

Annual Report
2023 Management Program
Westford Ponds
Westford, MA

Prepared by: SŌLitude Lake Management
590 Lake Street
Shrewsbury, MA 01545

Prepared for: Town of Westford
c/o Matthew Salem
55 Main Street
Westford, MA 01886

Submitted on: December 18, 2023

Introduction

In accordance with the 2023 Aquatic Management Program contract between SŌLitude Lake Management and the Town of Westford for the Westford Ponds, work was performed on the following waterbodies this year.

Waterbody Name	Pre-Management Survey/WQ	Late Season Survey/WQ	Management Activity
Forge Pond	Yes	Yes	Harvesting
Old Mill/Graniteville Pond	No	Yes	None
Long Sought For Pond	No	Yes	Herbicide Treatment
Kennedy Pond	No	Yes	None
Keyes Pond	No	Yes	None
Nabnasset Lake	Yes (conducted by SLM under separate contract)	Yes	Herbicide & Algaecide Treatments
Burge's Pond	No	Yes	None



The following document and attachments serve to provide this year's management and monitoring results, as well as recommendations for the 2024 management season. As proposed, TRC conducted all monitoring work with the exception of the pre-treatment vegetation survey at Nabnasset Lake.

All management activities were conducted in compliance with the current Orders of Conditions issued by the Westford Conservation Commission and the Licenses to Apply Chemicals (# WM04-0001255 – Long Sought For Pond, WM04-0001244 - Nabnasset Lake) issued by the MA DEP Office of Watershed Management.

Per the Town's request, this year's pre-management work consisted of vegetation and water quality monitoring at Forge Pond only. SOLitude was also contracted directly by the Nabnasset Lake Preservation Association to conduct a pre-management vegetation survey in early May before the contract between Solitude and the Town had been secured. Management activities in 2023 were limited to a herbicide treatment at Long Sought For Pond and an herbicide and two algaecide treatments at Nabnasset Lake. Late season vegetation and water quality monitoring was conducted at all seven waterbodies.

Pre-Management Surveys

Forge Pond

The pre-management survey of Forge Pond was conducted by TRC on August 18th. Of the thirteen species of aquatic plants present in Forge Pond, four are considered non-native; Eurasian milfoil (*Myriophyllum spicatum*), variable milfoil (*Myriophyllum heterophyllum*), fanwort (*Cabomba caroliniana*) and brittle naiad (*Najas minor*). Water quality samples were also collected from three locations at Forge Pond on this day. The detailed TRC report on the pre-management survey and water quality sampling of Forge Pond is attached as **Appendix A**. We understand from the Town that mechanical harvesting was conducted at Forge Pond shortly after the pre-management survey was completed.

Nabnasset Lake

The pre-management survey of Nabnasset Lake was conducted by SOLitude Biologists on May 2nd. The primary purpose of this survey was to document the extent and density of non-native plant growth consisting of curlyleaf pondweed (*Potamogeton crispus*) and variable milfoil. Sparse to dense areas of curlyleaf pondweed were observed primarily along the northern shoreline of the lake, with other areas of sparse growth within cove areas in the eastern side of the pond. Only one area of variable milfoil growth was observed near the entrance to Shipley Swamp. See **Appendix B, Figure 1** for a map of the non-native plant distribution at Nabnasset Lake at the time of the May survey.



Herbicide Treatments

Treatments were conducted at both Nabnasset Lake and Long Sought for Pond in 2023.

Long Sought For Pond

Based on resident reports and historical knowledge of the plant distribution at Long Sought For Pond, an herbicide treatment was conducted on June 14th to control areas of non-native curlyleaf pondweed and nuisance native pondweeds. Presence of the target species was confirmed on the day of treatment and Tribune (diquat) herbicide was applied to approximately 50 acres of the pond (See **Appendix B - Figure 2**).

Prior to treatment, notification was posted on the Town’s website and Facebook page, and water-use restriction signs were posted along the shoreline by the Association.

Nabnasset Lake

Based on the May 2nd pre-treatment survey, approximately 25-acres of Nabnasset Lake was treated with Tribune (diquat) herbicide to control curlyleaf pondweed and variable milfoil (see **Appendix B - Figure 3**). Additionally, half lake copper sulfate treatments were conducted on July 10th and September 7th. These treatments were conducted based on the presence of cyanobacteria as reported by the Association.

Prior to treatments, notification was posted on the Town’s website and Facebook page, and water-use restriction signs were posted along the shoreline by the Association.

Late Season Assessments

The late season plant mapping and WQ sampling at all seven Westford waterbodies was conducted by TRC on September 27th-28th and October 2nd. An overview of the results is provided in the table below and the detailed TRC report is attached as **Appendix C**.

Waterbody	Vegetation Summary	WQ Summary
Keyes Pond	Fourteen aquatic plant species present, including one non-native species, variable milfoil. Plant growth was generally present at over 50% bottom cover in a band around the shoreline, but biomass was mostly present in the lower half of the water column.	Dissolved oxygen profile shows stratification and oxygen loss in hypolimnion. Elevated phosphorus levels at the surface and bottom. Reduced water clarity.



<p>Old Mill/Graniteville Pond</p>	<p>Thirteen species of aquatic plants including non-native species fanwort, Eurasian milfoil and variable milfoil. Plants are dense throughout the upper basin and along the shore of the lower basin, dominated mostly by fanwort.</p>	<p>Generally good water quality results.</p>
<p>Nabnasset Lake</p>	<p>Thirteen aquatic species were present including non-native variable milfoil and brittle naiad. No curlyleaf pondweed or water chestnut observed. Tapegrass, which has been problematic in the past, was generally present in low density</p>	<p>Good dissolved oxygen levels except right near the bottom. Phosphorus slightly elevated at the surface and more so near the bottom.</p>
<p>Long Sought for Pond</p>	<p>Ten species of aquatic plants, generally present at sparse density and low biomass. One small area of curlyleaf pondweed present at the northern end.</p>	<p>Some stratification still present, with associated low dissolved oxygen near the bottom. Surface phosphorus levels are desirable but higher levels are observed in the hypolimnion.</p>
<p>Kennedy Pond</p>	<p>Nine species of aquatic plants - no non-native species present. Plant growth cover generally trace to moderate, consisting mostly of low growing species.</p>	<p>Desirable dissolved oxygen levels. Low levels of phosphorus and nitrogen.</p>
<p>Forge Pond</p>	<p>Fourteen species including four non-native species, dominated by fanwort and Eurasian milfoil with lesser amounts of variable milfoil and brittle naiad. Growth in the littoral zone is generally moderate to dense.</p>	<p>Significant oxygen depletion present in the water column. Elevated phosphorus levels at the surface increase substantially in the hypolimnion.</p>
<p>Burge's Pond</p>	<p>Seven aquatic plant species none of which are non-native. Significant plant cover through the shoreline littoral zone, consisting mostly of lower growing species.</p>	<p>Dissolved oxygen levels low throughout the water column. Reduced clarity. Nutrients at desirable levels.</p>



Water Quality Improvement Feasibility Study

SOLitude and TRC were also contracted in 2023 to conduct a Water Quality Improvement Feasibility Study at Nabnasset Lake, Long Sought for Pond, Keyes Pond and Forge Pond. These waterbodies in particular showed evidence of elevated phosphorus levels and internal loading. A primary task of this investigation was to collect sediment samples from each of the ponds to be analyzed for phosphorus fractions and then use that information along with historical water quality results to determine if these lakes were good candidates for nutrient management using alum.

The results of this study are included in the TRC Late Season report (**Appendix C**).

Ongoing Management Recommendations

Consistent with prior years, we recommend continuing annual monitoring and management, if warranted, at all the subject ponds in Westford in 2024. We strongly recommend initiating monitoring of all ponds in the spring to sufficiently allow for scheduling appropriate management actions.

The following table provides specific details on management recommendations for each of the ponds, subject to discussion with the Town.

Waterbody	Management Strategy
Keyes Pond	<ul style="list-style-type: none"> ● Continued monitoring ● Manage non-native milfoil ● Consider low-dose alum treatment
Old Mill/Graniteville Pond	<ul style="list-style-type: none"> ● Continued monitoring ● Manage non-native species
Nabnasset Lake	<ul style="list-style-type: none"> ● Continued monitoring ● Manage non-native milfoil & curlyleaf pondweed ● Consider low-dose alum treatment ● Conduct additional sampling to further investigate a high-dose alum treatment.
Long Sought for Pond	<ul style="list-style-type: none"> ● Continued monitoring ● Manage non-native curlyleaf pondweed and nuisance native pondweeds. ● Consider low dose alum treatment



Kennedy Pond	<ul style="list-style-type: none"> ● Continued monitoring
Forge Pond	<ul style="list-style-type: none"> ● Continued monitoring ● Management of non-native species ● Consider low-dose alum treatment ● Conduct additional sampling to further investigate a high-dose alum treatment. ● Develop a nutrient budget
Burge's Pond	<ul style="list-style-type: none"> ● Continued monitoring ● Further investigation of dissolved oxygen issues

Appendices

- Appendix A – TRC Pre Management Report for Forge Pond

- Appendix B
 - Nabnasset Pre-Treatment Invasive Plant Map
 - Long Sought For Pond Treatment Map
 - Nabnasset Lake Treatment Map

- Appendix C - TRC Late Season Report

APPENDIX A

TRC Pre-Management Report for Forge Pond





August 31, 2023

Dominic Meringolo
SOLitude Lake Management
590 Lake Street
Shrewsbury, Massachusetts 01545

**Re: Aquatic Plant and Water Quality Report – 2023
Littleton and Westford, Massachusetts
TRC Project No. 560206.0000.0000**

Dear Mr. Meringolo,
TRC provides SOLitude Lake Management (SOLitude) with this annual monitoring program at Forge Pond located within the Towns of Littleton and Westford.

Annual Monitoring

The annual monitoring survey consisted of aquatic vegetation mapping and water quality sampling and was completed on August 18, 2023.

Aquatic Vegetation Monitoring

Aquatic plants were surveyed using methods comparable to those used for prior surveys completed on behalf of the Town of Westford (ESS 2021). Plant rakes were used to help assess aquatic invasive plant densities. Data was collected using a combination of field notes and a Tablet with a GPS receiver capable of sub-meter accuracy. Aquatic plants observed during the annual monitoring survey are presented in Table 1.

Additional details on the results of the aquatic plant survey are presented in the following section.

Forge Pond Aquatic Plant Survey

Thirteen species of aquatic plants were observed at Forge Pond during the annual monitoring survey (Table 1). Of these thirteen aquatic plant species, four were exotic invasives, including Eurasian milfoil, fanwort, variable-leaf milfoil, and brittle naiad. Overall aquatic plant cover and biovolume was also recorded during the annual monitoring survey at Forge Pond (Figures 1 & 2). Brittle naiad (*Najas minor*) was only observed in a few locations in the pond and covered approximately 5 acres during the 2023 annual monitoring survey (Figure 3). These beds were of sparse growth in areas where observed.

Aquatic invasive Eurasian milfoil (*Myriophyllum spicatum*) and fanwort (*Cabomba caroliniana*) were the most abundant exotic species observed during the annual monitoring survey. Eurasian milfoil covered approximately 42 acres during the 2023 annual monitoring survey (Figure 4). The beds were generally of sparse and moderate growth in most areas where observed.

Fanwort (*Cabomba caroliniana*) covered approximately 18 acres during the 2023 annual monitoring survey (Figure 5). The fanwort





beds were generally of moderate growth most areas where observed, however there were a few areas in the northwest and southwest coves of the pond that had dense growth.

Aquatic invasive variable-leaf milfoil (*Myriophyllum heterophyllum*) covered approximately 7 acres during the 2023 annual monitoring survey (Figure 6). Beds were generally of sparse where observed.

Additionally, curly leaf pondweed, (*Potamogeton crispus*) another exotic invasive which has been observed in the pond in past years, was not observed during the 2023 annual monitoring survey at Forge Pond. This is likely due to the fact that the survey was conducted outside of the plant's normal growing period. *P. crispus* is primarily found in late spring to early summer.

Table 1. Aquatic Plants Observed at Forge Pond during 2023 Annual Monitoring Survey.

Common Name	Scientific Name	Native or Exotic
Brittle Naiad	<i>Najas minor</i>	Exotic
Canadian Pondweed	<i>Elodea canadensis</i>	Native
Coontail	<i>Ceratophyllum demersum</i>	Native
Common Bladderwort	<i>Utricularia macrorhiza</i>	Native
Curly-leaf Pondweed	<i>Potamogeton crispus</i>	Exotic
Eurasian Milfoil	<i>Myriophyllum spicatum</i>	Exotic
Fanwort	<i>Cabomba caroliniana</i>	Exotic
Common Duckweed	<i>Lemna minor</i>	Native
Thinleaf Pondweed	<i>Potamogeton pusillus</i>	Native
Variable-leaf Milfoil	<i>Myriophyllum heterophyllum</i>	Exotic
Water Celery (Tapegrass)	<i>Vallisneria americana</i>	Native
White Water Lily	<i>Nymphaea odorata</i>	Native
Yellow Water Lily	<i>Nuphar lutea variegata</i>	Native

Water Quality Monitoring

TRC conducted water quality sampling at three locations within Forge Pond, including one location in the deepest portion of the waterbody. These locations were selected for consistency with ongoing water quality conducted by the Town and volunteers. TRC measured the following parameters in the field: dissolved oxygen, temperature, turbidity, pH, and water clarity (Secchi disk).

TRC collected water samples for laboratory analysis of the following analytes: hardness, nitrate nitrogen, alkalinity, total phosphorus, total Kjeldahl nitrogen, and ammonia nitrogen. Water samples were analyzed by a Massachusetts-certified analytical laboratory. Water quality results were consistent with previous year's results and are summarized in the following sections.

Dissolved Oxygen

Forge Pond exhibited dissolved oxygen concentrations suitable for aquatic life near the surface. However, water quality results indicate low to very low dissolved oxygen levels (hypoxia/anoxia) in much of the deepest waters (below five meters at the "deep hole") of Forge Pond (Table 2). The hypoxia observed in the deepest portions of Forge Pond was



typical of mid-summer and likely to be coming to its seasonal end, due to vertical mixing (turnover) as evidenced in the temperature profile (Table 3).

Turbidity

Turbidity was similar in all sampling locations at Forge Pond. The “bottom” sample was slightly higher than the other locations, but turbidity did not appear to be elevated in any of the locations sampled. Some variability was observed among sampling locations within a pond, with turbidity readings ranging twice as high at some locations as others.

Secchi Depth (Transparency)

Secchi depth is a measure of water transparency and may be reduced by suspended sediments, algal growth, or the presence of other organic matter in the water column. Reduced Secchi depths are typically associated with nutrient-enriched ponds.

In this study, Secchi depth was measured at the “deep hole” location as well as the “south bay” location. The Secchi readings were similar for both locations (Table 4), however the transparency at “deep hole” was slightly higher than what was recorded at the “south bay”. Although transparency was not excellent, it also did not appear to be severely limited.

pH, Hardness, and Alkalinity

The pH at Forge Pond was circumneutral (i.e., pH near 7.0).

Hardness was similar between sampling locations. Alkalinity was higher at the bottom location in Forge Pond.

Increased alkalinity suggests greater buffering capacity of the water (i.e., resistance to pH change). Ponds with low buffering capacity may be susceptible to more abrupt swings in pH than those with higher alkalinity.

Phosphorus and Nitrogen

Phosphorus and nitrogen are both major nutrients fueling plant and algal growth. Of the two, phosphorus tends to be limiting nutrient in most New England freshwater systems. However, nitrogen levels can also impact the overall productivity of the system and type of algal growth favored and may even influence the production of toxins in some cyanobacteria. In general, high water column nutrient levels can contribute to algal blooms and excessive aquatic plant growth, especially floating plants.

Total phosphorus concentrations were highest at the “bottom” location with a concentration of 0.085 mg/L, in Forge Pond (Table 4). The higher concentrations of total phosphorus are likely related to the low dissolved oxygen found at the deeper depths in Forge Pond this time of year. Algal blooms may occur even where total phosphorus levels are very low. However, they tend to be more frequent and are more likely to become problematic where concentrations regularly exceed 0.020 mg/L. Concentrations in excess of 0.020 mg/L were recorded at all three sampling locations of Forge Pond.

Overall nitrogen levels were highest at the bottom sampling location in Forge Pond, where the majority of concentrations of nitrogen were as total Kjeldahl nitrogen (TKN). Ammonia



nitrogen, which is a component of TKN, was also elevated at the “bottom” location.

Table 2. Dissolved Oxygen Profiles at Forge Pond During 2023 Annual Monitoring Survey

Depth m	Deep Hole		South Bay	
	%	mg/L	%	mg/L
0.5	60.4	4.98	70.2	5.79
1.0	57.3	4.75	61.2	5.11
2.0	37.7	3.14	57.5	4.82
3.0	15.6	0.11	2.4	0.24
4.0	0.7	0.05	1.5	0.14
5.0	0.6	0.05	1.5	0.15
6.0	0.5	0.05	-	-
7.0	0.6	0.05	-	-
8.0	0.5	0.05	-	-
9.0	0.4	0.04	-	-
10.0	0.4	0.05	-	-

Table 3. Temperature (°C) Profiles at Forge Pond During 2023 Annual Monitoring Survey

Depth (m)	Deep Hole	South Bay
0.5	24.2	24.0
1.0	24.2	23.4
2.0	23.8	23.2
3.0	21.4	22.5
4.0	18.8	19.6
5.0	16.4	17.5
6.0	14.1	-
7.0	13.1	-
8.0	11.8	-
9.0	11.4	-
10.0	11.4	-

Table 4. Water Quality Parameters Collected During 2023 Annual Monitoring Survey

Parameter	Units	Forge Pond		
		FOR-A	FOR-B	FOR-C
		Deep Hole		South Bay
		Surface	Bottom	
Total depth	m	10.0		5



Parameter	Units	Forge Pond		
		FOR-A	FOR-B	FOR-C
		Deep Hole		South Bay
		Surface	Bottom	
Sample depth	m	0.5	9.0	0.5
Temperature	C	24	11.4	24.2
Dissolved oxygen	%	60.4	0.4	70.2
	mg/L	4.98	0.05	5.79
Turbidity	NTU	0.84	2.21	1.19
pH	SU	8.07	6.95	8.07
Secchi Depth	m	2		2
Hardness	mg/L	58.2	67.2	52.3
Alkalinity	mg/L	40.3	59.1	38.3
Total phosphorus	mg/L	0.039	0.085	0.035
Nitrate nitrogen	mg/L	0.01	0.01	0.01
Nitrite nitrogen	mg/L	0.005	0.005	0.005
Total Kjeldahl nitrogen	mg/L	0.52	1.48	0.63
Ammonia nitrogen	mg/L	0.0025	0.94	0.08

Recommendations

Continued water quality and aquatic vegetation monitoring is recommended for Forge Pond on an annual basis. For consistency, monitoring protocols should be the same as the previous year's monitoring conducted as part of this study.

References

ESS Group, Inc. [ESS]. 2021. Autumn 2021 Westford Ponds Report, 2021. Prepared for the Town of Westford, Massachusetts.

We appreciate the opportunity to work with you on this project. Please contact James Treacy at (781) 419-7742 if you have any questions.

Sincerely,

TRC

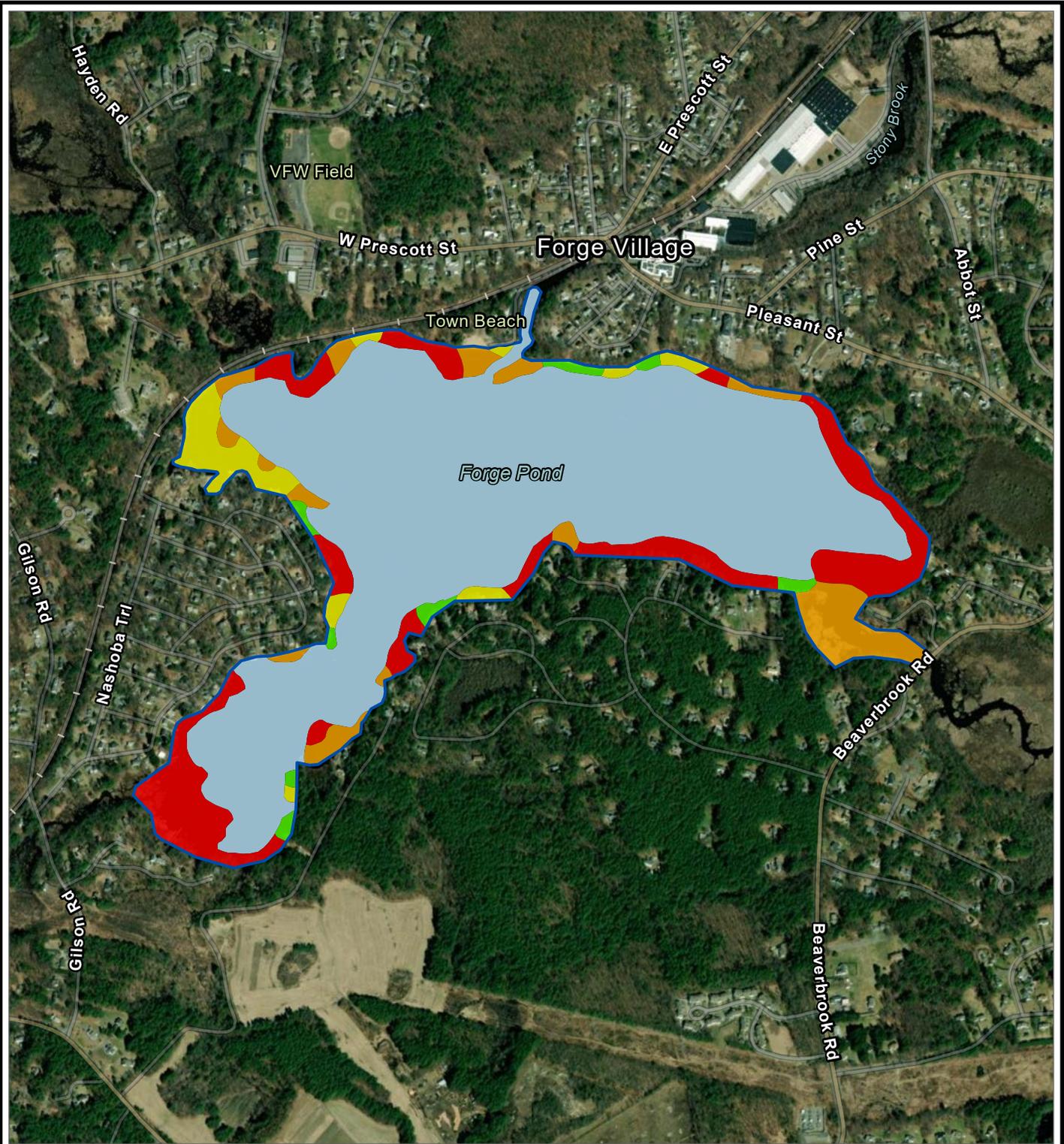
James Treacy
Staff Scientist

Attachments: Figures



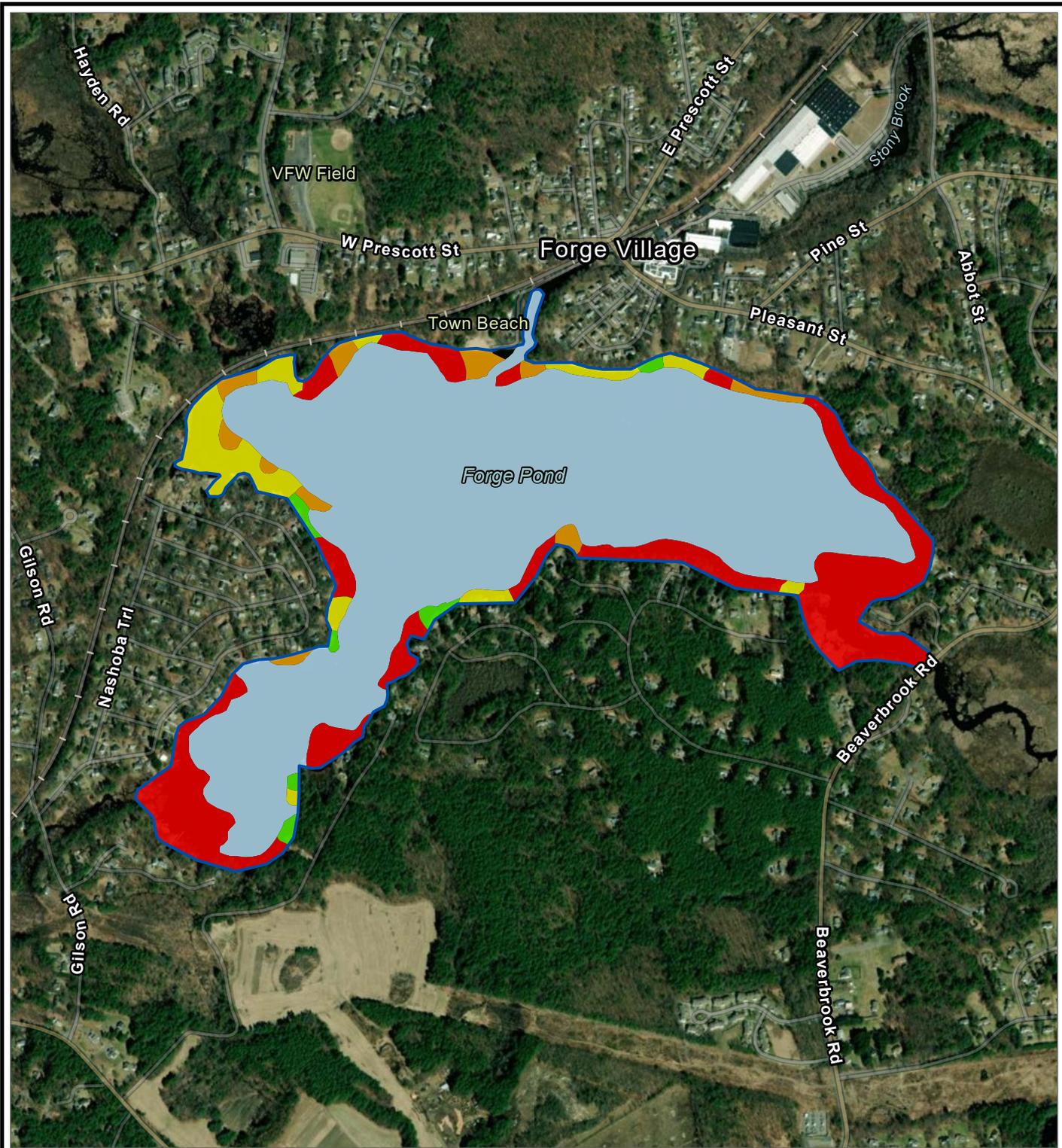
Figures

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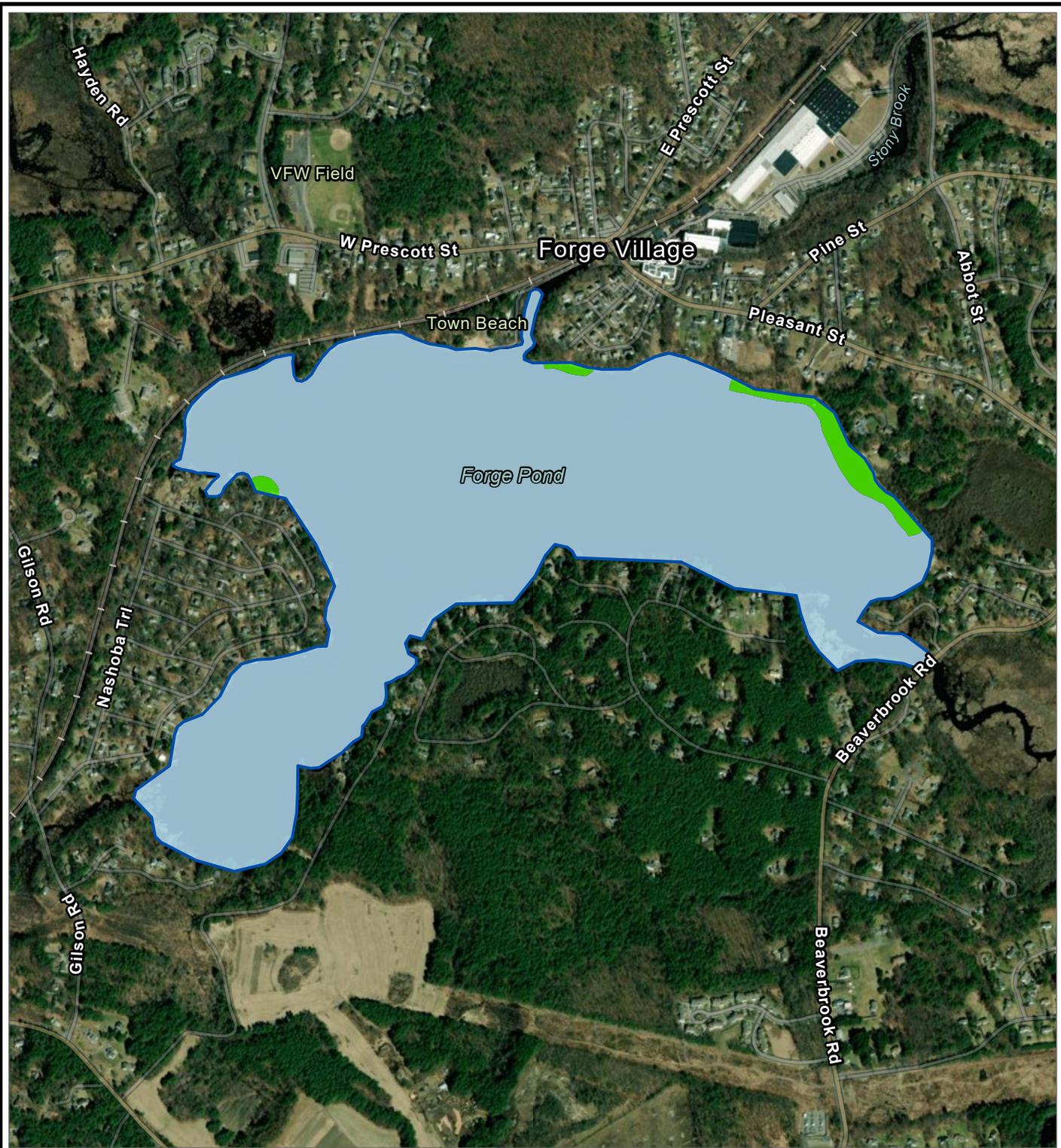
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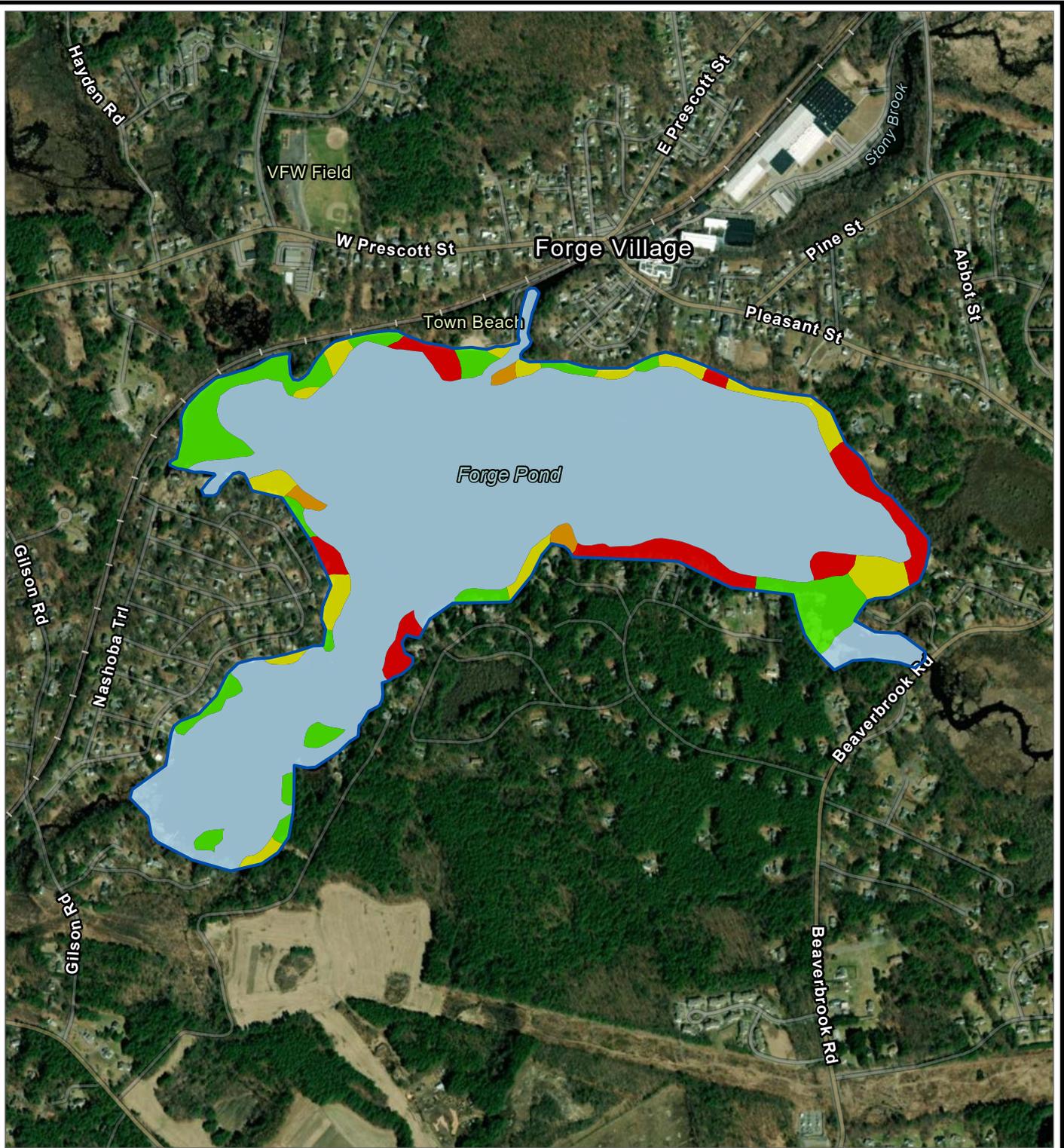
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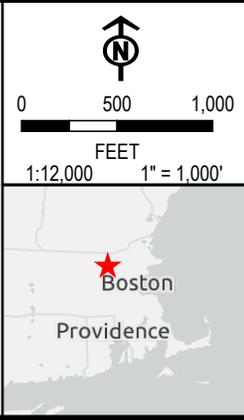


<p> POND OUTLINE</p> <p>BRITTLE NAIAD COVER</p> <p> 0% (200.9 ACRES)</p> <p> 1% - 25% (5.0 ACRES)</p>	<p></p> <p>0 500 1,000</p> <p>FEET</p> <p>1:12,000 1" = 1,000'</p>	<p>PROJECT: FORGE POND 2023 PLANT ASSESSMENT WESTFORD, MASSACHUSETTS</p>	
<p></p>		<p>TITLE: BRITTLE NAIAD COVER</p>	
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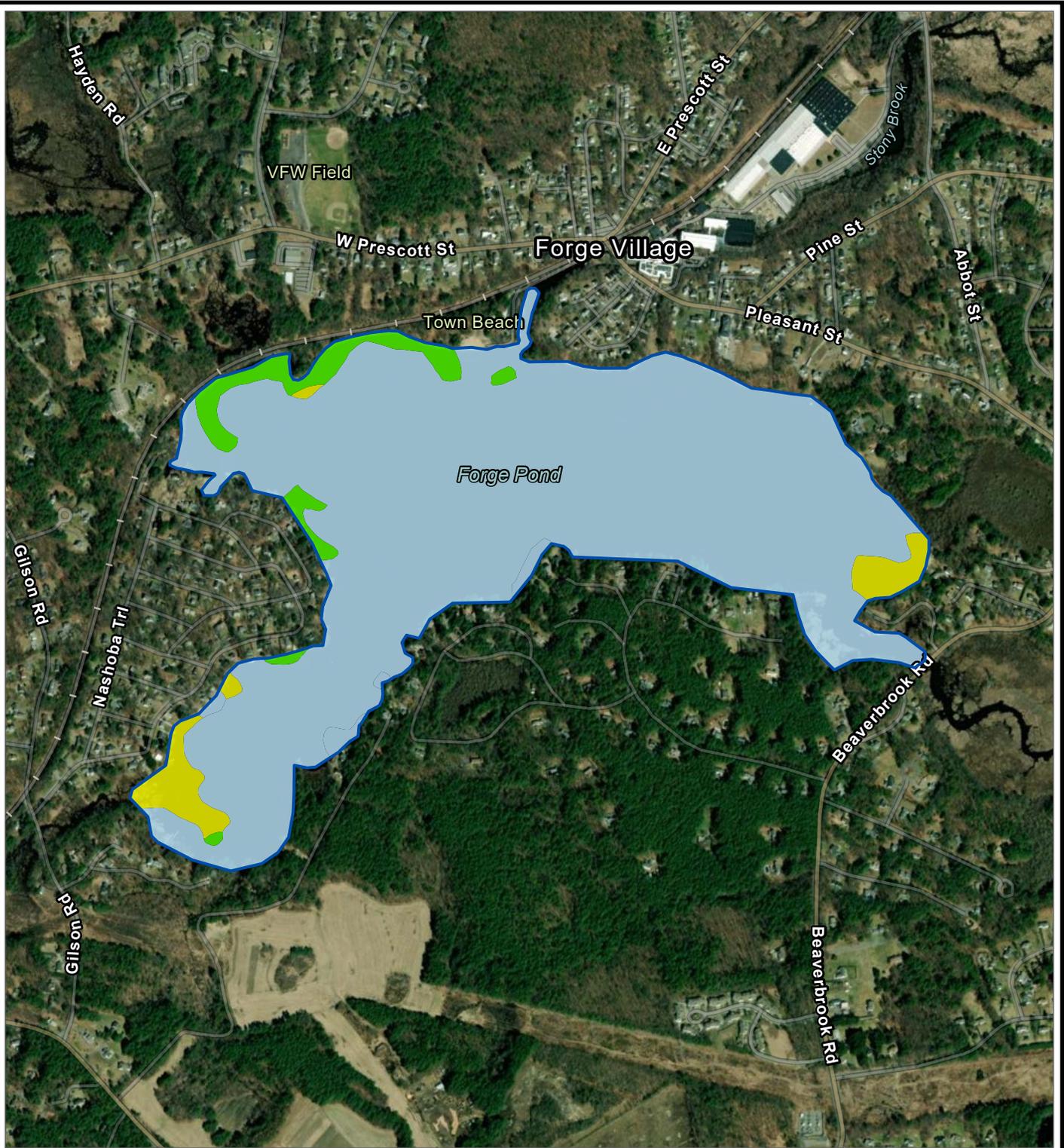


	POND OUTLINE
EURASIAN MILFOIL COVER	
	0% (163.8 ACRES)
	1% - 25% (18.1 ACRES)
	26% - 50% (10.5 ACRES)
	51% - 75% (1.5 ACRES)
	76% - 100% (12.1 ACRES)
BASE MAP: ESRI, WORLD IMAGERY, 2020 DATA SOURCES: TRC, GPS LOCATIONS, 8/9/2023	



PROJECT: FORGE POND 2023 PLANT ASSESSMENT WESTFORD, MASSACHUSETTS	
TITLE: EURASIAN MILFOIL COVER	
DRAWN BY: K. BACHAND	PROJ. NO.: 560206
CHECKED BY: A. OCHS	FIGURE 5
APPROVED BY: J. TREACY	
DATE: AUGUST 2023	
	
404 WYMAN STREET SUITE 375 WALTHAM, MA 02451 PHONE: 781.419.7696	
FILE:	FORGE_POND_FIGURES

COORDINATE SYSTEM: NAD 1983 STATEPLANE MASSACHUSETTS MAINLAND FIPS 2001 FEET, MAP ROTATION: 0
 -- SAVED BY: KBACHAND ON 8/11/2023, 12:05:12 PM - FILE PATH: T:\PROJECTS\SOLID\DELAKE\MANAGEMENT\FORGE_POND_2023\12-APRX\FORGE_POND_FIGURES.APRX - LAYOUT NAME: 560206_FORGE_POND_FIG05_FANWORT



POND OUTLINE

FANWORT COVER

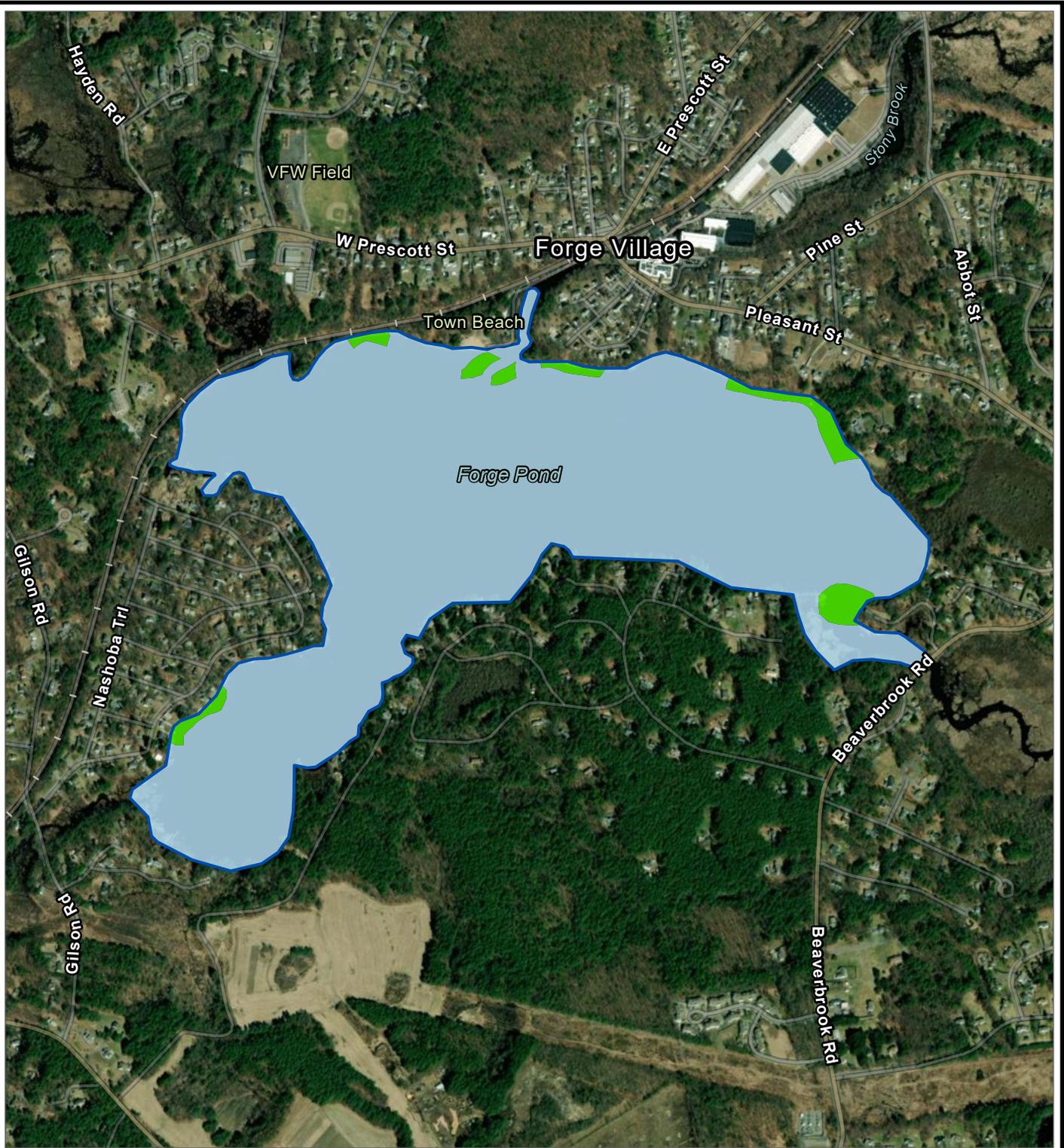
- 0% (188.1 ACRES)
- 1% - 25% (9.2 ACRES)
- 76% - 100% (8.8 ACRES)

BASE MAP: ESRI, WORLD IMAGERY, 2020
 DATA SOURCES: TRC, GPS LOCATIONS, 8/9/2023

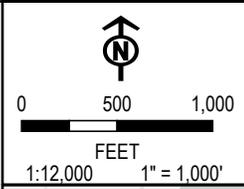

 0 500 1,000
 FEET
 1:12,000 1" = 1,000'


 Boston
 Providence

PROJECT: FORGE POND 2023 PLANT ASSESSMENT WESTFORD, MASSACHUSETTS	
TITLE: FANWORT COVER	
DRAWN BY: K. BACHAND	PROJ. NO.: 560206
CHECKED BY: A. OCHS	FIGURE 5
APPROVED BY: J. TREACY	
DATE: AUGUST 2023	
	
404 WYMAN STREET SUITE 375 WALTHAM, MA 02451 PHONE: 781.419.7696	
FILE:	FORGE_POND_FIGURES



POND OUTLINE
VARIABLE-LEAF MILFOIL COVER
 0% (199.0 ACRES)
 1% - 25% (7.0 ACRES)



PROJECT: **FORGE POND 2023 PLANT ASSESSMENT**
 WESTFORD, MASSACHUSETTS

TITLE: **VARIABLE-LEAF MILFOIL COVER**

DRAWN BY: K. BACHAND	PROJ. NO.: 560206
CHECKED BY: A. OCHS	FIGURE 6
APPROVED BY: J. TREACY	
DATE: AUGUST 2023	

	404 WYMAN STREET SUITE 375 WALTHAM, MA 02451 PHONE: 781.419.7696
	FILE: FORGEPOND_FIGURES

BASE MAP: ESRI, WORLD IMAGERY, 2020
 DATA SOURCES: TRC, GPS LOCATIONS, 8/9/2023

COORDINATE SYSTEM: NAD 1983 STATEPLANE MASSACHUSETTS MAINLAND FIPS 2001 FEET, MAP ROTATION: 0
 -- SAVED BY: KBACHAND ON 8/11/2023, 17:03:07 PM -- FILE PATH: T:\PROJECTS\SOLID\DELAKE\MANAGEMENT\FORGE_POND_2023\2-APRX\FORGE_POND_FIGURES.APRX LAYOUT NAME: 560206_FORGE_POND_FIG06_VFMILFOIL

APPENDIX B

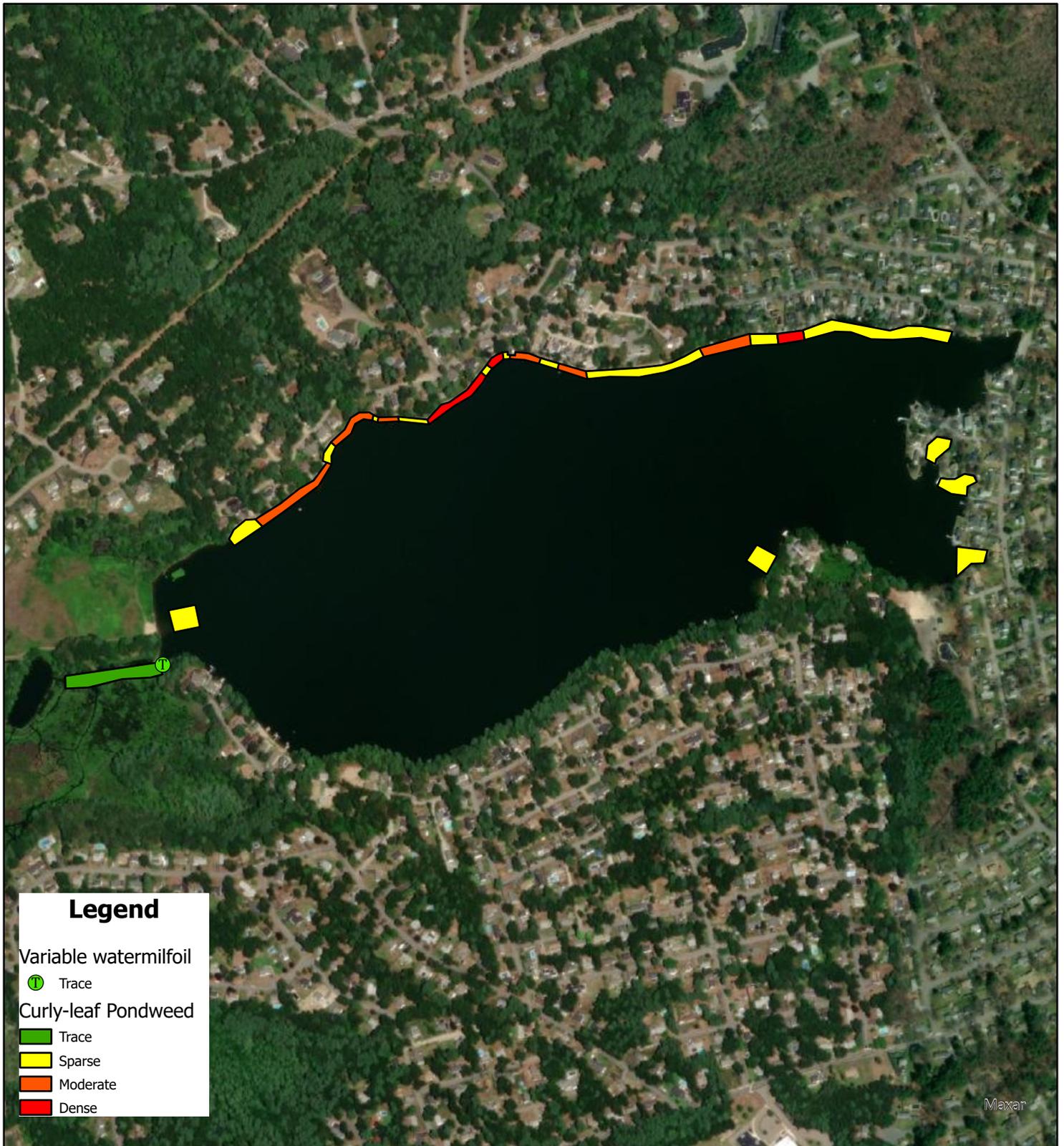
Figure 1 -Nabnasset Pre-Treatment Invasive Plant Map

Figure 2 - Long Sought For Pond Treatment Map

Figure 3 - Nabnasset Lake Treatment Map



FIGURE 1: Nabnasset Pond May 2, 2023 Survey Curly-leaf Pondweed and Variable Watermilfoil Density and Distribution



Nabnasset Lake
Westford, MA

Nabnasset Pond

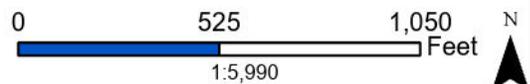


Map Date: 05/02/2023
Prepared by: KV
Office: SHREWSBURY, MA

Figure 2 - Long Sought For Pond - Westford, MA 2023 Proposed Treatment Areas

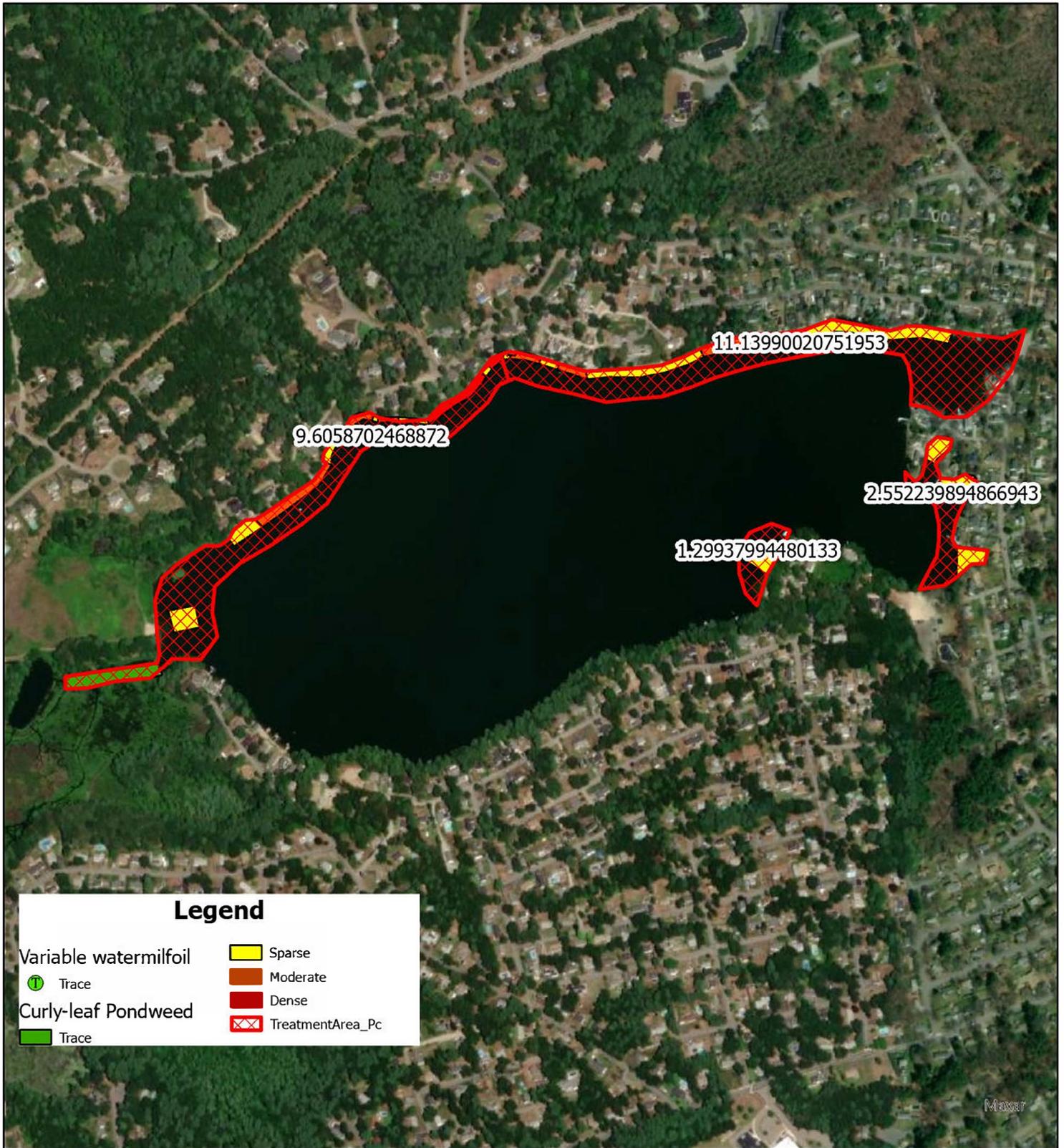


Long Sought For Pond



Date: 06/08/23
By: DM
Office: Shrewsbury, MA

FIGURE 3: Nabnasset Pond May 2, 2023 Survey
Curly-leaf Pondweed and Variable Watermilfoil Density and Distribution



Nabnasset Lake
Westford, MA

Nabnasset Pond

0 212.5425 850 Feet

1:8,190

N

Map Date: 05/02/2023
Prepared by: KV
Office: SHREWSBURY, MA

APPENDIX C

TRC Late Season Report



November 14, 2023

Dominic Meringolo
SOLitude Lake Management
590 Lake Street
Shrewsbury, Massachusetts 01545

**Re: Aquatic Plant and Water Quality Monitoring and Reporting, Post-treatment – 2023
Westford, Massachusetts
TRC Project No. 560206.0000.0000**

Dear Mr. Meringolo,

TRC Companies, Inc (TRC), was contracted by SOLitude Lake Management (SOLitude) to complete a pre-treatment monitoring program at one pond located within the Town of Westford (Town), as follows: Forge Pond. In addition, a post-treatment/late season monitoring event was completed at seven additional ponds, as follows: Forge Pond, Old Mill/Graniteville Ponds, Burge's Pond, Long Sought-for Pond, Kennedy Pond, Keyes Pond, and Nabnasset Lake. The post-treatment/late season monitoring program was completed to complement pre-treatment monitoring at Forge Pond, conducted by TRC in summer 2023.

This report provides the findings of the monitoring program, builds on the findings of prior monitoring efforts, and makes recommendations for management of these water bodies in 2024.

Post-treatment/Late Season Monitoring

The 2023 post-treatment/late season monitoring program consisted of aquatic vegetation mapping and water quality sampling and was completed at each of the seven ponds on the following dates:

- September 27 – Burge's Pond, Keyes Pond and Kennedy Pond
- September 28 – Nabnasset Lake and Forge Pond (including both the Westford and Littleton sides)
- October 2 – Long Sought-For Pond and Old Mill/Graniteville Ponds

Aquatic Vegetation Monitoring

Aquatic plants were surveyed using comparable methods to 2022 (TRC 2022). Plant rakes were used to help assess aquatic invasive plant densities. Data was collected using a combination of field notes and a Tablet system capable of sub-meter accuracy.

Overall, the aquatic plant communities in the seven Westford ponds have been relatively consistent with previous years, however variable-leaf milfoil (*Myriophyllum heterophyllum*) was observed for the first time in Keyes Pond since the pre-treatment mapping event in 2017. Additional details on the results of the aquatic plant surveys are presented, by pond, in the following sections.



Invasive variable-leaf milfoil (Myriophyllum heterophyllum) observed during the late season site visit at Keyes Pond on September 27, 2023.

Table 1. Aquatic Plants Observed during 2021 Post-treatment/Late Season Surveys

Common Name	Scientific Name	Native or Exotic	Keyes Pond	Long Sought-for Pond	Nabnasset Lake	Old Mill/Graniteville Ponds	Burge' s Pond	Kennedy Pond	Forge Pond
Aquatic Moss	<i>Fontinalis sp.</i>	Native							
Bigleaf Pondweed	<i>Potamogeton amplifolius</i>	Native			X				
Brittle Naiad	<i>Najas minor</i>	Exotic			X				X
Bushy Naiad	<i>Najas flexilis</i>	Native						X	
Canadian Waterweed	<i>Elodea canadensis</i>	Native				X			X
Clasping-leaf Pondweed	<i>Potamogeton perfoliatus</i>	Native						X	
Common Bladderwort	<i>Utricularia macrorhiza</i>	Native	X		X	X	X		X
Common Duckweed	<i>Lemna minor</i>	Native	X			X			
Coontail	<i>Ceratophyllum demersum</i>	Native	X			X			X
Curly-leaf pondweed	<i>Potamogeton crispus</i>	Exotic		X					
Eurasian Milfoil	<i>Myriophyllum spicatum</i>	Exotic				X			X
Fanwort	<i>Cabomba caroliniana</i>	Exotic				X			X
Flat-leaf Bladderwort	<i>Utricularia intermedia</i>	Native	X						
Floating-leaf Pondweed	<i>Potamogeton epihydrus</i>	Native				X			
Golden Hedge-hyssop	<i>Gratiola aurea</i>	Native			X	X		X	
Humped Bladderwort	<i>Utricularia gibba</i>	Native			X				
Little Floating Bladderwort	<i>Utricularia radiata</i>	Native					X		
Low Milfoil	<i>Myriophyllum humile</i>	Native					X		
Marsh Seedbox	<i>Ludwigia palustris</i>	Native	X			X		X	
Purple Bladderwort	<i>Utricularia purpurea</i>	Native	X	X					
Quillwort	<i>Isoetes spp.</i>	Native						X	
Robbins' Pondweed	<i>Potamogeton robbinsii</i>	Native							X
Spikerush	<i>Eleocharis sp.</i>	Native	X	X	X	X	X	X	
Stonewort	<i>Nitella sp.</i>	Native		X					
Southern Naiad	<i>Najas guadalupensis</i>	Native							
Thinleaf Pondweed	<i>Potamogeton pusillus</i>	Native	X	X	X				X
Variable-leaf Milfoil	<i>Myriophyllum heterophyllum</i>	Exotic	X		X	X			X
Water Celery (Tapegrass)	<i>Vallisneria americana</i>	Native		X	X				X
Water Starwort	<i>Calitriche palustris</i>	Native							X
Watershield	<i>Brasenia schreberi</i>	Native	X	X	X		X	X	X
Waterwort	<i>Elatine sp.</i>	Native			X			X	

Common Name	Scientific Name	Native or Exotic	Keyes Pond	Long Sought-for Pond	Nabnasset Lake	Old Mill/Graniteville Ponds	Burge' s Pond	Kennedy Pond	Forge Pond
White Water Lily	<i>Nymphaea odorata</i>	Native	X	X	X	X	X		X
Yellow Water Lily	<i>Nuphar lutea variegata</i>	Native	X	X	X	X	X	X	X
Total			14	10	13	13	7	9	14

Keyes Pond

Fourteen species of aquatic plants were observed in Keyes Pond during the 2023 post-treatment survey, including one exotic invasive (Table 1). See Appendix A for overall aquatic plant cover (Figure 1) and overall aquatic plant biovolume (Figure 2). Of note, the invasive variable-leaf milfoil (*Myriophyllum heterophyllum*) was observed in three locations, in sparse to patchy beds, covering just over 1 acre (Figure 3). This was first time this species since the pre-treatment mapping event in 2017.

Old Mill/Graniteville Ponds

Thirteen species of aquatic plants were observed at the Old Mill/Graniteville Ponds during the 2023 late season survey. Three exotic invasive species were also observed. Aquatic invasive fanwort (*Cabomba caroliniana*), Eurasian milfoil (*Myriophyllum spicatum*), and variable-leaf milfoil were observed during the late season mapping. See Appendix A for overall aquatic plant cover (Figure 4) and overall aquatic plant biovolume (Figure 5).

Fanwort was found growing in patchy to very dense stands covering 8.8 acres in both basins of the pond during the 2023 late season survey (Figure 6). This is consistent with the previous late season survey in 2021.

Eurasian milfoil was only observed in the upper basin (Figure 7). The total area covered was approximately 2.5 acres, which represents a decrease from the previous survey.



Very dense bed of fanwort reaching the surface in lower basin of Old Mill/Graniteville Ponds.

Variable-leaf milfoil was observed growing in sparse beds in both basins of the Old Mill/ Graniteville Ponds during the 2023 late season survey (Figure 8). Cover of this species was less than 1 acre, which is less than what was observed during the 2021 late season survey.

Nabnasset Lake

Thirteen species of aquatic plants were observed at Nabnasset Lake during the post-treatment survey (Table 1). See Appendix A for overall aquatic plant cover (Figure 9) and overall aquatic plant biovolume (Figure 10)

Aquatic invasive curly-leaf pondweed (*Potamogeton crispus*) was documented in Nabnasset Lake during the 2022 surveys, however, during the 2023 post-treatment/late season survey it was not observed. The 2023 post-treatment /late season survey at Nabnasset Lake was completed outside the maximum growing season for curly-leaf pondweed.

Water celery (*Vallisneria americana*), although not an exotic species, has been observed to grow at nuisance densities in past surveys; however, it was not observed to be widespread at Nabnasset Lake during the time of the 2023 post-treatment/late season survey (Figure 11). Water celery was generally present at low densities.

Variable-leaf milfoil was at a single location, adjacent to the lake in the outlet of Shipley Swamp (Figure 12). Brittle naiad (*Najas minor*) was observed along the northern shoreline of the lake typically growing at low densities. Brittle naiad coverage was observed to be just over 3 acres (Figure 13), which is a slight increase from the previous survey in 2022. Water chestnut (*Trapa natans*) had been observed during the 2021 survey; however, it was not observed at Nabnasset Lake during the 2023 post-treatment survey.

Long Sought-for Pond

Ten species of aquatic plants were observed at Long Sought-for Pond during the post-treatment/late season survey (Table 1). Total aquatic plant cover (Figure 14) and biovolume (Figure 15) are attached in Appendix A. Aquatic invasive curly-leaf pondweed was only observed at one location and covered less than 0.5 acres during the 2023 post-treatment survey (Figure 16). Although this is significantly less than what had been observed during the 2022 surveys, the post-treatment survey was completed outside the growing season for curly-leaf pondweed.

Additionally, a native thinleaf pondweed species (*Potamogeton spp.*) covered approximately 4 acres of the pond in typically at light growth (Figure 17). Although a native, this has been a target species which has been documented at nuisance levels in past years surveys at Long Sought-for Pond.

Eurasian milfoil which has not been observed since 2018, was not observed at Long Sought-for Pond during 2023 post-treatment monitoring.

Kennedy Pond

Nine species of aquatic plants were observed in Kennedy Pond during the late season survey (Table 1). No aquatic invasive plant species were found. However, as in prior years, the exotic invasive common reed (*Phragmites australis*) was observed growing along portions of the shoreline. Total aquatic plant cover (Figure 18) and biovolume (Figure 19) are attached in Appendix A



Nabnasset Lake during the post-treatment survey on September 28, 2023.

Forge Pond

Fourteen species of aquatic plants were observed during the 2023 late season survey of Forge Pond, including four exotic invasive species. See Appendix A for overall aquatic plant cover (Figure 20) and overall aquatic plant biovolume (Figure 21) The following exotic invasive species were observed: brittle naiad, Eurasian milfoil, fanwort, and variable-leaf milfoil.

Curly-leaf pondweed was not observed, although this species typically completes its life cycle in early summer. Therefore, it is likely to persist in Forge Pond and is expected to return to active growth in spring 2024.

Fanwort was observed in extensive beds covering approximately 33 acres (Figure 22). Most beds were sparse, with a few areas of patchy to dense growth.

Eurasian milfoil was observed in mostly patchy beds covering approximately 63 acres of Forge Pond during the 2023 post-treatment/late season survey (Figure 23). This is an increase from the previous survey in 2021. Eurasian milfoil was the dominant aquatic plant species during the 2023 post-treatment/late season survey at Forge Pond.

Variable-leaf milfoil covered approximately 4.5 acres in sparse beds along shoreline areas of Forge Pond during the 2023 post-treatment/late season survey (Figure 24). This is a slight decrease in areal extent from the previous survey in 2021.

Brittle naiad cover in Forge Pond was observed to be just over 5 acres in extent, occurring primarily as sparse growth (Figure 25).

Burge's Pond

Seven species of aquatic plants were found in Burge's Pond during the 2023 late season survey. No aquatic invasive plant species were observed in 2023 (Table 1), which is consistent with prior mapping of Burge's Pond dating back to post-treatment mapping completed in 2016. Total aquatic plant cover (Figure 26) and biovolume (Figure 29) are attached in Appendix A

Water Quality Monitoring

TRC conducted water quality sampling at three stations within each waterbody, including one location in the deepest portion of each waterbody. TRC measured the following parameters in the field: dissolved oxygen, temperature, turbidity, pH, and water clarity (Secchi disk).

TRC collected water samples for laboratory analysis of the following analytes: hardness, nitrate nitrogen, alkalinity, total phosphorus, total Kjeldahl nitrogen, and ammonia nitrogen. Water samples were analyzed by a Massachusetts-certified analytical laboratory. Notable water quality results are summarized in the following sections.

Dissolved Oxygen

Each water body exhibited dissolved oxygen concentrations suitable for aquatic life near the surface, except for Burges Pond. Dissolved oxygen conditions at this water body were below the state numerical criterion of 5.0 mg/L for warmwater fisheries.



Post-treatment/late season water quality results also indicate low (hypoxia) to very low (anoxia) dissolved oxygen levels in the deeper waters of all the ponds sampled. This pattern was most extensive in Keyes Pond and Forge Pond. Extensive areas of persistently low dissolved oxygen concentrations are typically considered unsupportive of most aquatic life. Additionally, they may increase the likelihood of internal phosphorus release from pond sediments, which can compound management issues associated with eutrophication (nutrient enrichment).

Turbidity

Turbidity varied somewhat within each of the water bodies. Surface turbidity was highest in Forge Pond and the highest overall turbidity observed was measured in bottom waters of Forge Pond.

Secchi Depth (Transparency)

Secchi depth is a measure of water transparency and may be reduced by suspended sediments, algal growth, or the presence of other organic matter in the water column. Reduced Secchi depths are typically associated with nutrient-enriched ponds, although this condition can also be caused by influx of turbid storm flows or wind events. During post-treatment/late season monitoring, the shallowest Secchi depths were measured at Keyes Pond, Nabnasset Lake and Forge Pond, where water transparency was 2.5 m or less. The deepest Secchi depths (i.e., clearest water) were measured at Burges Pond and Kennedy Pond, where transparency extended to 3.0 meters.

pH, Hardness, and Alkalinity

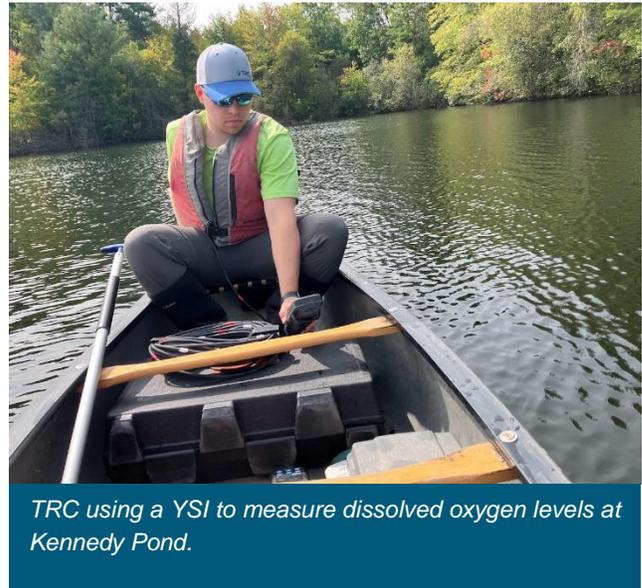
Similar to previous sampling events, most of the locations sampled during post-treatment/late season monitoring were circumneutral (i.e., pH near 7.0). The most acidic pH was measured in Keyes Pond and Burge's Pond, while the most basic pH measurements were collected in Long Sought-for Pond.

Hardness and alkalinity tend to be naturally higher in the Merrimack River valley than adjacent parts of eastern Massachusetts, although they can also be influenced by human activity in the watershed as well as atmospheric acid deposition. These parameters varied substantially between ponds, but generally demonstrated similar patterns in variation with lower hardness values corresponding to lower alkalinity. This is not unexpected, as harder waters tend to have a higher alkalinity (also known as acid neutralizing capacity). Increased alkalinity suggests greater buffering capacity of the water (i.e., resistance to pH change). Ponds with low buffering capacity, such as Burge's Pond, may be susceptible to more abrupt swings in pH than those with higher alkalinity, such as Forge Pond.

Phosphorus and Nitrogen

Phosphorus and nitrogen are both major nutrients fueling plant and algal growth. Of the two, phosphorus tends to be limiting nutrient in most New England freshwater systems. However, nitrogen levels can also impact the overall productivity of the system and type of algal growth favored, and may even influence the production of toxins in some cyanobacteria. In general, high nutrient levels in the water column can contribute to algal blooms and excessive floating plant growth. High availability of nutrients in the sediments can contribute to excessive rooted plant growth.

During post-treatment/late season monitoring, total phosphorus concentrations were generally highest at Keyes Pond and Long Sought-for Pond. Algal blooms may occur even where total phosphorus levels are very low. However, they tend to be more frequent and are more likely to become problematic where concentrations regularly exceed 0.020 mg/L. Sediment release of phosphorus is apparent when bottom (hypolimnetic) concentrations are much higher than surface (epilimnetic) concentrations during the time of the year when the water body is stratified



TRC using a YSI to measure dissolved oxygen levels at Kennedy Pond.

(warm surface water overlaying cold bottom water). This pattern is most apparent at Keyes Pond, Long Sought-for Pond, and Forge Pond. As indicated previously, release of sediment phosphorus may be aggravated by low dissolved oxygen concentrations at depth.

Overall nitrogen levels were highest at Nabnasset Lake and Forge Pond, particularly the bottom location (NAB-B). This is consistent with prior years. Ammonia nitrogen, which is a component of TKN, was also highest in the bottom location (NAB-B) at Nabnasset Lake (Table 4). Nitrate nitrogen levels were also greatest at Nabnasset Lake. High levels of nitrate nitrogen may be an indication of septic loading or stormwater runoff.

Sediment Results

According to laboratory results, sediment total phosphorus concentrations were highest in Forge Pond sediments, followed by Long Sought-For Pond, Keyes Pond, and Nabnasset Lake (Table 5). The iron-bound and loosely sorbed phosphorus fractions were highest in Forge Pond sediments, followed by Keyes Pond and Nabnasset Lake. However, notably, these fractions were very low in Long Sought-For Pond. Iron-bound phosphorus is readily released from sediments when dissolved oxygen conditions are low; therefore, together with loosely sorbed phosphorus it can be thought of as mobile phosphorus – readily releasing from sediments into the water column when dissolved oxygen levels are low. Given the higher concentration of iron-bound phosphorus in Forge Pond sediments, coupled with the large area of the pond bottom that goes anoxic during the summer, Forge Pond is likely to experience the highest internal phosphorus loading of the four water bodies (Table 5). Likewise, the lower concentration of iron-bound phosphorus in Long Sought-For Pond and relatively small area of seasonal anoxia in its bottom waters means that this pond is likely to experience the lowest internal phosphorus loading. Nabnasset Lake and Keyes Pond are likely to have intermediate levels of internal phosphorus loading. Of these two, internal phosphorus loading likely makes up a higher percentage of the overall phosphorus load in Nabnasset Lake.

One possible option for managing water bodies with excessive phosphorus is nutrient inactivation, which typically is accomplished through the application of alum (aluminum sulfate). Alum forms a flocculent when introduced into the water body and sinks into the surface sediments, binding to the excess phosphorus and inactivating it, regardless of dissolved oxygen levels. This means that it is unlikely to release phosphorus into overlying waters the way that iron can under anoxic conditions. The two main options for alum treatments are sediment dose alum treatment and low-dose alum treatment. The sediment dose treatment involves larger amounts of alum and is designed to address the phosphorus in the sediments while a low-dose alum treatment strips the water column of available phosphorus.

TRC used previously collected data to estimate overall nutrient budgets for Keyes Pond, Nabnasset Lake, and Long Sought-for Pond. This provides a means to view the internal phosphorus loading estimates from the current study in the context of overall conditions and assess whether internal loading is likely to be contributing a significant portion of the annual phosphorus budget. Based on the phosphorus results in the sediment samples, it does not seem likely that a sediment dose alum treatment would result in cost-effective improvement of phosphorus levels at Keyes Pond and Long Sought-for Pond, although low-dose treatments could still potentially be used as a tool to address water column phosphorus and prevent algae blooms. However, sediment dose alum treatments appear to have more potential to be useful for water quality improvement in Nabnasset Lake and Forge Pond. Therefore, TRC recommends additional study of this management option for those two water bodies. For Nabnasset Lake, TRC recommends additional sediment coring and sampling to develop the alum dosing that would be needed for a sediment-targeted nutrient inactivation program. This data would be necessary to support permitting and develop cost estimates for implementation of the program. Forge Pond was not part of the Town's management and monitoring program at the time the pond nutrient budgets were developed for Nabnasset Lake and the other two ponds. Therefore, a basic nutrient budget analysis would be necessary in order to better understand the significance of the internal phosphorus loading at Forge Pond. Although it is likely to have the highest magnitude of internal loading among the four water bodies sampled this year, this needs to be understood in the context of total loading (i.e., internal plus external) to be able to assess whether sediment-targeted nutrient inactivation is likely to be a cost-effective phosphorus reduction solution.

Table 2. Dissolved Oxygen Profiles at Deep Hole Locations during 2023 Post-treatment/Late Season Monitoring

Depth	Keyes Pond		Old Mill/Graniteville Ponds		Burge's Pond		Kennedy Pond		Long Sought-for Pond		Nabnasset Lake		Forge Pond	
	m	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%	mg/L	%
0.5	50.8	5.00	69.2	6.63	41.2	3.96	66.8	6.19	89.1	8.44	71.7	6.77	63.1	6.03
1.0	44.9	4.45	63.8	6.18	40.0	3.81	67.2	6.30	86.1	8.11	67.3	6.35	59.1	5.69
2.0	38.1	3.80	59.7	5.82	38.9	3.70	66.5	6.25	83.1	7.92	68.6	6.48	50.7	4.91
3.0	12.5	1.27	56.3	5.53	39.9	3.80	65.1	6.13	80.2	7.66	68.5	6.47	51.4	5.01
4.0	2.20	0.23	55.2	5.44	39.9	3.80	65.3	6.17	76.6	7.33	68.1	6.44	41.6	4.07
5.0	1.40	0.15	2.40	0.24	38.6	3.69	63.6	6.00	75.7	7.24	68.8	6.52	20.8	2.04
6.0	1.20	0.13			11.3	1.10	62.1	5.87	68.5	6.58	58.5	5.56	1.70	0.17
7.0							2.00	0.20	65.9	6.33	2.20	0.22	1.20	0.13
8.0									1.70	0.17	1.30	0.13	1.10	0.12
9.0									1.00	0.10			1.00	0.11
10.0													1.00	0.11
Total depth (m)	6.0		5.0		6.0		7.0		9.0		8.0		10.0	

Table 3. Temperature Profiles at Deep Hole Locations during 2023 Post-treatment/Late Season Monitoring

Depth (m)	Keyes Pond	Old Mill/Graniteville Ponds	Burge's Pond	Kennedy Pond	Long-Sought-for Pond	Nabnasset Lake	Forge Pond
0.5	16.7	17.6	18.2	19.4	18.3	18.7	17.7
1.0	16.2	17.0	18.2	19.0	18.3	18.5	17.3
2.0	15.8	16.7	18.2	18.8	17.9	18.5	17.0
3.0	15.4	16.2	18.2	18.7	17.8	18.4	16.9
4.0	13.4	16.2	18.1	18.6	17.7	18.4	16.6
5.0	11.6	16.0	18.1	18.5	17.6	18.3	16.3
6.0	10.3		17.4	18.5	17.5	17.9	15.1
7.0				15.6	17.4	15.0	13.6
8.0					14.9	14.5	12.6
9.0					14.0		12.2
10.0							12.3
Total depth (m)	6.0	5.0	6.0	8.0	9.0	8.0	8.0

Table 4. Water Quality Parameters Collected During 2023 Post-treatment/Late Season Monitoring

Parameter	Units	Keyes Pond			Old Mill/Graniteville Ponds			Burge's Pond			Kennedy Pond			Long Sought-for Pond			Nabnasset Lake			Forge Pond		
Station ID		KEY-A	KEY-B	KEY-C	OLD-A	OLD-B	OLD-C	BUR-A	BUR-B	BUR-C	KEN-A	KEN-B	KEN-C	LSF-A	LSF-B	LSF-C	NAB-A	NAB-B	NAB-C	FOR-A	FOR-B	FOR-C
Location		Deep Hole		Outlet	Deep hole 1	Deep hole 2	Inlet	Deep Hole		In-pond	Deep Hole		In-pond	Deep Hole		Inlet	Deep Hole		Outlet	Deep Hole		Inlet
	Surface	Bottom	Surface		mid-depth	Surface		Bottom	Surface		Bottom	Surface		Bottom	Surface		Bottom	Surface		Bottom	Surface	
Total depth	m	6		0.5	5		1.5	6		3	8		1	9		0.5	8		2	10		3
Sample depth	m	0.5	5	0.5	0.5	2	0.5	0.5	5	0.5	0.5	6	0.5	0.5	8	0.5	0.5	7	0.5	0.5	8	0.5
Temperature	C	16.7	11.6	16.5	17.6	16.7	17.6	18.2	18.1	18.4	19.4	18.5	19.3	18.3	14.9	18.4	18.7	15	17.7	17.7	12.6	21.8
Dissolved oxygen	%	50.8	1.4	49.2	69.2	59	70.4	41.2	38.6	51.3	66.8	62.1	70.4	89.1	1.7	69.2	71.7	2.2	70.6	63.1	1.1	71.9
	mg/L	5	0.15	4.78	6.63	5.76	6.74	3.96	3.69	4.86	6.19	5.87	6.53	8.44	0.17	6.53	6.77	0.22	6.77	6.03	0.12	6.3
Turbidity	NTU	1.38	2.3	1.47	0.38	0.3	0.1	1.55	1.86	1.57	1.67	2.19	1.88	0.24	1.5	0.32	1.64	2.24	1.95	2.17	2.37	1.65
pH	SU	6.65	6.72	6.66	7.11	7.1	7.1	6.83	6.19	6.08	6.65	6.93	7.05	7.47	7.31	7.55	7.34	7.23	7.39	7.18	7.21	7.2
Secchi Depth	m	1.5		bottom (0.5)	3.0	2.5	bottom (1.5)	3.5		2.5	3.5		bottom (1.0)	3.0		bottom (0.5)	2.5		bottom (2.0)	2.0		1.5
Hardness	mg/L	24.4	37.6	24.3	52.4	50.8	54.3	2.0	2.1	1.9	34.8	35.5	35.5	30.7	35.5	30.7	43.8	54.2	43.8	51.9	61.8	51.1
Alkalinity	mg/L	20	32	22	37	36	36	10	10	10	10	10	20	23	37	30	28	43	30	46	52	39
Total phosphorus	mg/L	0.058	0.115	0.032	0.022	0.023	0.022	0.013	0.020	0.011	0.018	0.015	0.022	0.020	0.217	0.016	0.035	0.081	0.025	0.036	0.101	0.045
Nitrate nitrogen	mg/L	0.01	0.01	0.01	0.08	0.08	0.15	0.01	0.01	0.01	0.01	0.01	0.01	0.04	0.03	0.04	0.2	0.14	0.21	0.04	0.01	0.04
Total Kjeldahl nitrogen	mg/L	0.33	0.71	0.33	0.30	0.29	0.13	0.23	0.23	0.21	0.22	0.20	0.24	0.28	0.84	0.36	0.39	1.30	0.48	0.32	1.01	0.31
Ammonia nitrogen	mg/L	0.025	0.30	0.025	0.06	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.10	0.53	0.15	0.12	0.95	0.11	0.025	0.64	0.05

Table 5. Sediment Lab Results

Analyte	Units	Location			
		Keyes Pond	Nabnasset Lake	Long Sought-For Pond	Forge Pond
Percent Moisture	%	93.1	90	90.3	93.5
Percent Solid	%	6.9	10	9.7	6.5
Iron Bound Phosphorous	mg/Kg	98.71	61.87	43.85	185.43
Loosely-sorbed Phosphorus	mg/kg	<5.0	<5.0	<1.0	<5.0
Total Phosphorus	mg/Kg	990	695	1130	2470
Estimated Internal Phosphorus Loading Per Year	mg/Kg	13.2	18.5	3.4	147.4
Significance of Internal Phosphorus Load		Low	Moderate	Very Low	Unknown

2024 Monitoring

Biannual water quality and aquatic vegetation monitoring is recommended for the seven Westford ponds (Forge Pond, Old Mill/Graniteville Ponds, Burge’s Pond, Long Sought-for Pond, Kennedy Pond, Keyes Pond, and Nabnasset Lake) in 2024. This will allow for the refinement of next year’s monitoring and management program using data that are up-to-date and accurately reflect the current condition of each water body. TRC recommends completing the post-treatment/late season monitoring program in September or early October to maximize comparability of the results to prior years.

In addition to the biannual water quality and aquatic vegetation monitoring, TRC would also recommend conducting a basic nutrient budget analysis for Forge Pond, in order to better understand the significance of the internal phosphorus loading in the context of external loading inputs and loss process outputs. A basic nutrient budget analysis would cost around \$10,000 to \$15,000 to complete and would consist of at least two wet weather sampling events, two dry weather water quality sampling events, and the associated analysis. For Nabnasset Lake, TRC would recommend additional sediment coring and sampling to develop the necessary dosing for a sediment targeted nutrient inactivation program. This would provide the information needed to develop implementation cost estimates and permit the project. The recommended budget for the dosing study for Nabnasset Lake would be \$25,000 to \$30,000.

References

TRC Companies, Inc. [TRC]. 2022. Aquatic Plant and Water Quality Monitoring and Reporting, Post-treatment, 2022. Prepared for Town of Littleton.

We appreciate the opportunity to work with you on this project. Please contact James Treacy at (781) 419-7742 if you have any questions.

Sincerely,

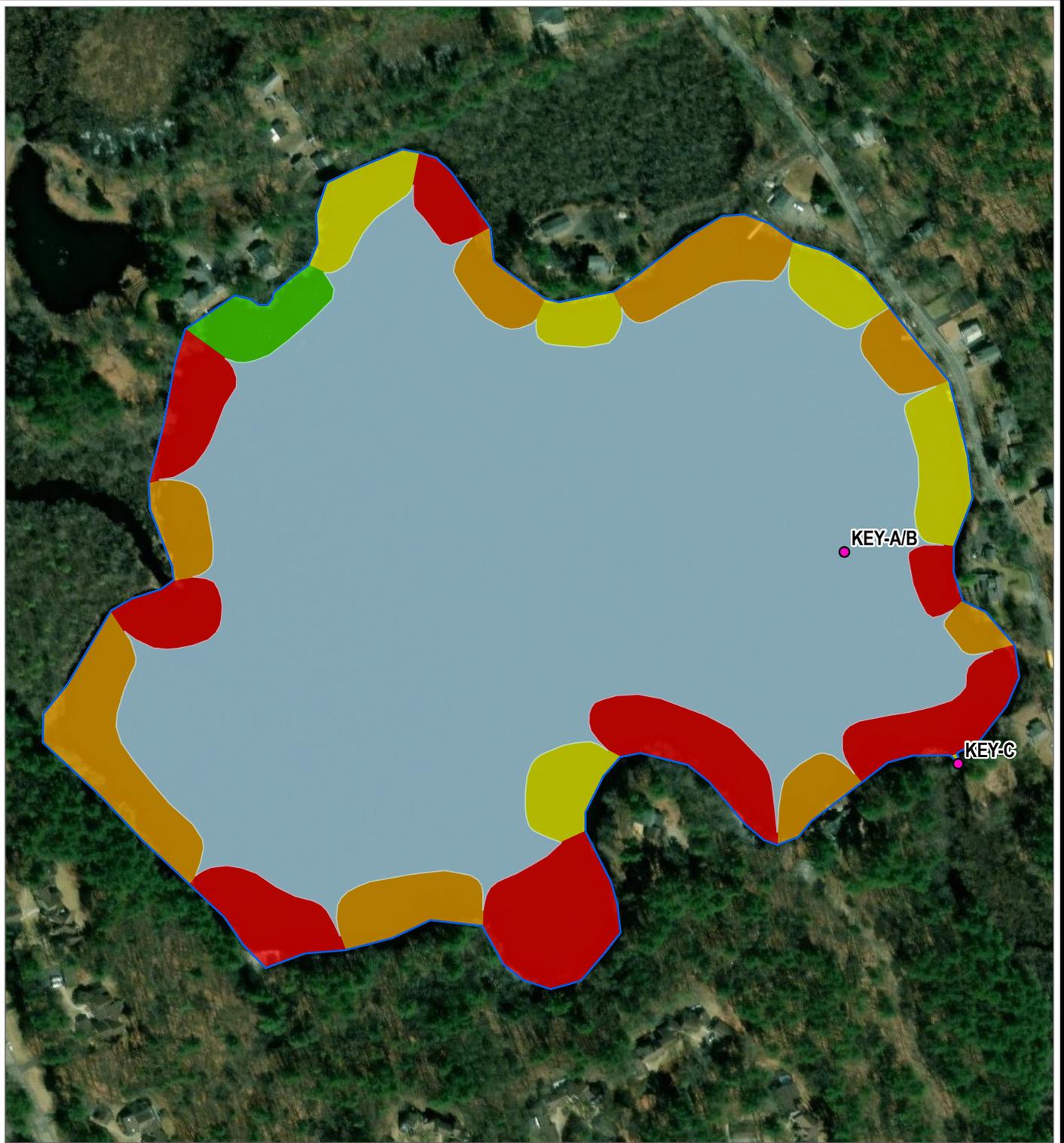
TRC Companies, Inc



James Treacy
Staff Scientist

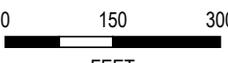
Appendix A: Figures

COORDINATE SYSTEM: NAD 1983 STATEPLANE MASSACHUSETTS MAINLAND FIPS 2001; MAP ROTATION: 0
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 WATER QUALITY LOCATIONS
TOTAL PLANT COVERAGE
 0% (28.61 ACRES)
 1% - 25% (0.55 ACRES)
 26% - 50% (2.33 ACRES)
 51% - 75% (4.12 ACRES)
 76% - 100% (5.05 ACRES)

BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 09/27/2023; MASSDEP, HYDROGRAPHY, 2019



 1:3,200 1" = 267'


PROJECT: SOLITUDE LAKE MANAGEMENT LLC
KEYES POND
WESTFORD, MA

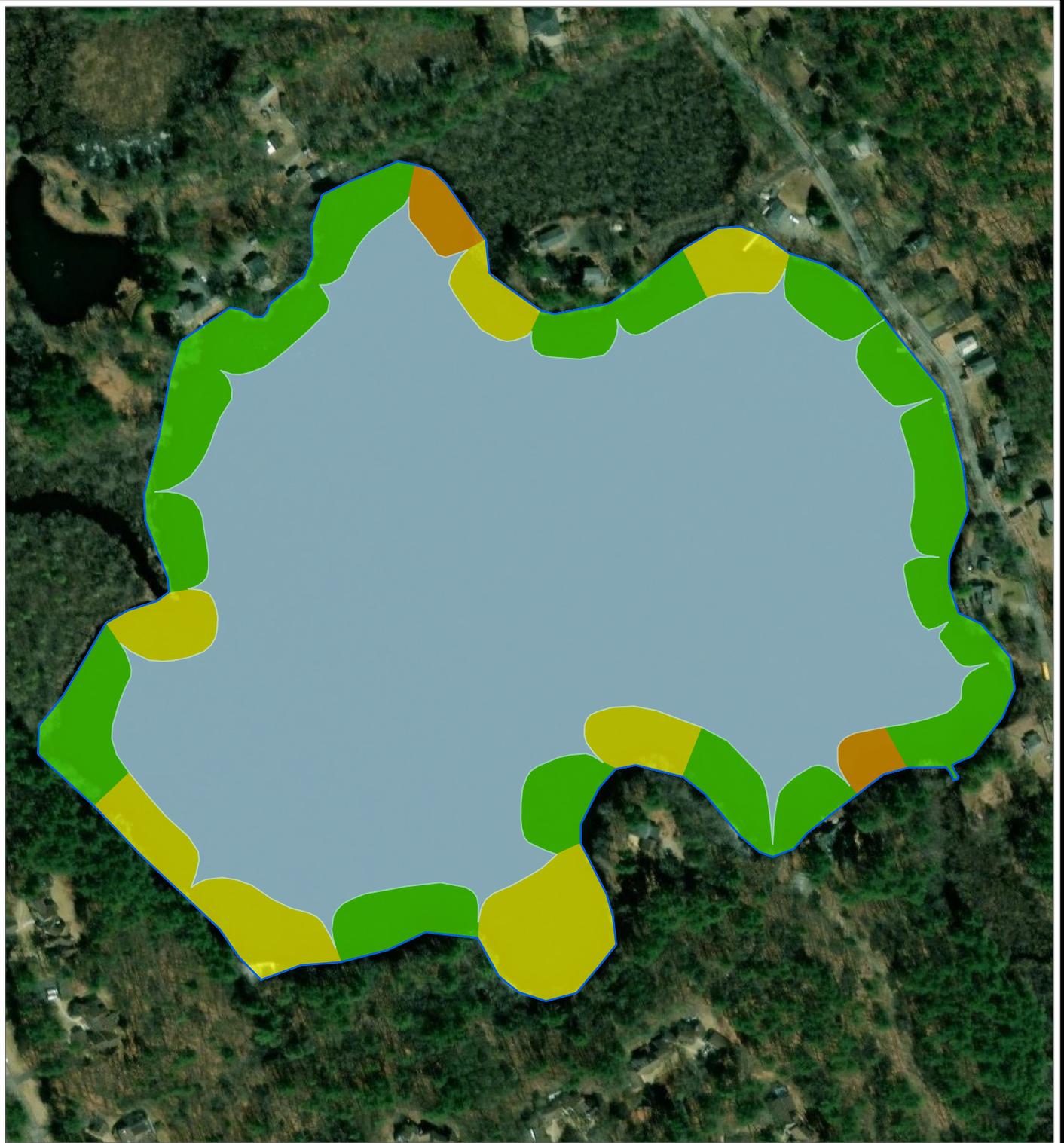
TITLE:
KEYES POND TOTAL PLANT COVERAGE
POST-TREATMENT / FALL SURVEY

DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 1
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	


 10 HEMINGWAY DRIVE
 2ND FLOOR
 EAST PROVIDENCE, RI 02915
 PHONE: 401.330.1236

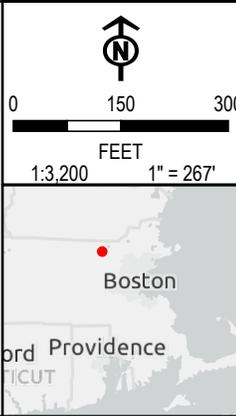
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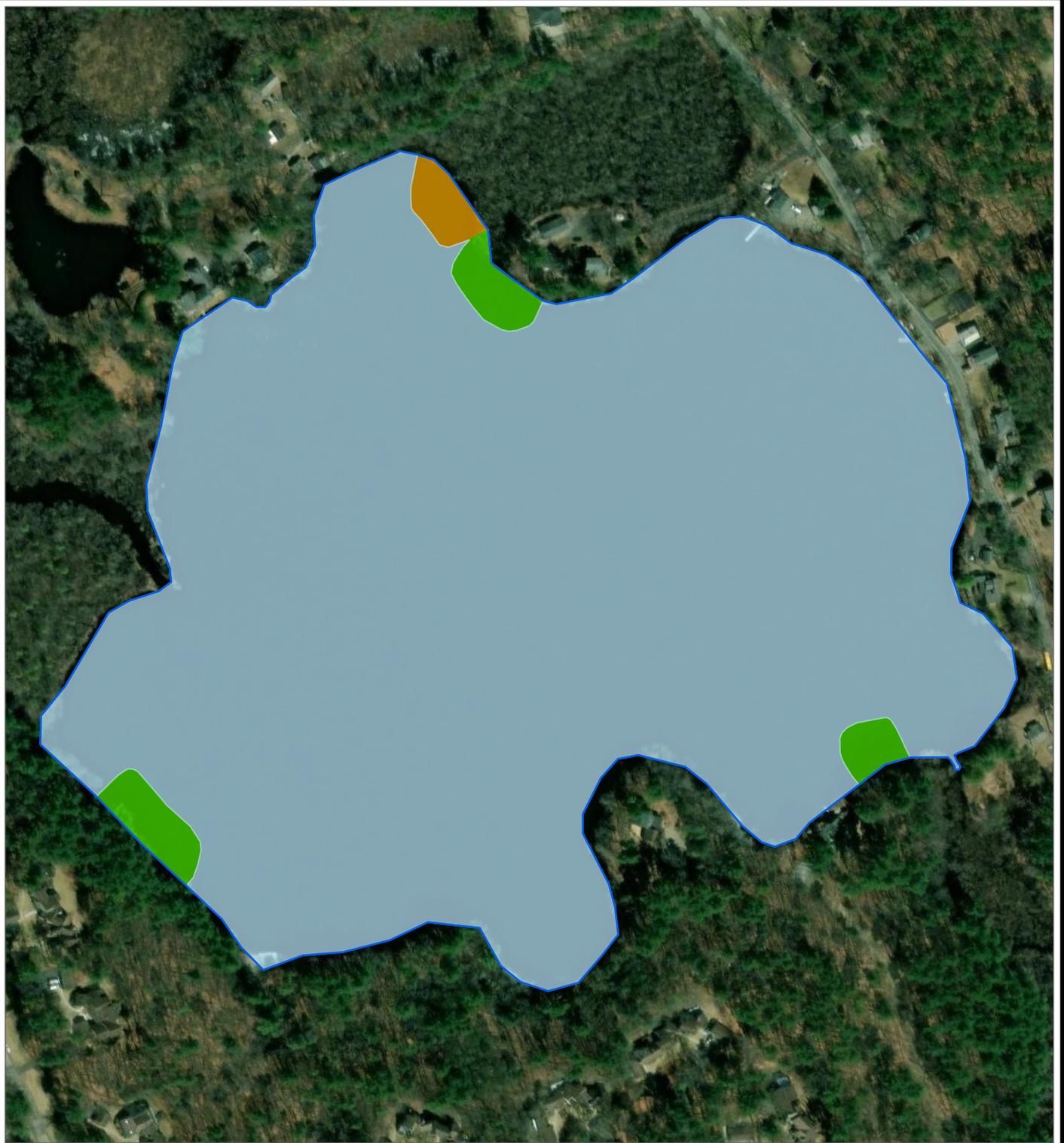
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	1% - 25% (7.57 ACRES)
	26% - 50% (3.94 ACRES)
	51% - 75% (0.55 ACRES)
	76% - 100% (0 ACRES)

BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 09/27/2023; MASSDEP, HYDROGRAPHY, 2019



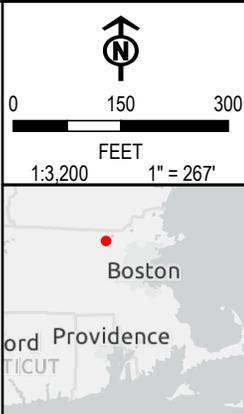
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KEYES POND WESTFORD, MA	
TITLE: KEYES POND TOTAL PLANT BIOVOLUME POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 2
APPROVED BY: J. TREACY	
DATE: OCTOBER 2023	
	
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE:	560206_WESTFORD_KEYES_2023

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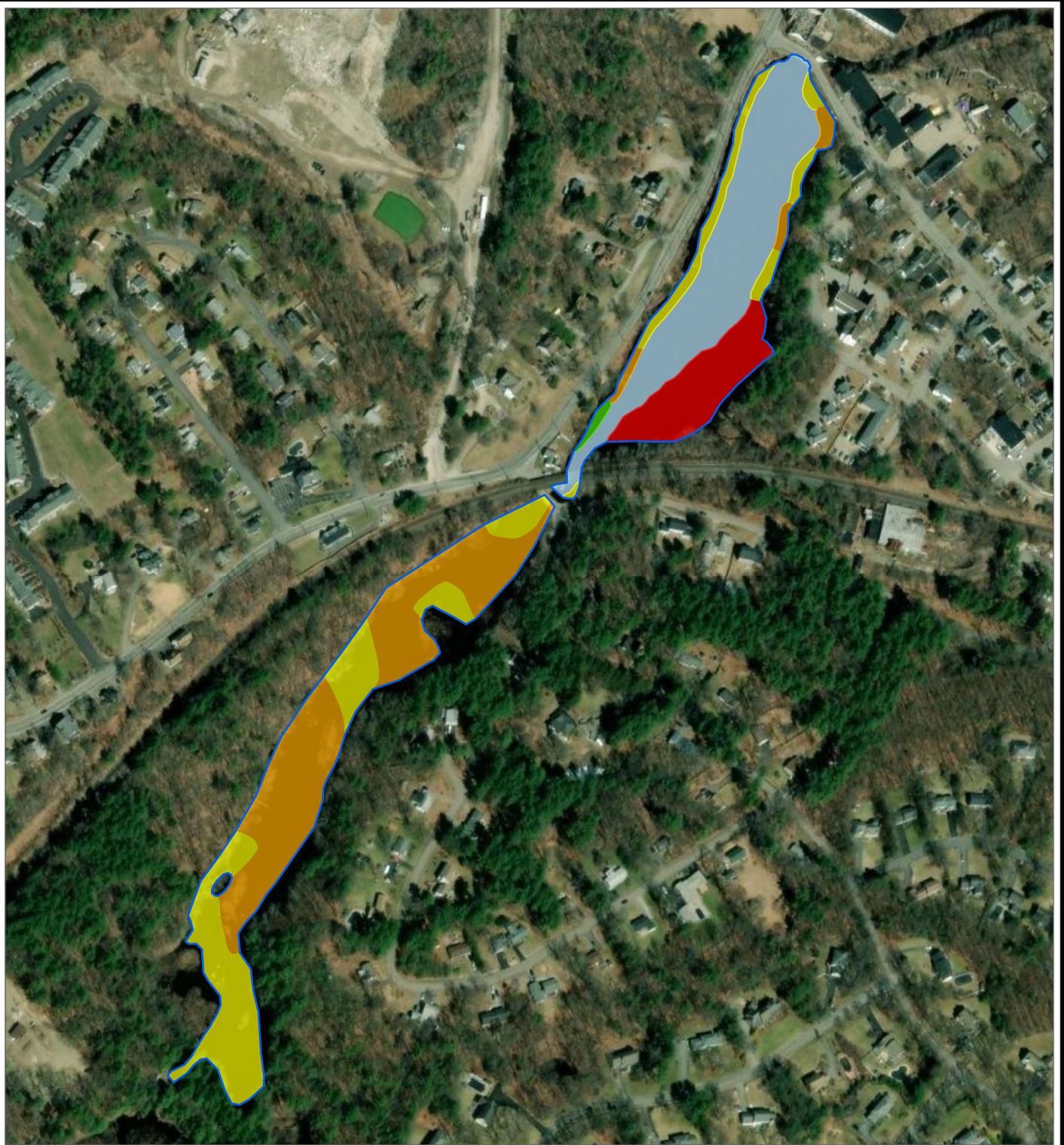
VARIABLE-LEAF MILFOIL COVERAGE	
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	26% - 50% (0 ACRES)
	51% - 75% (0.32 ACRES)
	76% - 100% (0 ACRES)

BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 09/27/2023; MASSDEP, HYDROGRAPHY, 2019



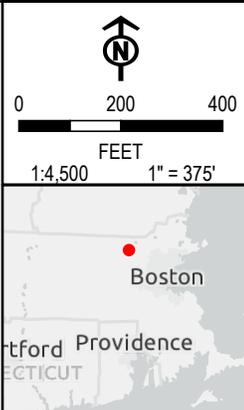
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KEYES POND WESTFORD, MA	
TITLE: KEYES POND VARIABLE-LEAF MILFOIL COVERAGE POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 3
APPROVED BY: J. TREACY	
DATE: OCTOBER 2023	
	
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE:	560206.WESTFORD_KEYES_2023

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TOTAL PLANT BIOVOLUME

	0% (3.51 ACRES)
	1% - 25% (0.07 ACRES)
	26% - 50% (3.22 ACRES)
	51% - 75% (3.95 ACRES)
	76% - 100% (1.35 ACRES)



PROJECT: SOLITUDE LAKE MANAGEMENT LLC	
OLD MILL GRANITEVILLE POND WESTFORD, MA	
TITLE: OLD MILL GRANITEVILLE POND TOTAL PLANT BIOVOLUME POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 5
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE:	560206_WESTFORD_OMG_2023

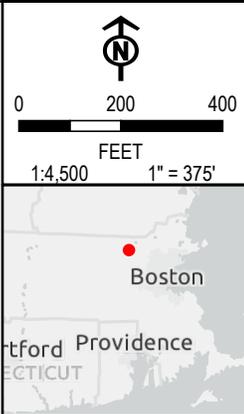
BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 10/2/2023; MASSDEP,
 HYDROGRAPHY, 2019

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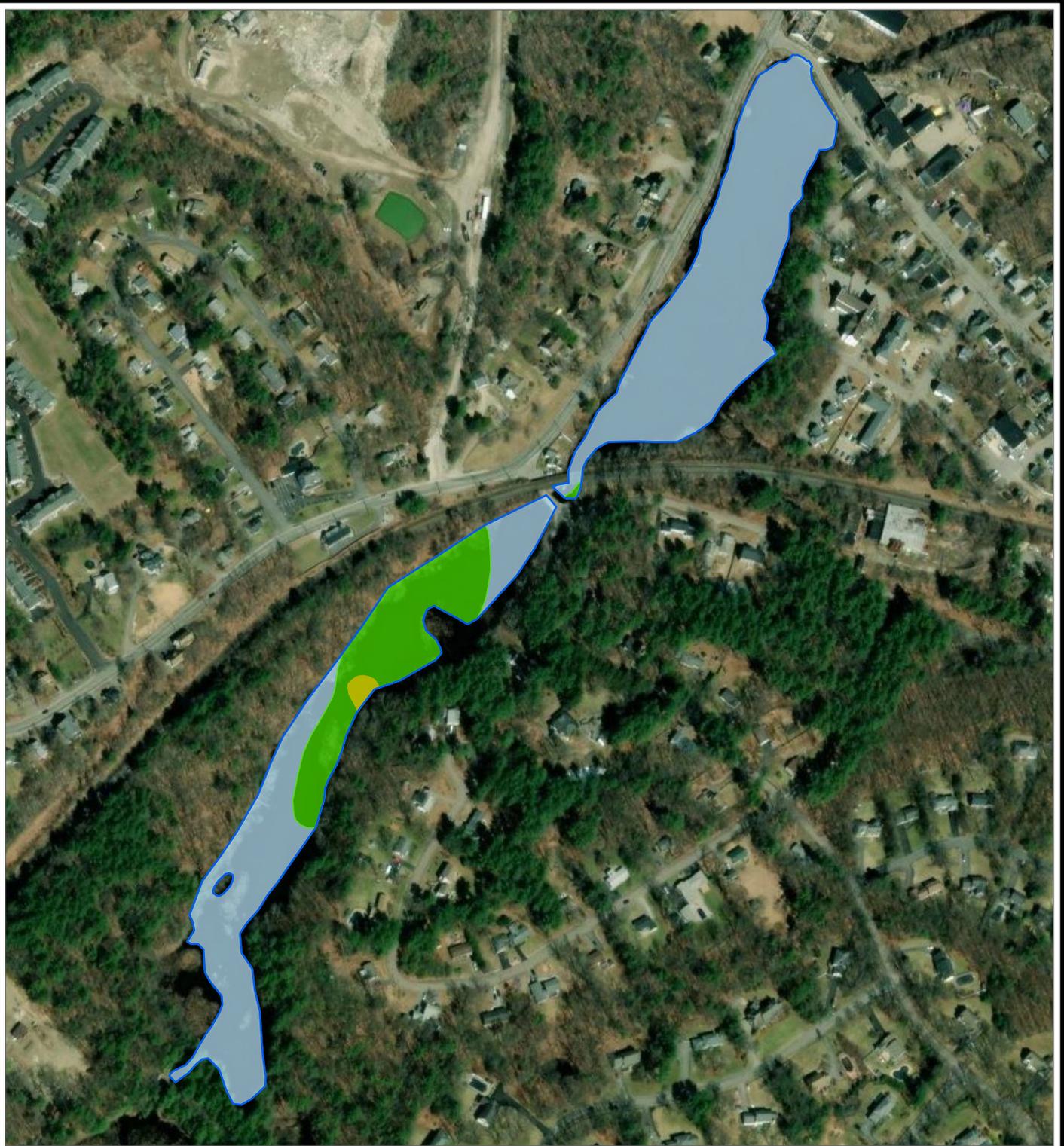
FANWORT COVERAGE	
	0% (3.51 ACRES)
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	26% - 50% (1.95 ACRES)
	51% - 75% (4.64 ACRES)
	76% - 100% (1.32 ACRES)

BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 10/2/2023; MASSDEP, HYDROGRAPHY, 2019



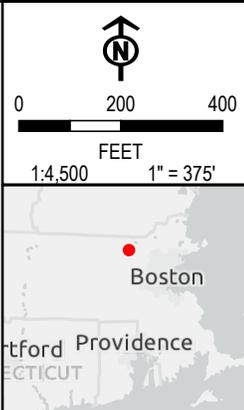
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TITLE: OLD MILL GRANITEVILLE POND	
FANWORT COVERAGE	
POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 6
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	
	
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE:	560206_WESTFORD_OMG_2023

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EURASIAN MILFOIL COVERAGE

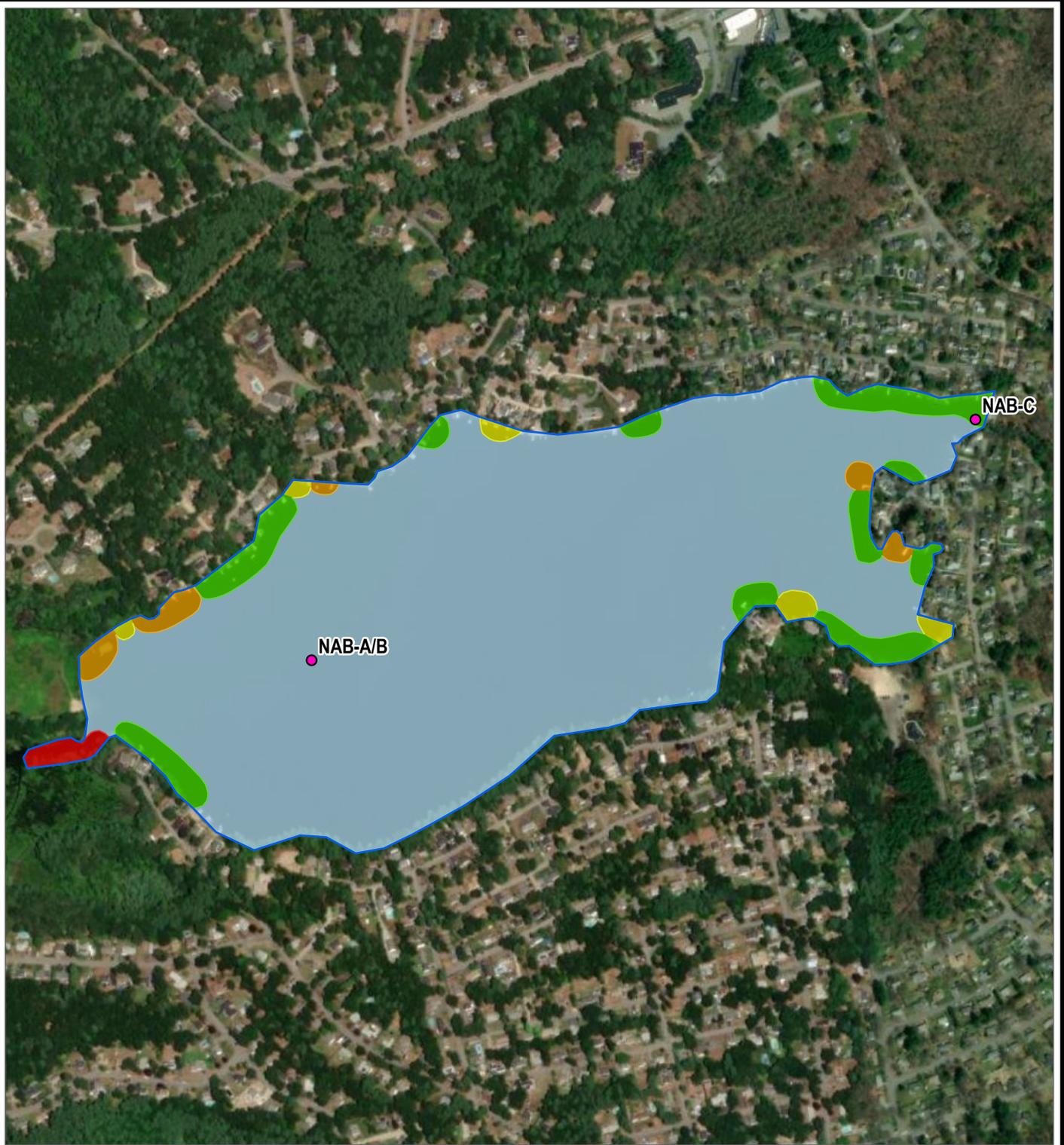
	0% (9.54 ACRES)
	1% - 25% (2.45 ACRES)
	26% - 50% (0.11 ACRES)
	51% - 75% (0 ACRES)
	76% - 100% (0 ACRES)



PROJECT: SOLITUDE LAKE MANAGEMENT LLC	
OLD MILL GRANITEVILLE POND WESTFORD, MA	
TITLE: OLD MILL GRANITEVILLE POND EURASIAN MILFOIL COVERAGE POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 7
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	
	
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE:	560206_WESTFORD_OMG_2023

BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 10/2/2023; MASSDEP,
 HYDROGRAPHY, 2019

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● WATER QUALITY LOCATIONS
TOTAL PLANT COVERAGE
 0% (112.36 ACRES)
 1% - 25% (9.55 ACRES)
 26% - 50% (1.48 ACRES)
 51% - 75% (2.28 ACRES)
 76% - 100% (0.90 ACRES)

BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 09/28/2023; MASSDEP, HYDROGRAPHY, 2019

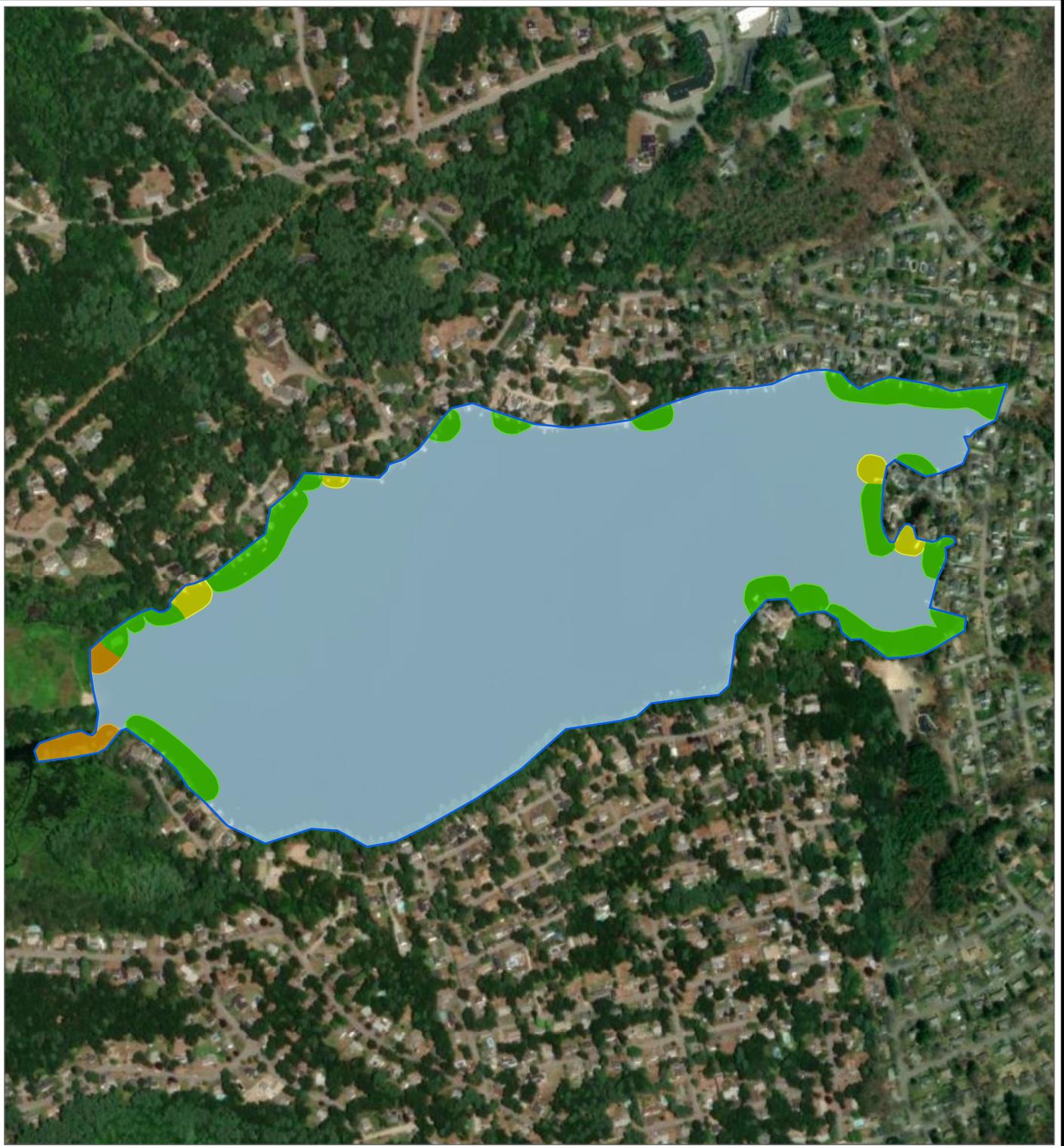
0 250 500
 FEET
 1:8,200 1" = 683'

Boston

Westford Providence
CONNECTICUT

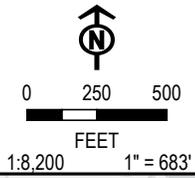
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TITLE: NABNASSET POND TOTAL PLANT COVERAGE POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN CHECKED BY: J. TREACY APPROVED BY: J. TREACY DATE: NOVEMBER 2023	PROJ. NO.: 560206.0000.0000 <div style="text-align: center; font-weight: bold; font-size: 1.2em;">FIGURE 9</div>
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE: 560206_WESTFORD_NABNASSET_2023	

COORDINATE SYSTEM: NAD83 2011 MASSACHUSETTS MAINLAND FTUS; MAP ROTATION: 0
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TOTAL PLANT BIOVOLUME

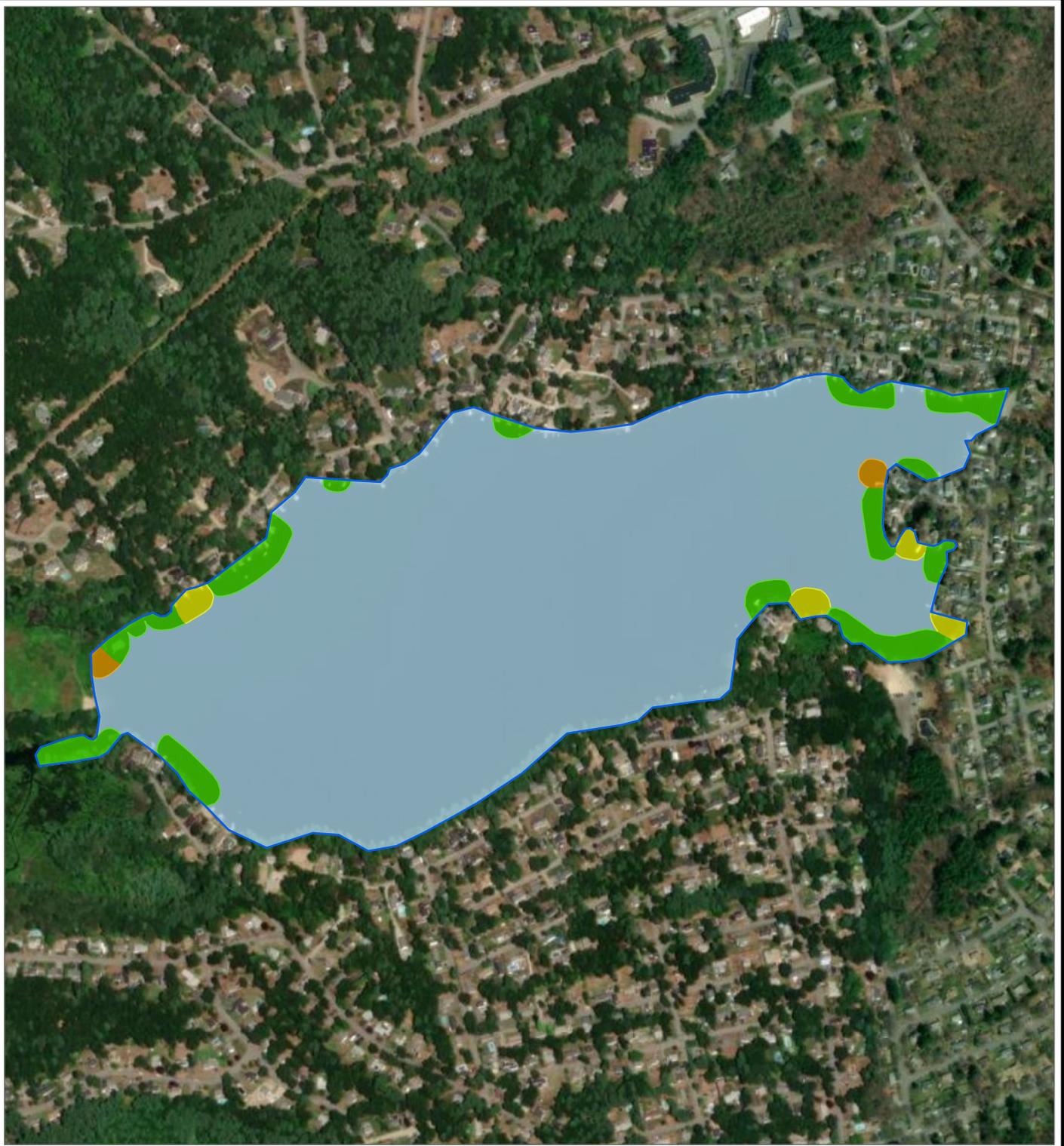
- 0% (112.36 ACRES)
- 1% - 25% (11.63 ACRES)
- 26% - 50% (1.34 ACRES)
- 51% - 75% (1.25 ACRES)
- 76% - 100% (0 ACRES)



BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 09/28/2023; MASSDEP,
 HYDROGRAPHY, 2019

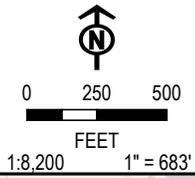
PROJECT: SOLITUDE LAKE MANAGEMENT LLC	
NABNASSET POND WESTFORD, MA	
TITLE:	
NABNASSET POND TOTAL PLANT BIOVOLUME POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 10
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE:	560206_WESTFORD_NABNASSET_2023

COORDINATE SYSTEM: NAD83 2011 MASSACHUSETTS MAINLAND FTUS; MAP ROTATION: 0
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WATER CELERY COVERAGE

- 0% (114.49 ACRES)
- 1% - 25% (9.75 ACRES)
- 26% - 50% (1.67 ACRES)
- 51% - 75% (0.67 ACRES)
- 76% - 100% (0 ACRES)



PROJECT: SOLITUDE LAKE MANAGEMENT LLC	
NABNASSET POND WESTFORD, MA	
TITLE:	
NABNASSET POND WATER CELERY COVERAGE POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 11
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE:	560206_WESTFORD_NABNASSET_2023

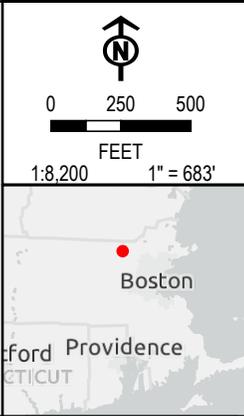
BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 09/28/2023; MASSDEP,
 HYDROGRAPHY, 2019

COORDINATE SYSTEM: NAD83 2011 MASSACHUSETTS MAINLAND FTUS; MAP ROTATION: 0
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VARIABLE-LEAF MILFOIL COVERAGE	
	0% (125.65 ACRES)
	1% - 25% (0.90 ACRES)
	26% - 50% (0 ACRES)
	51% - 75% (0 ACRES)
	76% - 100% (0 ACRES)

BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 09/28/2023; MASSDEP, HYDROGRAPHY, 2019



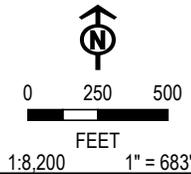
PROJECT: SOLITUDE LAKE MANAGEMENT LLC	
NABNASSET POND WESTFORD, MA	
TITLE: NABNASSET POND VARIABLE-LEAF MILFOIL COVERAGE, POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 12
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	
	
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE:	560206_WESTFORD_NABNASSET_2023

COORDINATE SYSTEM: NAD83 2011 MASSACHUSETTS MAINLAND FTUS; MAP ROTATION: 0
 -- SAVED BY: JBERThERMAN ON 11/10/2023, 1:35:33 PM; FILE PATH: T:\PROJECTS\WESTFORD\PONDS\560206_2023\2-APPROX\NABNASSET_2023\560206_WESTFORD_NABNASSET_2023.APRX; LAYOUT NAME: NABNASSET BRITTLE NAIAD



BRITTLE NAIAD COVERAGE

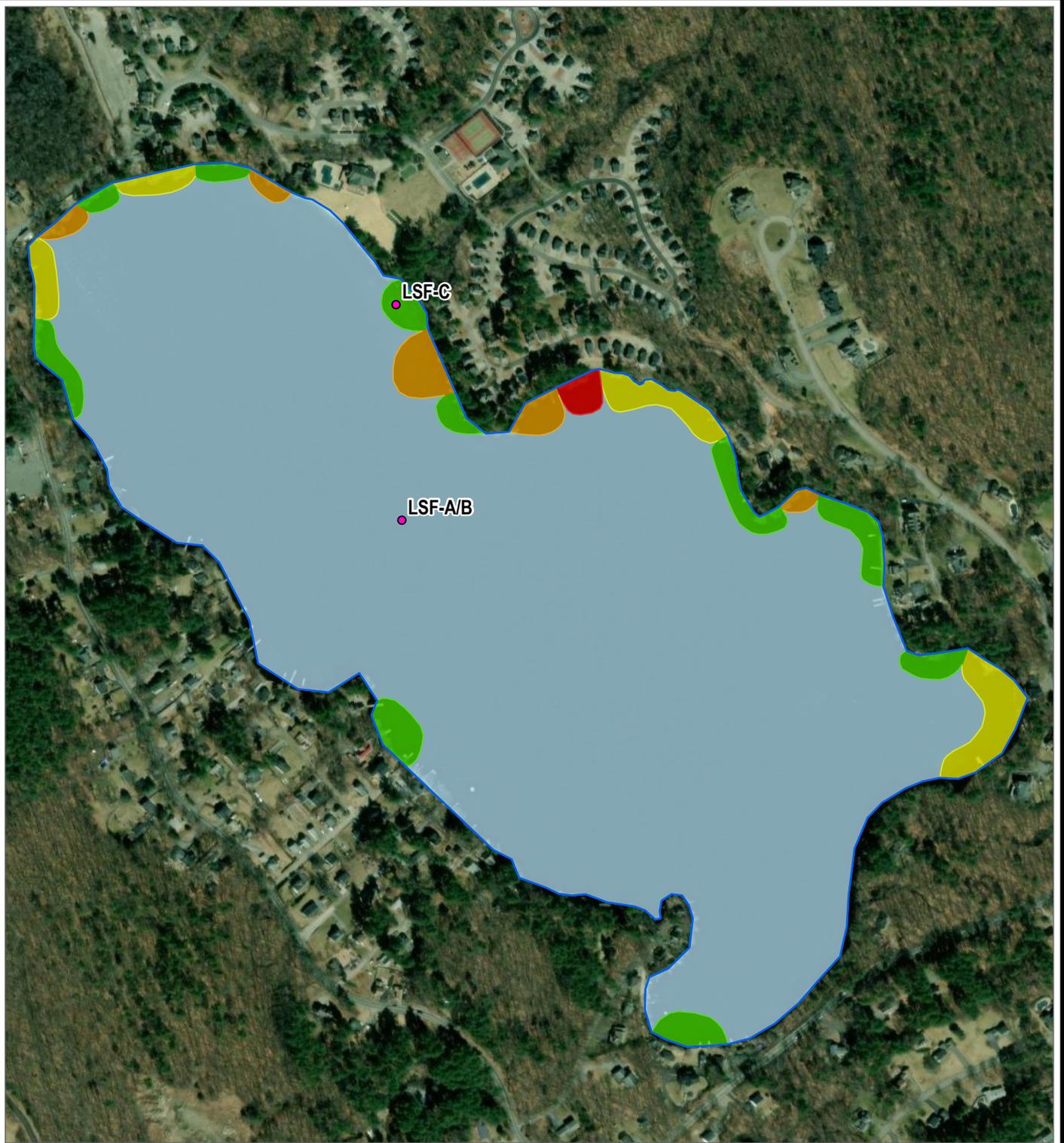
- 0% (123.57 ACRES)
- 1% - 25% (1.63 ACRES)
- 26% - 50% (1.20 ACRES)
- 51% - 75% (0.16 ACRES)
- 76% - 100% (0 ACRES)



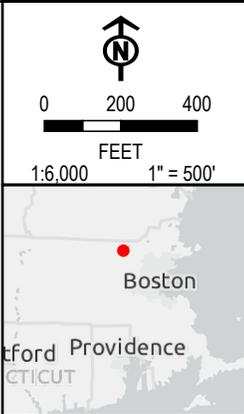
PROJECT: SOLITUDE LAKE MANAGEMENT LLC	
NABNASSET POND WESTFORD, MA	
TITLE:	
NABNASSET POND BRITTLE NAIAD COVERAGE POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 13
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE:	560206_WESTFORD_NABNASSET_2023

BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 09/28/2023; MASSDEP,
 HYDROGRAPHY, 2019

COORDINATE SYSTEM: NAD83 2011 MASSACHUSETTS MAINLAND FTUS; MAP ROTATION: 0
 - SAVED BY: J. BERTHERMAN ON 11/13/2023, 11:00:12 AM - FILE PATH: T:\1-PROJECTS\WESTFORD_PONDS\560206_WESTFORD_LSF_2023\APRX - LAYOUT NAME: TOTAL COVER

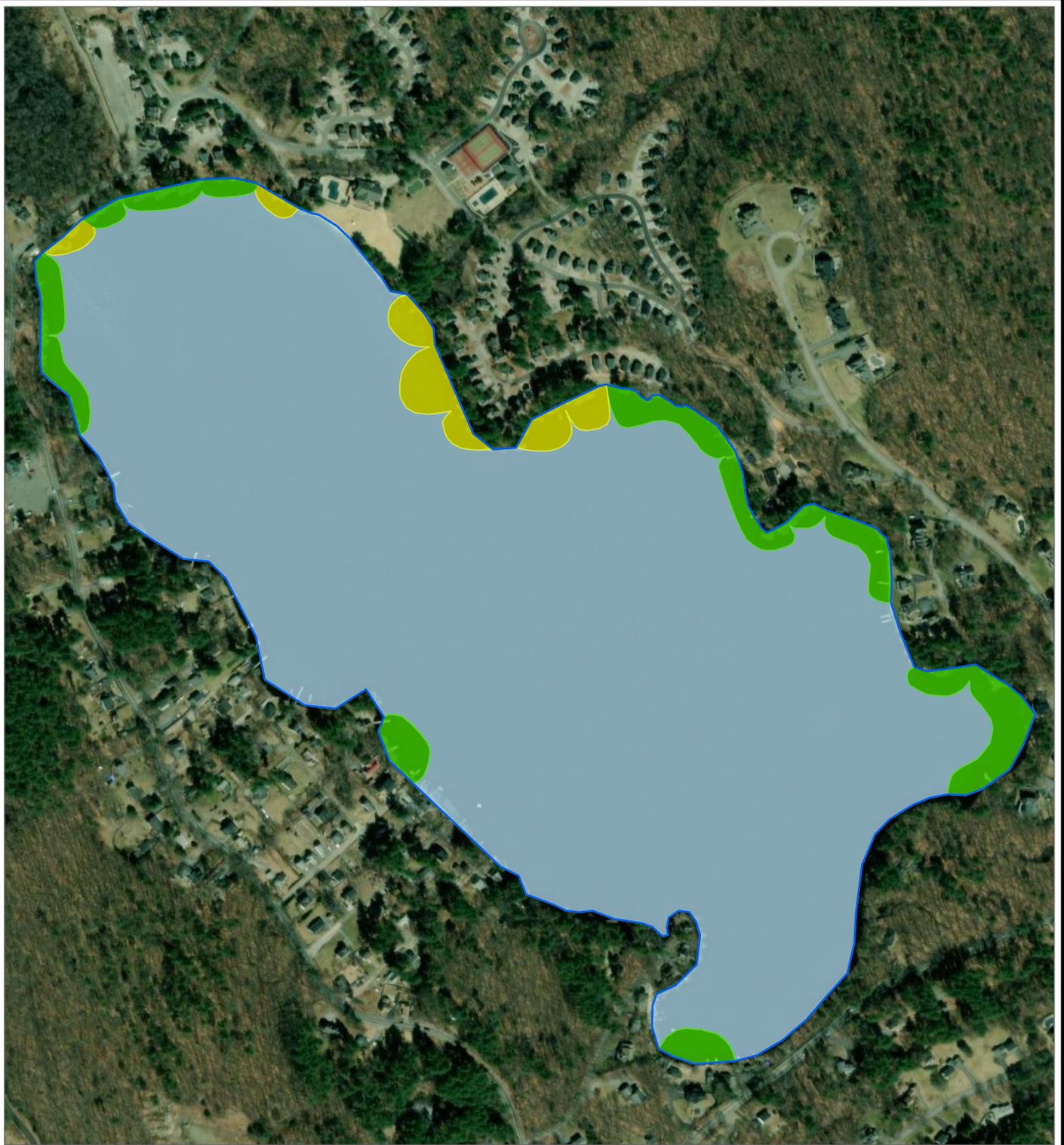


●	WATER QUALITY LOCATIONS
TOTAL PLANT COVERAGE	
■	0% (99.29 ACRES)
■	1% - 25% (4.69 ACRES)
■	26% - 50% (3.26 ACRES)
■	51% - 75% (1.88 ACRES)
■	76% - 100% (0.41 ACRES)
BASE MAP: USGS COLOR ORTHO IMAGERY DATA SOURCES: TRC, GPS DATA, 10/02/2023; MASSDEP, HYDROGRAPHY, 2019	



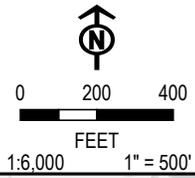
PROJECT: SOLITUDE LAKE MANAGEMENT LLC	
LONG-SOUGHT-FOR POND WESTFORD, MA	
TITLE: LONG-SOUGHT-FOR POND TOTAL PLANT COVERAGE POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 14
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	
	
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE:	560206_WESTFORD_LSF_2023

COORDINATE SYSTEM: NAD 1983 STATEPLANE MASSACHUSETTS MAINLAND FIPS 2001 FEET, MAP ROTATION: 0
 -- SAVED BY: J. BERTHERMAN ON 11/13/2023, 11:07:28 AM - FILE PATH: T:\1-PROJECTS\WESTFORD\PONDS\560206_WESTFORD_LSF_2023\2-APRXL\SF_2023\560206_WESTFORD_LSF_2023\560206_WESTFORD_LSF_2023.APRX - LAYOUT NAME: BIOVOLUME



TOTAL PLANT BIOVOLUME

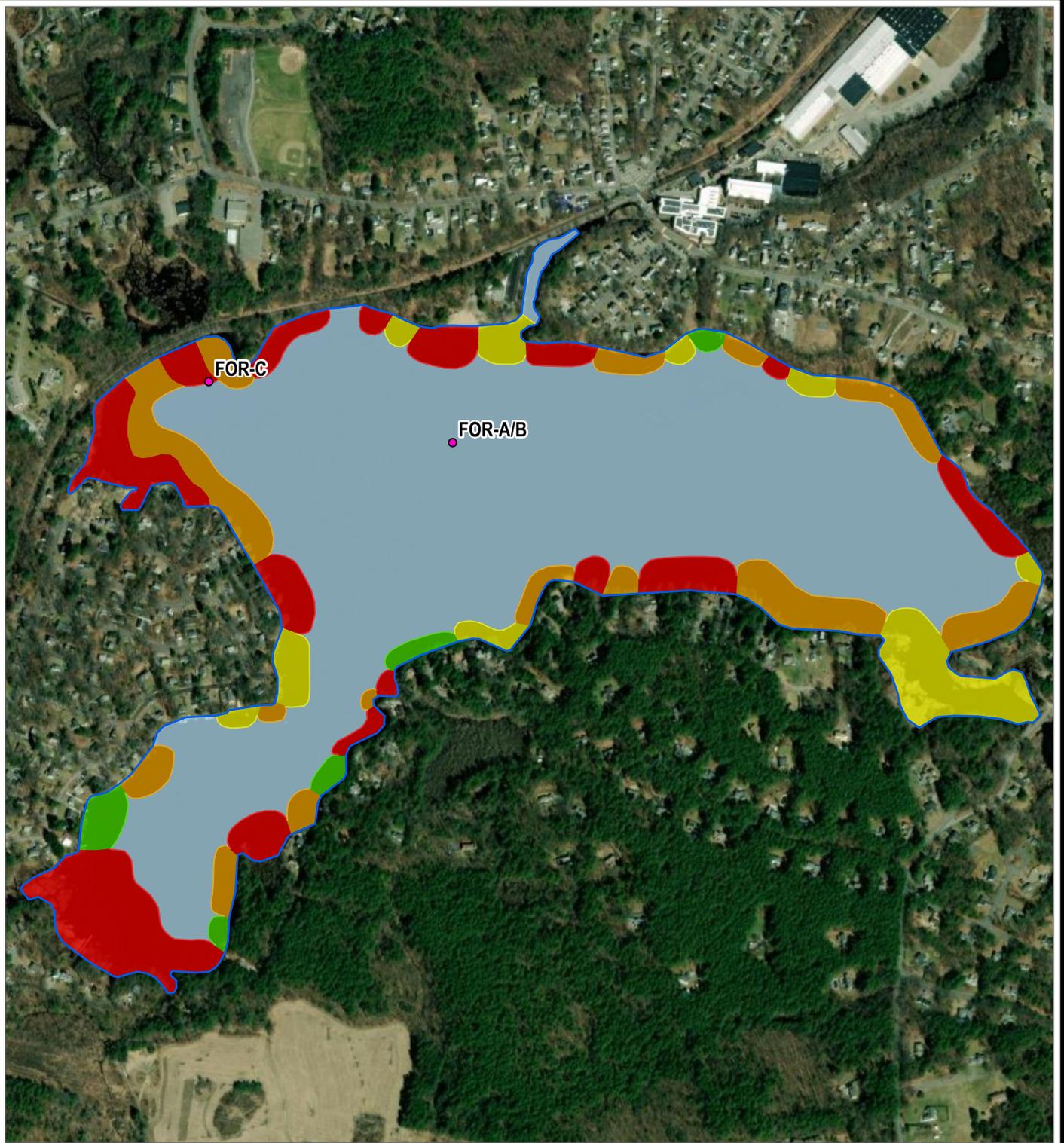
- 0% (99.29 ACRES)
- 1% - 25% (7.39 ACRES)
- 26% - 50% (2.85 ACRES)
- 51% - 75% (0 ACRES)
- 76% - 100% (0 ACRES)



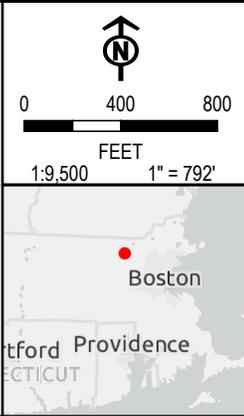
PROJECT: SOLITUDE LAKE MANAGEMENT LLC	
LONG-SOUGHT-FOR POND WESTFORD, MA	
TITLE: LONG-SOUGHT-FOR POND TOTAL PLANT BIOVOLUME POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 15
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE:	560206_WESTFORD_LSF_2023

BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 10/02/2023; MASSDEP,
 HYDROGRAPHY, 2019

COORDINATE SYSTEM: NAD 1983 STATEPLANE MASSACHUSETTS MAINLAND FIPS 2001; MAP ROTATION: 0
 -- SAVED BY: J.BERTHERMAN ON 11/19/2023, 14:35:15 PM; FILE PATH: T:\PROJECTS\WESTFORDPONDS\560206_2023\2-APRX\FORGE_2023.APRX; LAYOUT NAME: TOTAL COVERAGE

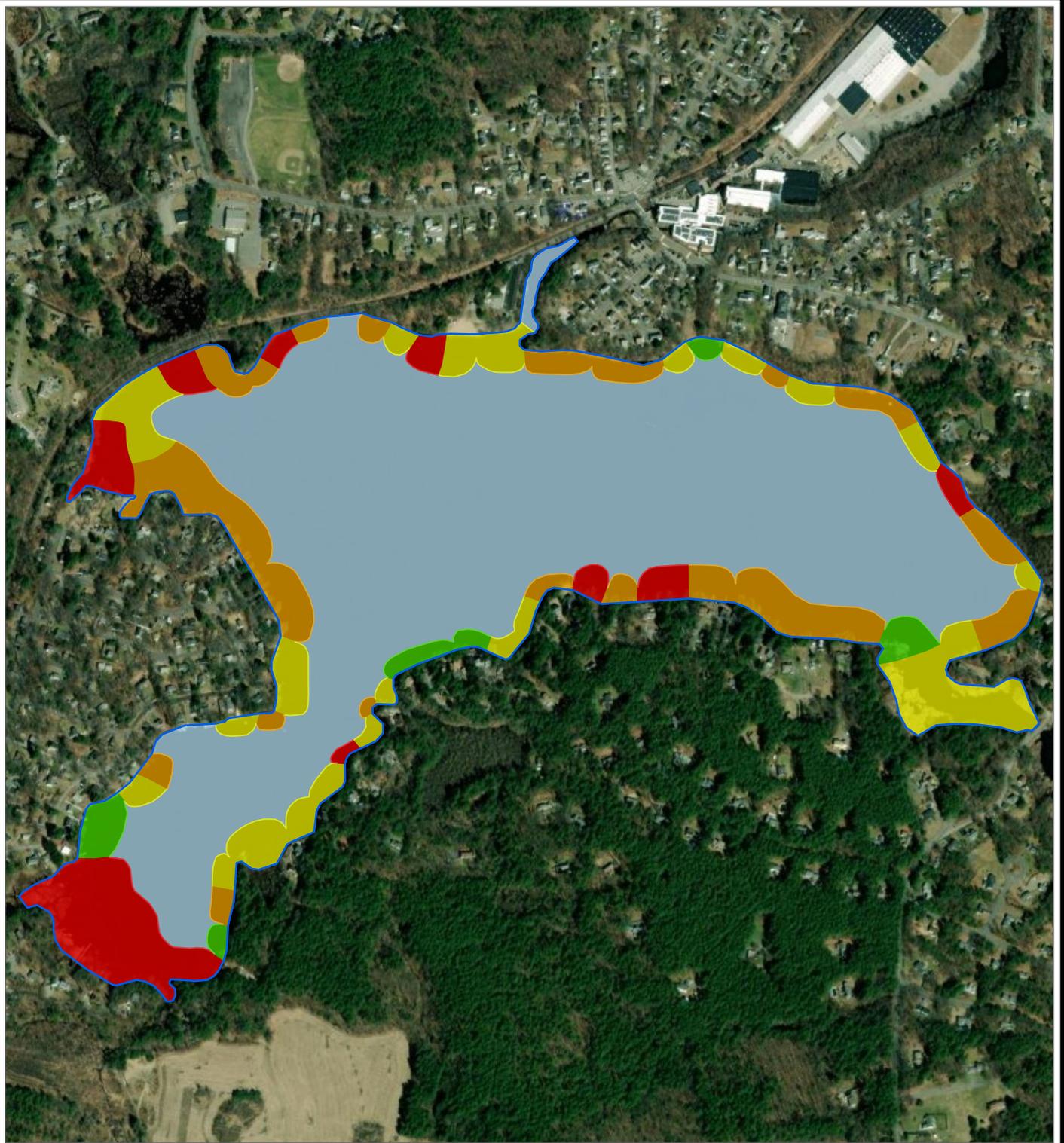


●	WATER QUALITY LOCATIONS
TOTAL PLANT COVERAGE	
	0% (138.05 ACRES)
	1% - 25% (3.93 ACRES)
	26% - 50% (13.10 ACRES)
	51% - 75% (21.01 ACRES)
	76% - 100% (29.48 ACRES)
BASE MAP: USGS COLOR ORTHO IMAGERY DATA SOURCES: TRC, GPS DATA, 09/28/2023; MASSDEP, HYDROGRAPHY, 2019	



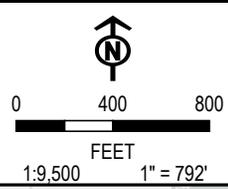
PROJECT: SOLITUDE LAKE MANAGEMENT LLC	
FORGE POND WESTFORD, MA	
TITLE: FORGE POND TOTAL PLANT COVERAGE POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 20
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE:	560206_WESTFORD_FORGE_2023

COORDINATE SYSTEM: NAD 1983 STATEPLANE MASSACHUSETTS MAINLAND FIPS 2001 FEET, MAP ROTATION: 0
 -- SAVED BY: J. BERTHERMAN ON 11/19/2023, 1:44:15 PM - FILE PATH: T:\PROJECTS\WESTFORD\PROJECTS\2023\2-APRX\FORGE_2023\60206_WESTFORD_FORGE_2023.APRX - LAYOUT NAME: BIOVOLUME



TOTAL PLANT BIOVOLUME

	0% (138.05 ACRES)
	1% - 25% (4.99 ACRES)
	26% - 50% (22.29 ACRES)
	51% - 75% (23.23 ACRES)
	76% - 100% (17.01 ACRES)



PROJECT: **SOLITUDE LAKE MANAGEMENT LLC**
FORGE POND
WESTFORD, MA

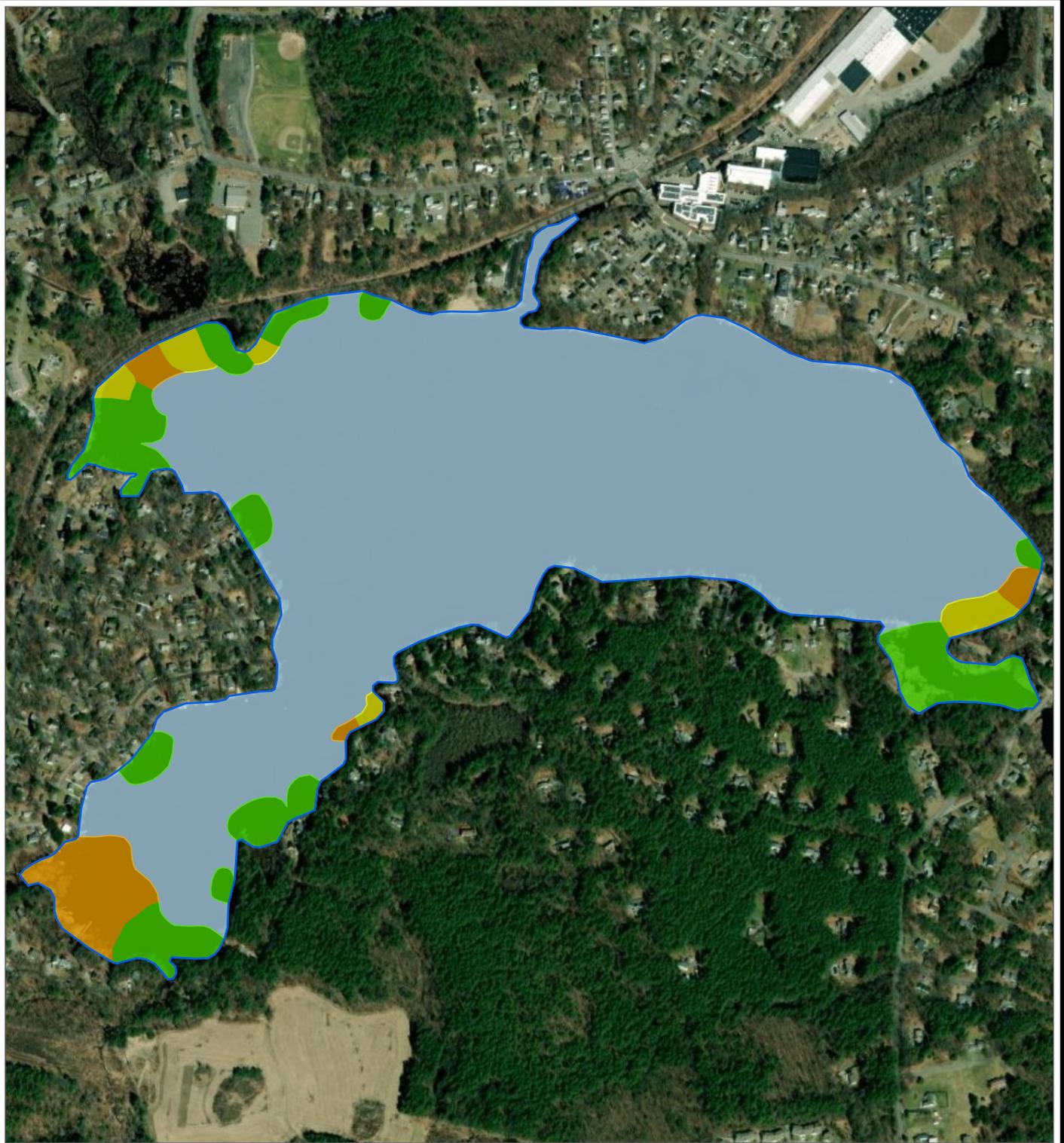
TITLE: **FORGE POND TOTAL PLANT BIOVOLUME**
POST-TREATMENT / FALL SURVEY

DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 21
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	

BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 09/28/2023; MASSDEP,
 HYDROGRAPHY, 2019

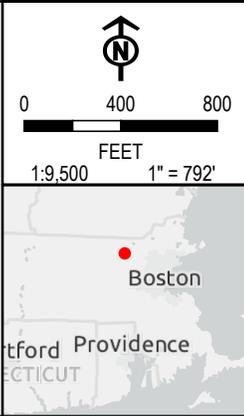
	10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236
	FILE: 560206_WESTFORD_FORGE_2023

COORDINATE SYSTEM: NAD 1983 STATEPLANE MASSACHUSETTS MAINLAND FIPS 2001; MAP ROTATION: 0
 -- SAVED BY: J. BERTHERMAN ON 11/13/2023, 14:46:00 PM - FILE PATH: T:\PROJECTS\WESTFORDPONDS\560206_2023\2-APRX\FORGE_2023\APRX_LAYOUT_NAME_FANWORT_COVERAGE



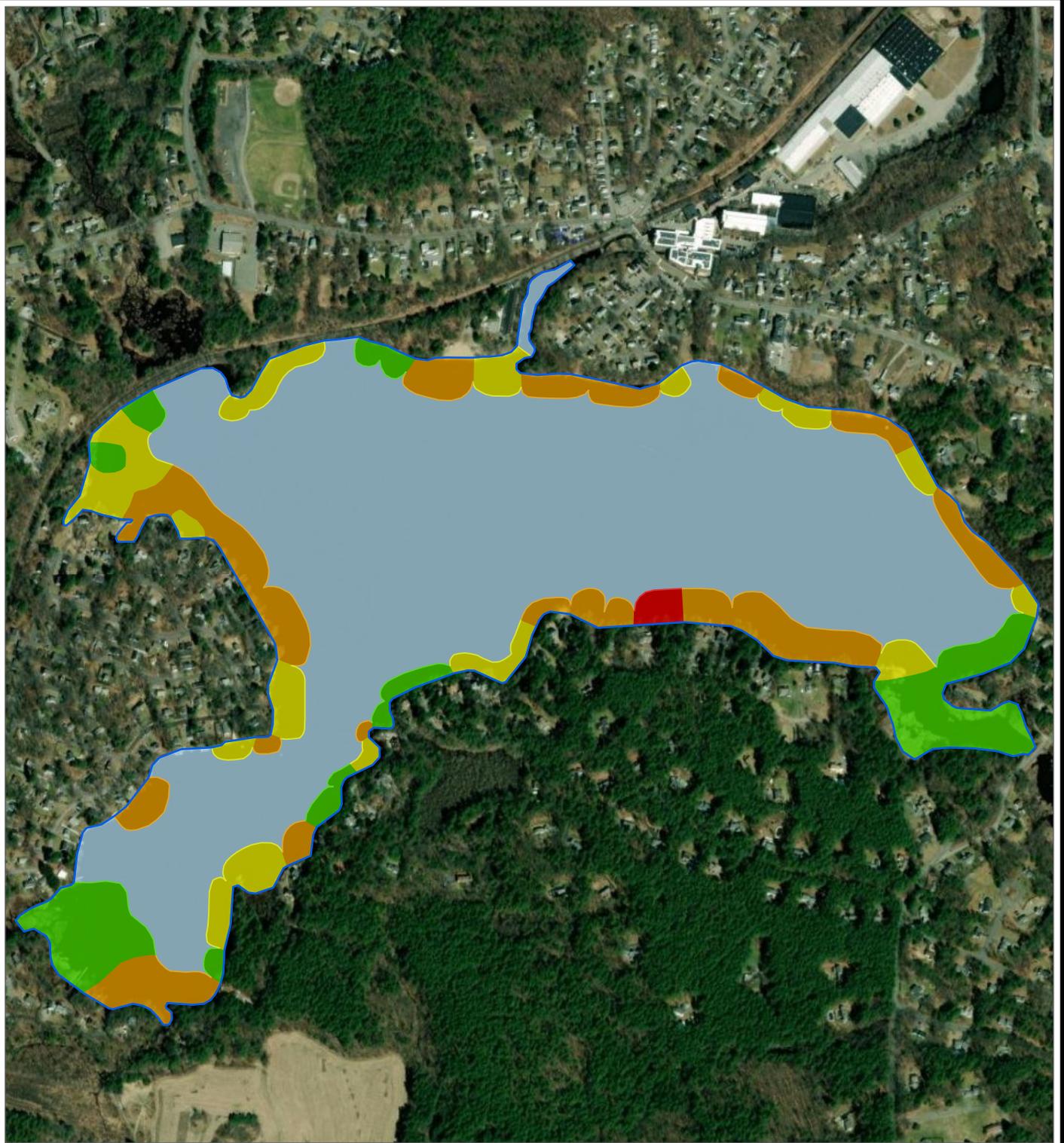
FANWORT COVERAGE	
	0% (172.04 ACRES)
	1% - 25% (21.08 ACRES)
	26% - 50% (3.98 ACRES)
	51% - 75% (8.47 ACRES)
	76% - 100% (0 ACRES)

BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 09/28/2023; MASSDEP, HYDROGRAPHY, 2019



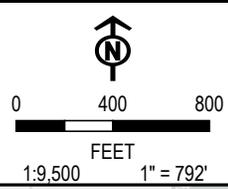
PROJECT: SOLITUDE LAKE MANAGEMENT LLC	
FORGE POND WESTFORD, MA	
TITLE: FORGE POND FANWORT COVERAGE POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 22
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	
	
FILE:	10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236 560206_WESTFORD_FORGE_2023

COORDINATE SYSTEM: NAD 1983 STATEPLANE MASSACHUSETTS MAINLAND FIPS 2001 FEET, MAP ROTATION: 0
 -- SAVED BY: J. BERTHERMAN ON 11/13/2023, 14:50:20 PM -- FILE PATH: T:\PROJECTS\WESTFORD\PROJECTS\2023\2-APPROX\FORGE_2023\2-APPROX\WESTFORD_FORGE_2023\APRX_LAYOUT_NAME: EURASIAN MILFOIL COVERAGE



EURASIAN MILFOIL COVERAGE

	0% (142.04 ACRES)
	1% - 25% (18.82 ACRES)
	26% - 50% (17.17 ACRES)
	51% - 75% (26.45 ACRES)
	76% - 100% (1.10 ACRES)



PROJECT: **SOLITUDE LAKE MANAGEMENT LLC**
FORGE POND
WESTFORD, MA

TITLE: **FORGE POND EURASIAN MILFOIL COVERAGE**
POST-TREATMENT / FALL SURVEY

DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 23
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	

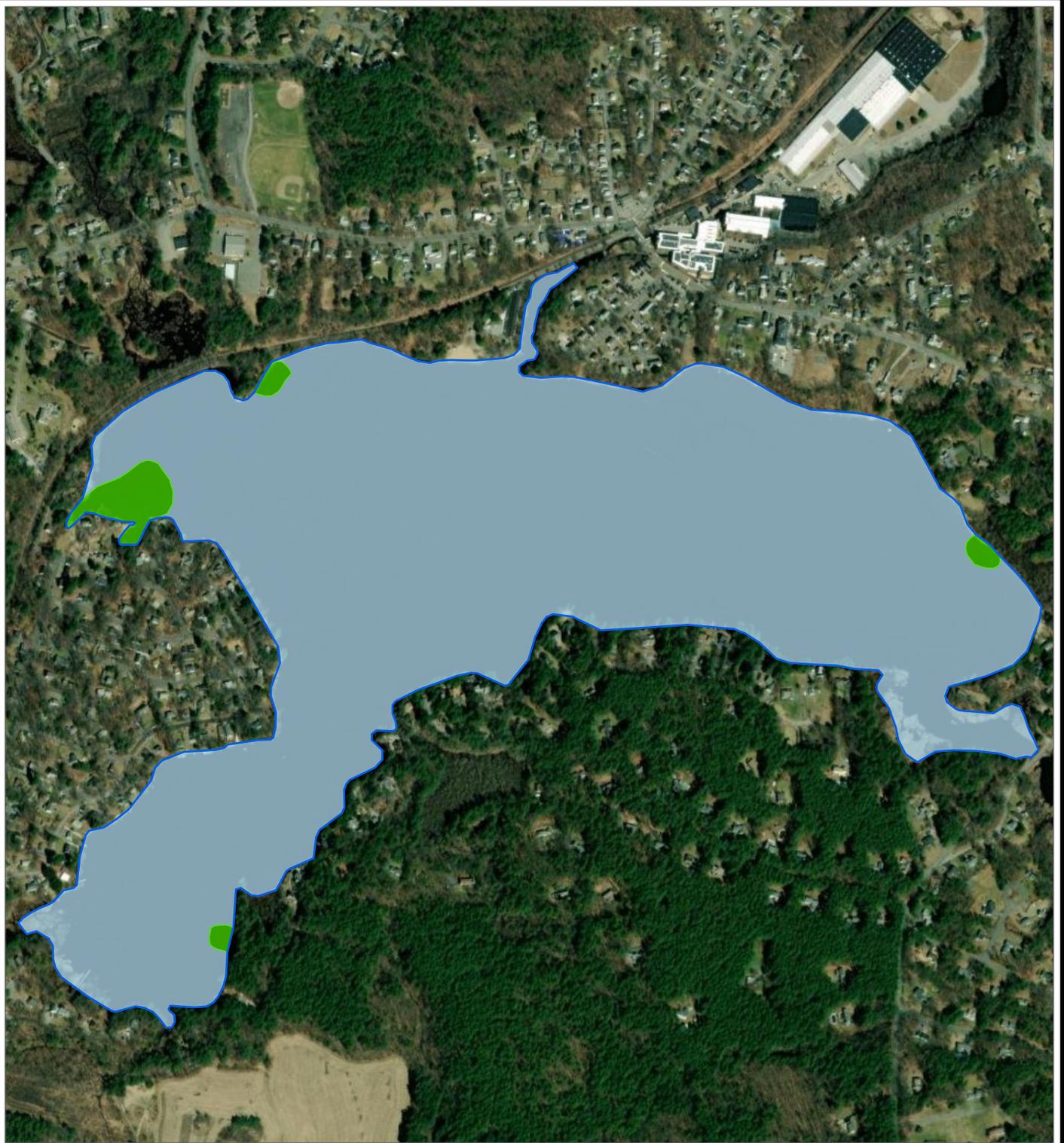
BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 09/28/2023; MASSDEP,
 HYDROGRAPHY, 2019



10 HEMINGWAY DRIVE
 2ND FLOOR
 EAST PROVIDENCE, RI 02915
 PHONE: 401.330.1236

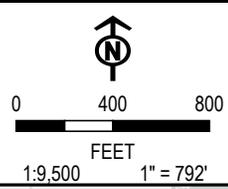
FILE: 560206_WESTFORD_FORGE_2023

COORDINATE SYSTEM: NAD 1983 STATEPLANE MASSACHUSETTS MAINLAND FIPS 2001 FEET, MAP ROTATION: 0
 -- SAVED BY: J. BERTHERMAN ON 11/13/2023, 14:59:03 PM - FILE PATH: T:\PROJECTS\WESTFORDPONDS\560206_2023\2-APRX\FORGE_2023\APRX_ LAYOUT NAME: VARIABLE-LEAF MILFOIL COVERAGE



VARIABLE-LEAF MILFOIL COVERAGE

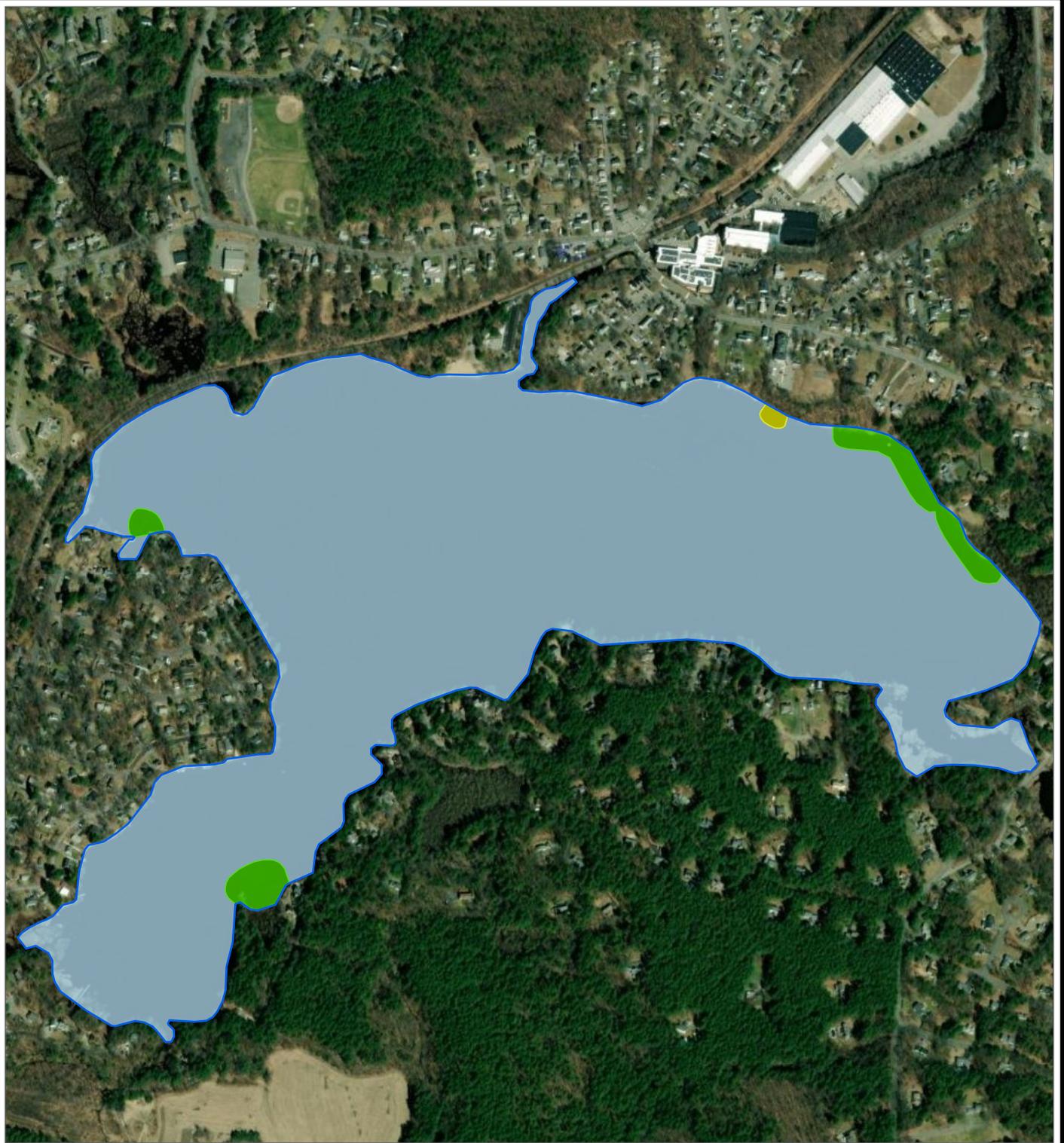
- 0% (201.05 ACRES)
- 1% - 25% (4.52 ACRES)
- 26% - 50% (0 ACRES)
- 51% - 75% (0 ACRES)
- 76% - 100% (0 ACRES)



PROJECT: SOLITUDE LAKE MANAGEMENT LLC	
FORGE POND WESTFORD, MA	
TITLE: FORGE POND VARIABLE-LEAF MILFOIL COVERAGE POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 24
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE:	560206_WESTFORD_FORGE_2023

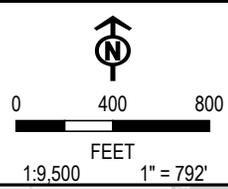
BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 09/28/2023; MASSDEP,
 HYDROGRAPHY, 2019

COORDINATE SYSTEM: NAD 1983 STATEPLANE MASSACHUSETTS MAINLAND FIPS 2001; MAP ROTATION: 0
 -- SAVED BY: J. BERTHERMAN ON 11/13/2023, 1:50:45 PM - FILE PATH: T:\PROJECTS\WESTFORDPONDS\560206_2023\2-APRX\FORGE_2023\560206_WESTFORD_FORGE_2023.APRX; LAYOUT NAME: BRITTLE NAIAD COVER



BRITTLE NAIAD COVERAGE

	0% (199.89 ACRES)
	1% - 25% (5.38 ACRES)
	26% - 50% (0.30 ACRES)
	51% - 75% (0 ACRES)
	76% - 100% (0 ACRES)



PROJECT: **SOLITUDE LAKE MANAGEMENT LLC**
FORGE POND
WESTFORD, MA

TITLE: **FORGE POND BRITTLE NAIAD COVERAGE**
POST-TREATMENT / FALL SURVEY

DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 25
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	

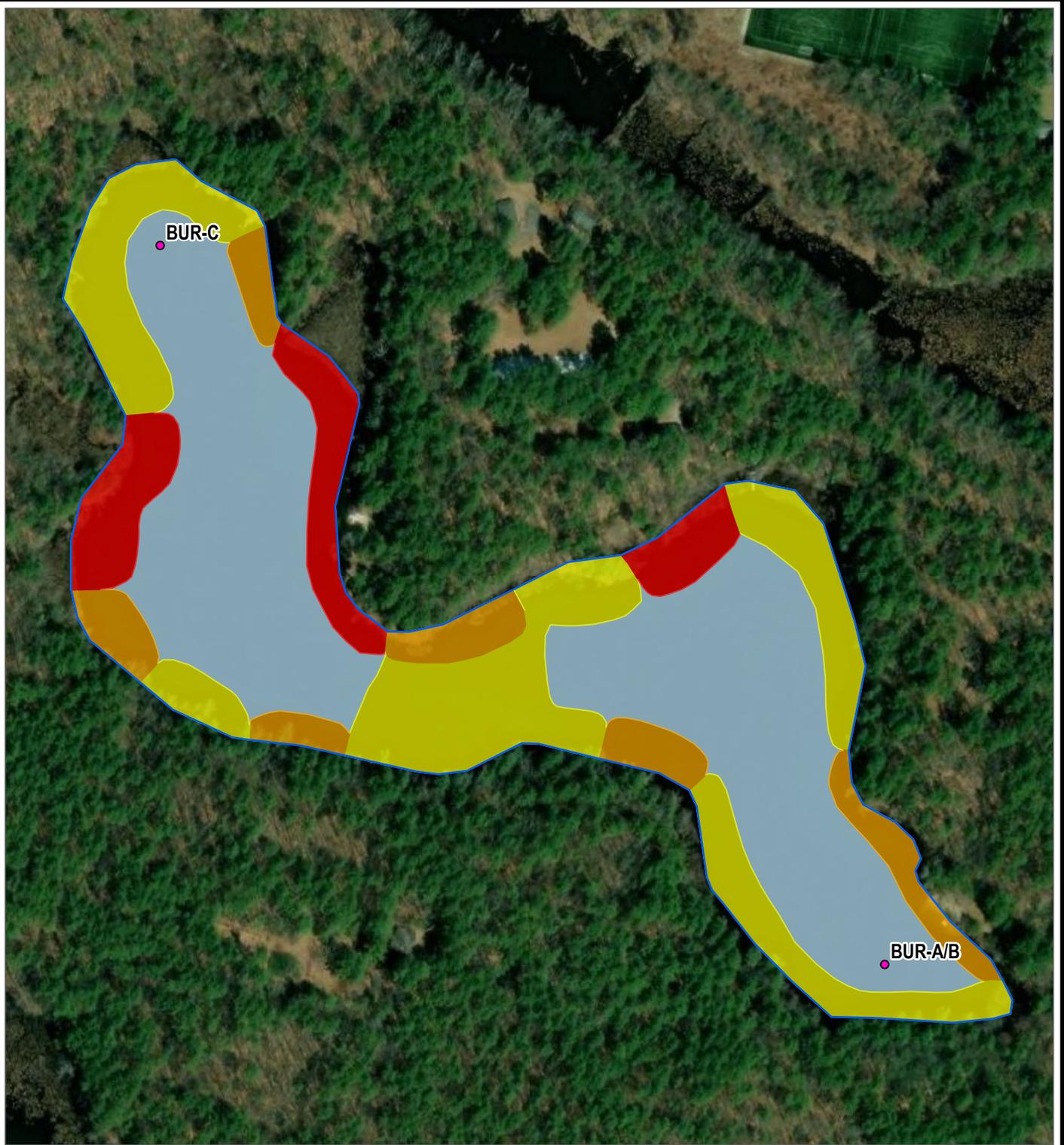
BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 09/28/2023; MASSDEP,
 HYDROGRAPHY, 2019



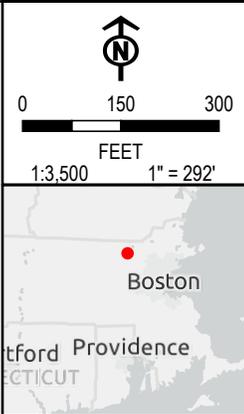
10 HEMINGWAY DRIVE
 2ND FLOOR
 EAST PROVIDENCE, RI 02915
 PHONE: 401.330.1236

FILE: 560206_WESTFORD_FORGE_2023

COORDINATE SYSTEM: NAD 1983 STATEPLANE MASSACHUSETTS MAINLAND FIPS 2001 FEET, MAP ROTATION: 0
 -- SAVED BY: J.BERTHERMAN ON 11/13/2023, 15:49:22 PM - FILE PATH: T:\PROJECTS\WESTFORDPOND\S1560206_2023\2-APRX\BURGESS_2023\560206_WESTFORD_BURGESS_2023.APPX - LAYOUT NAME: TOTAL COVERAGE

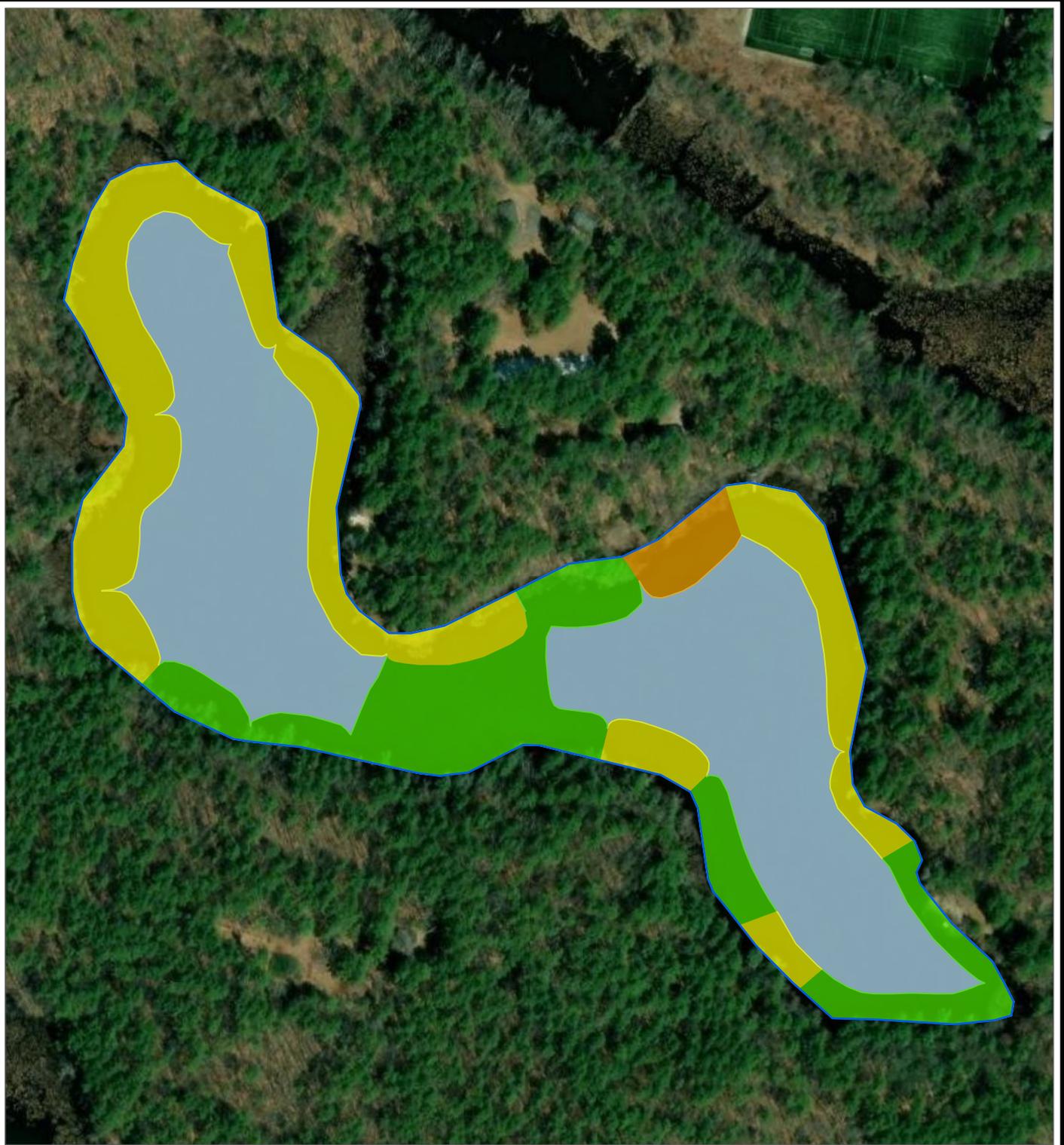


	WATER QUALITY LOCATIONS
TOTAL PLANT COVERAGE	
	0% (13.43 ACRES)
	1% - 25% (0 ACRES)
	26% - 50% (7.53 ACRES)
	51% - 75% (2.72 ACRES)
	76% - 100% (2.81 ACRES)
BASE MAP: USGS COLOR ORTHO IMAGERY DATA SOURCES: TRC, GPS DATA, 09/27/2023; MASSDEP, HYDROGRAPHY, 2019	



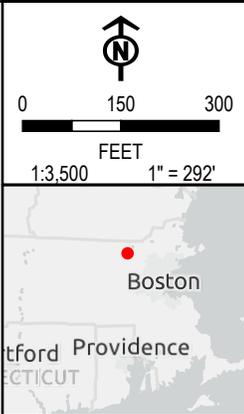
PROJECT: SOLITUDE LAKE MANAGEMENT LLC	
BURGES POND WESTFORD, MA	
TITLE: BURGES POND TOTAL PLANT COVERAGE POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 26
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE:	560206_WESTFORD_BURGESS_2023

COORDINATE SYSTEM: NAD 1983 STATEPLANE MASSACHUSETTS MAINLAND FIPS 2001 FEET, MAP ROTATION: 0
 -- SAVED BY: J. BERTHERMAN ON 11/13/2023, 1:59:59 PM - FILE PATH: T:\PROJECTS\WESTFORD\560206_WESTFORD_BURGESS_2023\2-APPROX\BURGESS_2023\560206_WESTFORD_BURGESS_2023.APPX - LAYOUT NAME: BIOVOLUME



TOTAL PLANT BIOVOLUME	
	0% (13.43 ACRES)
	1% - 25% (4.99 ACRES)
	26% - 50% (7.45 ACRES)
	51% - 75% (0.61 ACRES)
	76% - 100% (0 ACRES)

BASE MAP: USGS COLOR ORTHO IMAGERY
 DATA SOURCES: TRC, GPS DATA, 09/27/2023; MASSDEP, HYDROGRAPHY, 2019



PROJECT: SOLITUDE LAKE MANAGEMENT LLC	
BURGES POND WESTFORD, MA	
TITLE: BURGES POND TOTAL PLANT BIOVOLUME POST-TREATMENT / FALL SURVEY	
DRAWN BY: J. BERTHERMAN	PROJ. NO.: 560206.0000.0000
CHECKED BY: J. TREACY	FIGURE 27
APPROVED BY: J. TREACY	
DATE: NOVEMBER 2023	
	
10 HEMINGWAY DRIVE 2ND FLOOR EAST PROVIDENCE, RI 02915 PHONE: 401.330.1236	
FILE:	560206_WESTFORD_BURGESS_2023