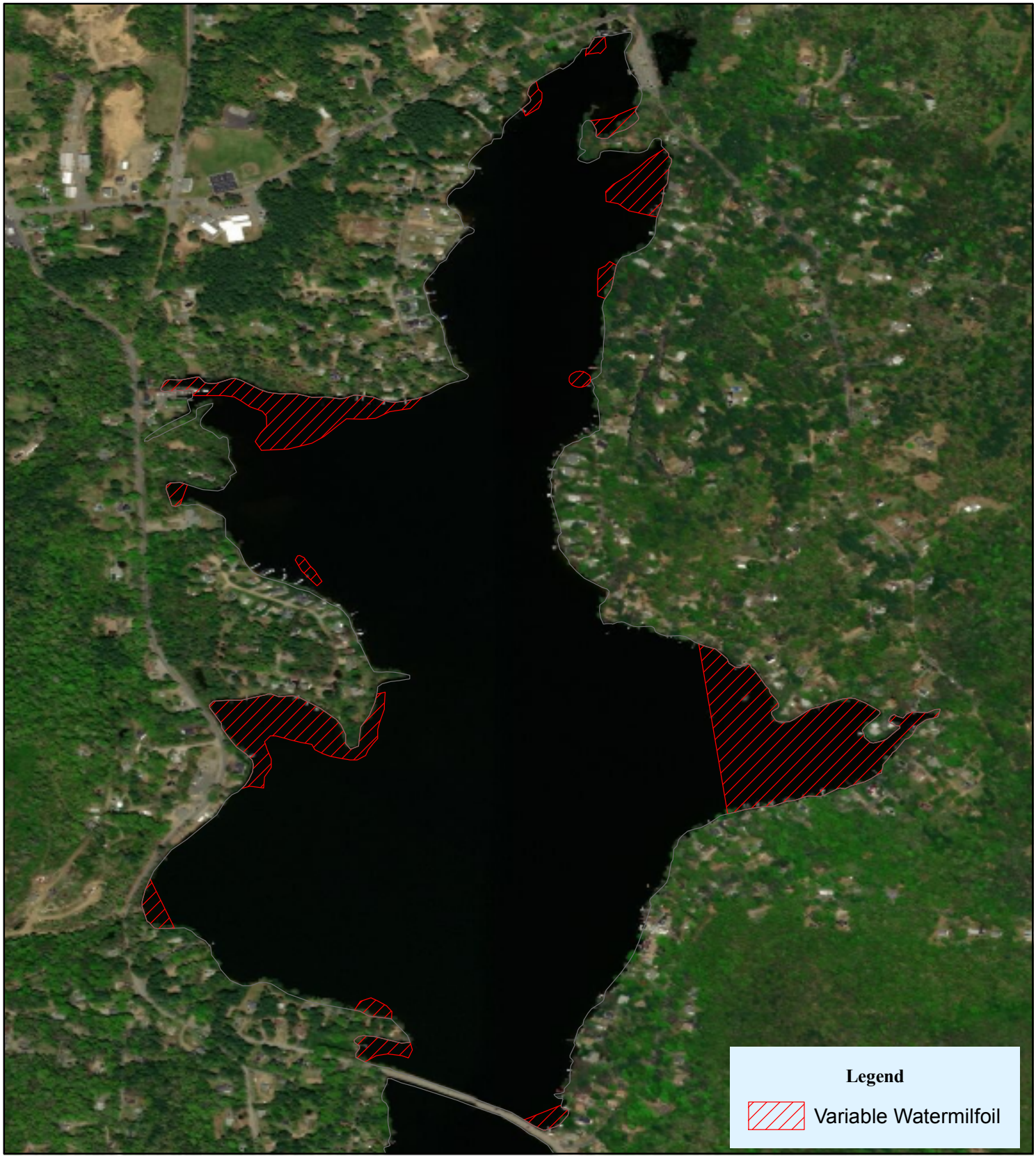
True Color– The color of the filtered pond water, free of particulates represents only dissolved organic matter (DOM) and is the "true color" of the water. This value can be subtracted from the apparent color to determine the quality of water inputs.

Dissolved oxygen (DO) is very important in the pond system. Not only do fish and other aquatic fauna require adequate levels of oxygen, but it also controls many aspects of water chemistry. Values below 5.0 mg/l are undesirable for most aquatic life, however lower values are not uncommon near the sediment layer where oxygen demand is great and oxygen influx is at a minimum. Under extreme anoxic conditions (<1.0 mg/l), phosphorus can be released from the sediment and stimulate algae blooms. Under stratified conditions, which occur in many deeper lakes, oxygen depletion can occur in a significant portion of the water column during summer and winter.
Dissolved oxygen levels remained very good at each station during both the May and September surveys.

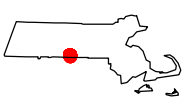
Temperature – is one of the limiting factors for algae and plant growth; as temperature increases, biological activity (photosynthesis, respiration, and decomposition) increases to a point. Temperature is directly related to the amount of available dissolved oxygen, where warmer water holds less oxygen. In deeper waterbodies, temperature stratification occurs; a thermocline occurs at depth where the top layer is warmer and actively exchanges nutrients with the air. The bottom layer is distinctly cooler and isolated from surface impacts.
Temperature measurements were commonly gradual throughout the sampled months.

FIGURE 1: Pre-Treatment Distribution of Variable Watermilfoil

SOLITUDE LAKE MANAGEMENT



Hamilton Reservoir
Holland, MA



Hamilton Reservoir

0 830 1,660

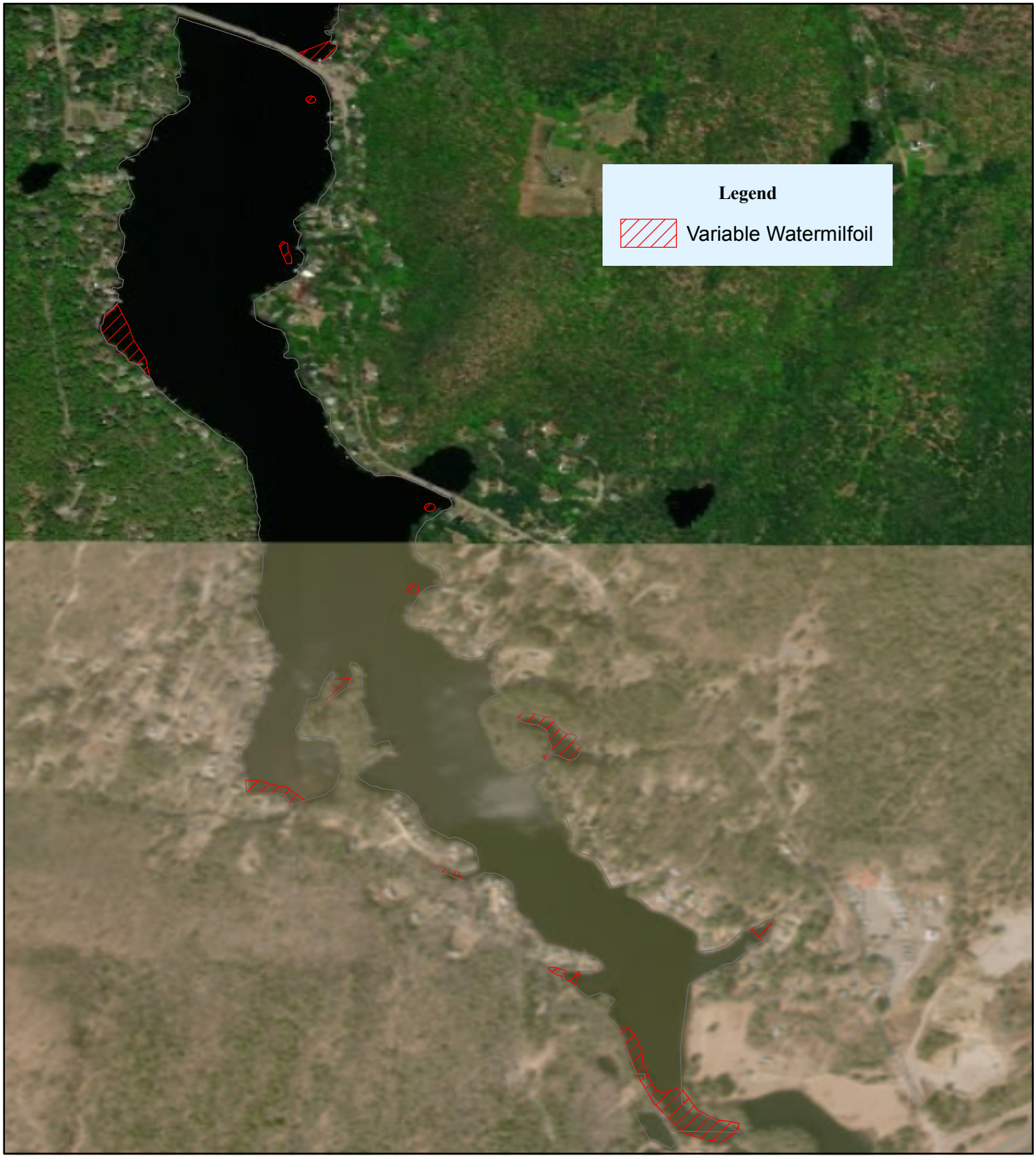
1:10,500 Feet

N

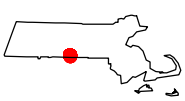
Map Date: 02/21/2019
Prepared by: JMP
Office: SHREWSBURY, MA

FIGURE 2: Distribution of Variable Watermilfoil

SOLITUDE LAKE MANAGEMENT



Hamilton Reservoir
Holland, MA



Lower Hamilton Reservoir

0 960 1,920

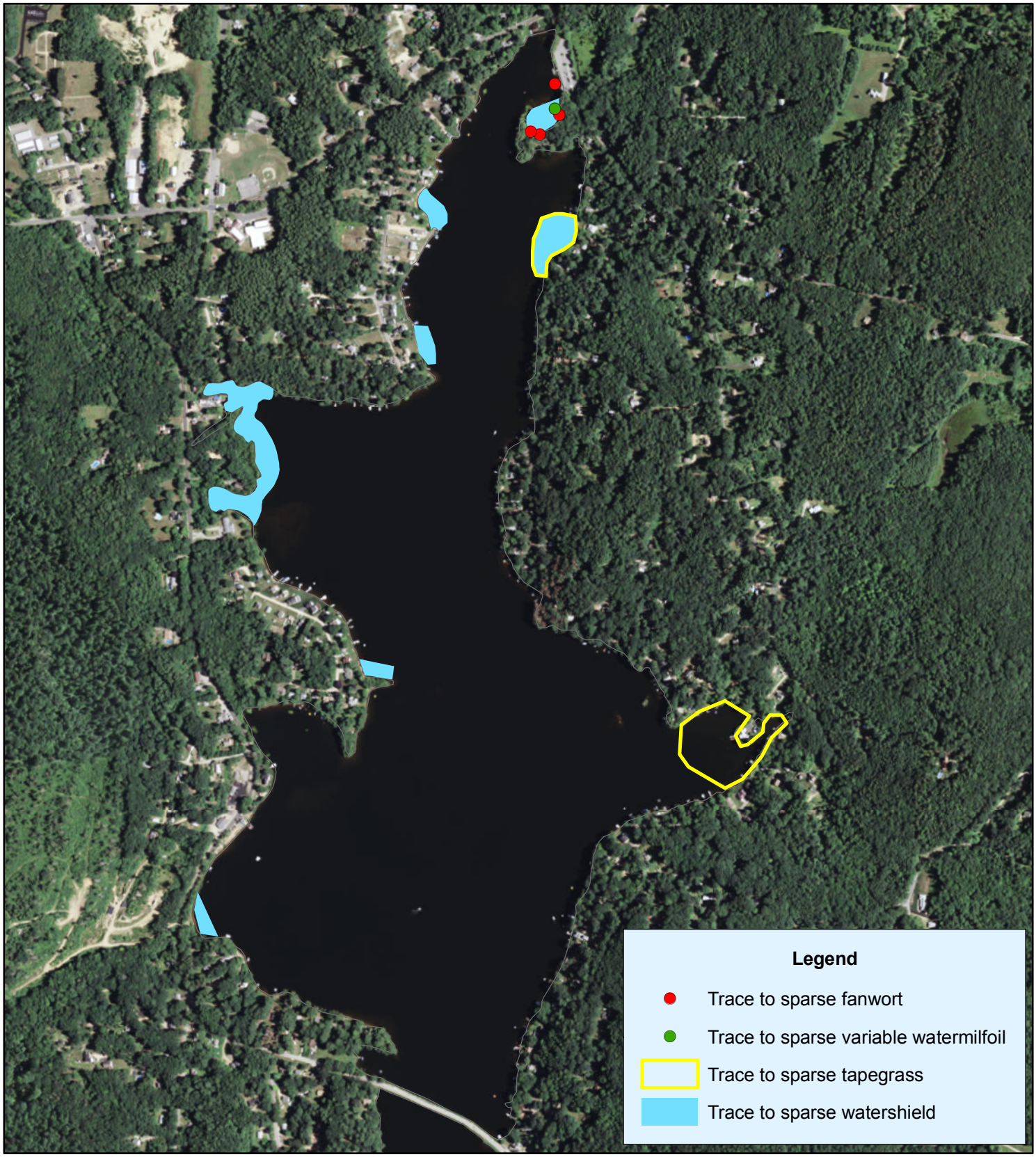
1:12,000 Feet

N

Map Date: 02/21/2019
Prepared by: JMP
Office: SHREWSBURY, MA

Figure 3: Density & Distribution of Target Vegetation

SOLITUDE LAKE MANAGEMENT
888.480.5253
solitudelakemanagement.com



Hamilton Reservoir
Holland, MA

Upper Hamilton Reservoir

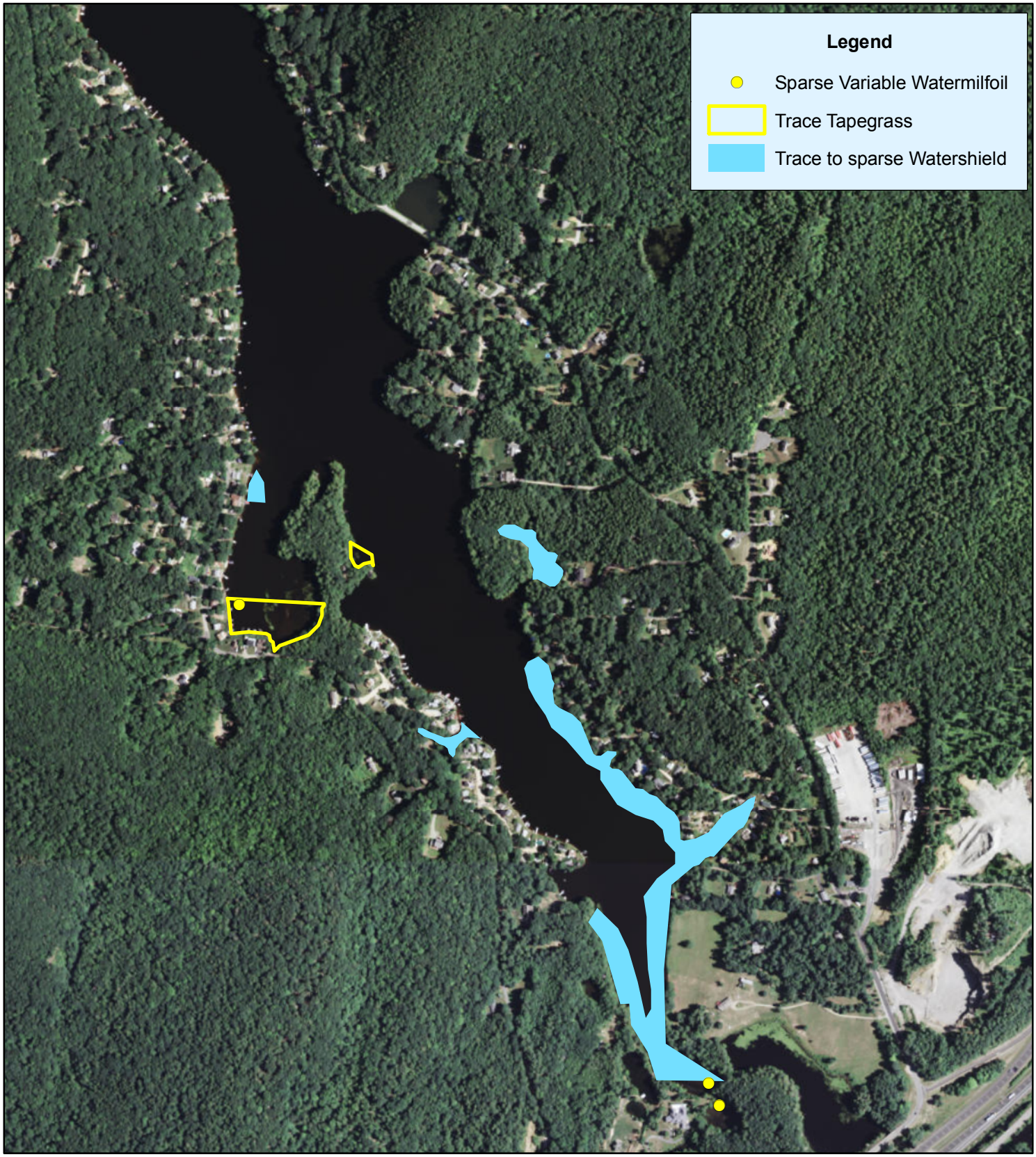
0 950 1,900 N

1:10,381 Feet

Map Date: 07/24/2018
Prepared by: ALM
Office: SHREWSBURY, MA

Figure 4: Distribution of Target Aquatic Vegetation

SOLITUDE
LAKE MANAGEMENT
888.480.5253
solitudelakemanagement.com



Hamilton Reservoir
Holland, MA

Lower Hamilton Reservoir

0 820 1,640

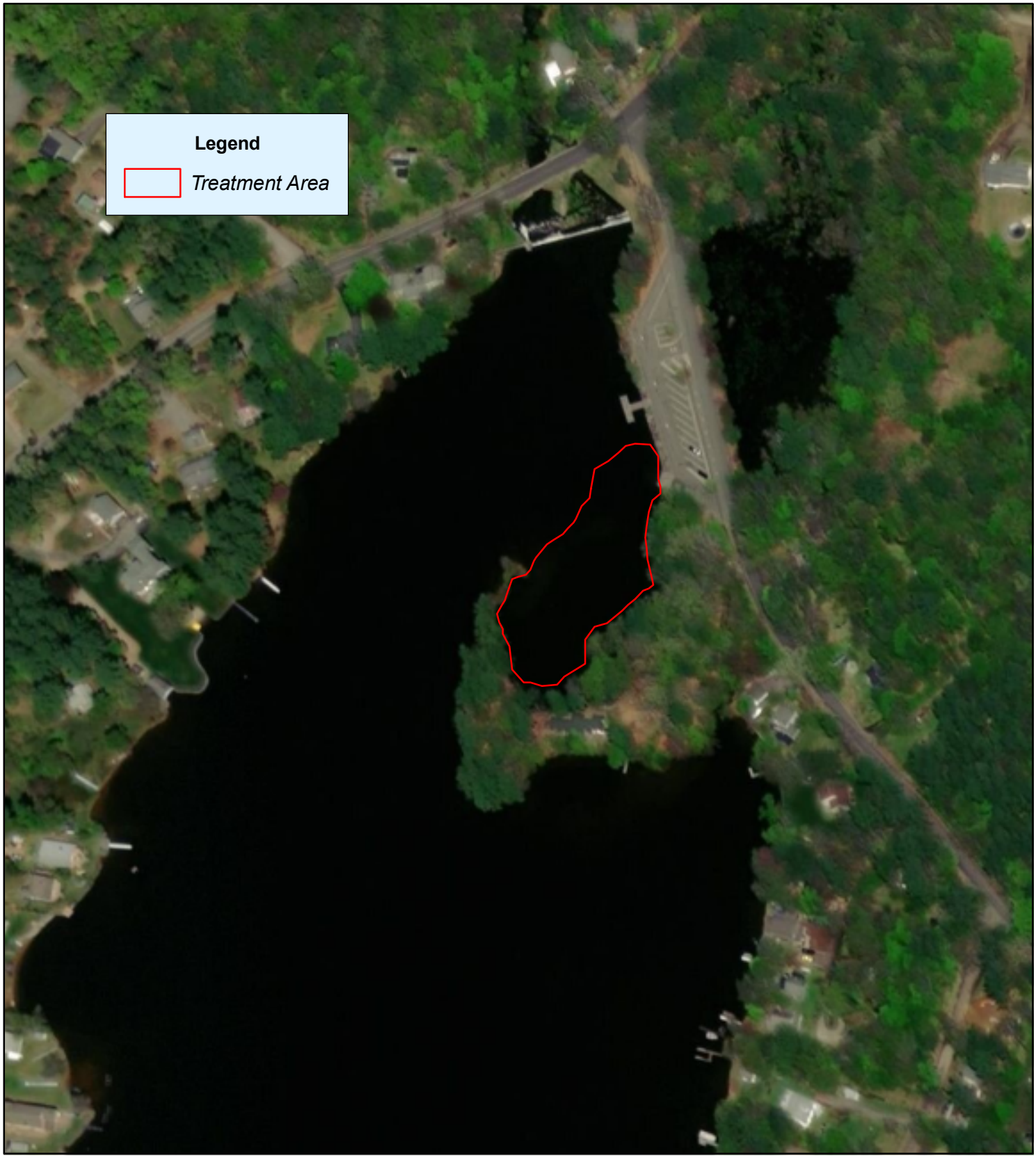
1:9,000 Feet

N

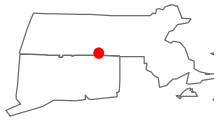
Map Date: 07/24/2018
Prepared by: ALM
Office: SHREWSBURY, MA

Figure 5: Fanwort Treatment Areas

SOLITUDE LAKE MANAGEMENT



Hamilton Reservoir
Holland, MA



Upper Hamilton Reservoir

0 190 380 Feet

1:2,317

N

Map Date: 02/21/2019
Prepared by: JMP
Office: SHREWSBURY, MA

FIGURE 6: Water Quality Stations of North and South Basin

SOLITUDE LAKE MANAGEMENT

Hamilton Reservoir
Holland, MA
[Worcester]

Hamilton Reservoir

0 975 1,950

1:12,517 Feet

N

Map Date: 5/31/2017
Prepared by: ALM
Office: SHREWSBURY, MA