Whitney Pond

Baseline Assessment Survey Report
June 2012

Prepared for:

Groton Lakes Association
c/o Mr. Bill Strickland
Groton, MA 01450

Prepared by:

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AQUATIC CONTROL TECHNOLOGY, INC.
POND AND LAKE MANAGEMENT SPECIALISTS

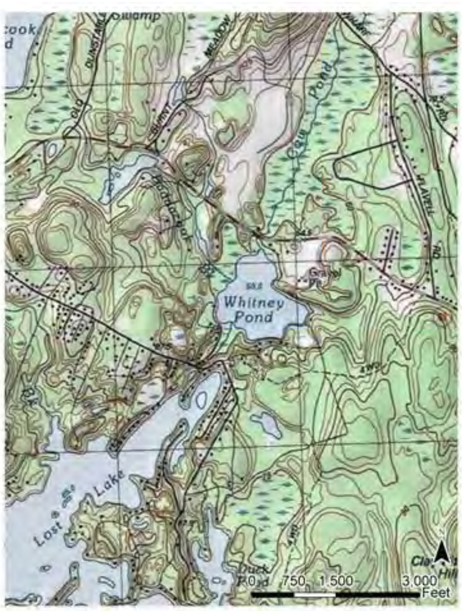
Introduction:

Whitney Pond: Dense variable milfoil visible from the pond's surface in the foreground

A Biologist from Aquatic Control conducted a baseline biological survey of Whitney Pond on May 30 2012. The objective of this survey was to document current vegetation growth and water quality conditions in the waterbody and to provide management recommendations. Tasks included in this field inspection consisted of a vegetation survey, representative measurements of sediment type, measurements of water depth, water quality sampling and water clarity measurements. The survey days were sunny with little wind, allowing for good visualization of the pond below the water's surface. Results of the survey are presented first followed by a discussion of management options and recommendations.

Site Description:

Waterbody:



Whitney Pond is an approximately 37 acre waterbody located in Groton Massachusetts. Baddacook Brook in the north-eastern corner of the pond and the outlet stream from Lost Lake in the south-western corner of Whitney Pond serve as the primary inlets for the waterbody. The outlet of the waterbody is located in the northern-most corner of Whitney Pond. Here water exits Whitney Pond and travels north into Cow Pond Brook, flows through Cow Pond Brook Reservoir and eventually reaches Massapoag Pond.

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Watershed:

Land Use Type	Area (acres)
Commercial	0.7
Cropland	27.6
Forest	640.8
Forested Wetland	65.5
High Density Residential	1.8
Low Density Residential	43.1
Medium Density Residential	0.6
Mining	2.5
Multi-Family Residential	1.4
Non-Forested Wetland	61.2
Open Land	1.8
Pasture	12.7
Urban Public/Institutional	1.5
Very Low Density Residential	31.7
Water	50.9
Whitney Pond Sub-Basin	943.9
Total Groton Lakes Watershed	3965.5

The watershed of Whitney Pond was estimated using a USDA topographical map. The watershed is depicted on figure 3 and encompasses an area of 943.9 acres. The ratio of the Whitney pond watershed to lake area would be 25 to 1. Due to the fact that both Baddacook Lake and Lost Lake and Knops Ponds flow directly into Whitney Pond, the outflow is likely more accurately represented by looking at the ratio of the total Groton Lake Watershed Area to the Area of Whitney Pond (~107 to 1). Given these high ratios it would be very challenging to maintain concentrations of long-acting systemic herbicides such as Sonar.

Land uses and activities within the watershed can affect water quality and quantity. Figure 3 shows the reported land uses based on 2005 data compiled from the MA DEP and the table (left) summarizes the proportions of the different land use types in the Whitney Pond watershed. Reviewing this information is a good place to begin addressing watershed management techniques and can form a basis for further investigations and monitoring (see watershed management section).

Survey Methods and Results:

Vegetation:

Dense Variable milfoil reaching the surface in five feet of water

The vegetation survey was conducted utilizing a variety of techniques including a throw rake, underwater camera system, and visual observations (figure 2). Two non-native invasive species were observed in the waterbody including variable milfoil (*Myriophyllum heterophyllum*) and curly-leaf pondweed (*Potamogeton crispus*).

Native in-pond species observed included coontail (*Ceratophyllum demersum*), bladderwort (*Utricularia sp.*), robbin's pondweed (*Potamogeton robbinsii*), floating leaf pondweed

(*Potamogeton natans*), waterthread pondweed (*Potamogeton diversifolius*), flatstem pondweed (*Potamogeton zosteriformis*), white waterlily (*Nymphaea odorata*), yellow waterlily (*Nuphar variegatum*), watershield (*Brassenia schreberi*) (figure 2, table 1).

Vegetation is generally dense throughout the littoral zone of Whitney Pond. At the data points the percent cover ranged from 20 to 100 percent cover, with an average percent cover of 82 percent at vegetated sites. In the shallow water depths variable milfoil and waterlily populations were dominant. In general the community shifted to a solely submersed plant species community with variable milfoil and coontail becoming dominant in water depths between four and fifteen feet.

<u>Water Clarity, Water Depth and Sediment Depth:</u>

Water Clarity was measured using a Secchi disk over the deep hole of Whitney Pond (Figure 4, sample site 2). The water clarity measurement at Whitney Pond was 7.7 feet (2.3 meters) on the day of the survey. This is a desirable clarity reading for a waterbody of this size and type.

Water depth measurements were collected utilizing a tape measure and sounding weight at predetermined locations throughout the pond. The average water depth observed on the day of the survey was 13.4 feet and the maximum water depth observed was 30 feet.

Sediment is characterized as muck, sand, gravel or peat. The unconsolidated sediment in the pond was primarily composed of muck.

<u>Water Quality:</u>

Two surface water quality sample sets were collected on the day of the survey. The first sample set was collected mid-pond over the deep hole in Whitney Pond and the second set was collected where the outlet stream from Lost Lake enters Whitney Pond (figure 4).

To collect the samples, sterile one-liter sample bottles were submersed elbow deep and filled. The samples were sent to a Massachusetts Certified Laboratory to test for pH, alkalinity, turbidity, nitrate nitrogen, ammonia nitrogen, total Kjeldahl nitrogen, total phosphorous, true color, apparent color and E. coli. The results are summarized below in table 1.

Table 1: A Summary of Water Quality Sample Results for 2012

Parameter	Units	Deep Hole	Lost Lake Inlet
pH	S.U.	6.85	6.75
Alkalinity	$CaCO_3$/L	31.0	32.0
Turbidity	NTU	1.00	2.10
Total Kjeldahl Nitrogen	mg/L	0.500	0.600
Ammonia Nitrogen	mg/L	<0.1	<0.1
Nitrate nitrogen	mg/L	<0.03	<0.03
Total Phosphorous	mg/L	<0.02	<0.02
True Color	Pt-Co	20	15
Apparent Color	Pt-Co	25	30
E. coli	CFU/100ml	<10	<10

pH: pH is a measurement of the concentration of hydrogen ions (h^+) in solution, which reflects the acidity or alkalinity of the measured solution. The pH measurement scale ranges from 0-14, where zero is extremely acidic, seven is neutral, and 14 is the most basic. A pH measurement within the range of 5.5-8.5 S.U. is typical for the northeastern United States and is desired for maintaining a healthy fishery. Maintaining a stable pH ($\pm$ 1 S.U.) is also important, as frequent fluctuations can have adverse effects on water chemistry and fisheries. The pH levels measured in Whitney Pond were both near neutral and within the desired range.

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 fish and wildlife populations. Total alkalinity measures the presence of carbonates, bicarbonates and hydroxides and is mostly a function of the surrounding soils and geology. Values below 20 mg/l typically illustrate that the pond may be susceptible to adverse fluctuations in pH. The alkalinity measurements for the samples collected in Whitney Pond indicate that the waterbody should be well buffered against pH fluctuations.

Turbidity: Turbidity is a relative measurement of the amount of suspended particles in the water. Turbidity values can range from less than one to thousands of units, however, values in most healthy ponds rarely rise above 5 NTU and typically <1 NTU in waterbodies used for swimming. The turbidity measurements in Whitney Pond were elevated but were not so high as to be a safety concern.

Ammonia nitrogen: Nitrogen is an essential element for plant growth. Nitrogen is found in the environment in several forms. High levels of nitrogen can indicate poor water quality. In particular high concentrations of ammonia nitrogen can be toxic to fish. Ammonia is also important due to the fact that it is a by product of the decomposition of organic material. In the presence of oxygen, ammonia is readily converted to nitrate nitrogen. Therefore high ammonia nitrogen concentrations may indicate low oxygen levels to anoxic conditions. Levels of ammonia nitrogen observed in the samples collected at Whitney Pond were all desirably below laboratory detection limits (0.100 mg/L).

Nitrate nitrogen: Nitrate nitrogen is the end product of the nitrogen cycle under aerobic conditions. Nitrate nitrogen is the form of nitrogen that is most readily available to plants as a nutrient source. High levels of nitrate nitrogen indicate an imbalance between the amount of nitrogen entering a system and the amount being utilized by organisms and may also indicate fertilizer or septic system inputs. Excess nutrients may stimulate nuisance plant and algae growth. Generally speaking nitrate concentrations higher than 0.3 mg/l are sufficient to support such nuisance plant and algae growth. Nitrate nitrogen levels were below detectable levels (0.0300 mg/L) for both sample locations.

Kjeldahl nitrogen: Kjeldahl nitrogen results signify the amounts of organic or biomass nitrogen and ammonium in a sample. Since this form of nitrogen is not as readily utilized by plants as nitrate nitrogen, concentrations generally need to be greater that 1.0 mg/l to support nuisance algae and plant growth. The levels of Kjeldahl nitrogen in the samples collected from Whitney Pond were 0.5 and 0.6. While these levels may not support nuisance algal blooms, they are likely indicative of elevated levels of organic biomass breakdown, due to heavy plant growth.

Total Phosphorous: Although excess nitrogen can contribute to nuisance plant growth, the ratio of nitrogen to phosphorous in a system is equally important. This ratio will determine which nutrient is the most limiting (i.e.; which nutrient is found in least supply relative to the growth requirements of the plants). Phosphorus is usually the limiting nutrient for plant and algae growth in freshwater systems. Total phosphorus is a reading of particulate and dissolved phosphorus in the water column. Concentrations of 0.03 mg/l or greater are considered sufficient to stimulate nuisance algae blooms. Phosphorous levels in both samples were desirably below detectable levels (0.0200 mg/L). The low levels of both phosphorous and nitrogen given the conditions observed may indicate the quick uptake of nutrients by the dense aquatic plant growth. It is important to understand that each sample is representative of a mere “snap-shot” or conditions at a moment in time. As a result, it would be necessary to perform more frequent sampling to establish a more meaningful baseline/mean value for the continually fluctuating nitrogen and phosphorous levels.

True Color/Apparent Color: Apparent color is the color of the unfiltered water that is caused by both suspended and dissolved matter. True color is measured after the water has been filtered to remove the suspended matter and is therefore the color due to dissolved constituents only. Water color can effect light penetration and, as a result, can limit rooted plant and algae growth. The disparity between true and apparent color can indirectly indicate the amount of suspended material in the water. The results from Whitney Pond indicate moderate levels of color in the water and that the color of the water is due more to dissolved particles, such as tannic acid, than suspended particles.

Escherichia coliform: E. coli. is one of many naturally occurring bacteria found within the intestine of humans and animals. The presence of *E. coli* in pond and/or Pond water is indicative of some level of recent sewage or animal waste contamination. The current swimming standard for freshwater is no single sample shall exceed 235 colonies per 100 ml. The bacterial samples taken in both Whitney Pond were below laboratory detection levels indicating acceptable conditions for swimming and other contact recreation.

<u>Temperature and Dissolved Oxygen:</u>

Table 2: Whitney Pond temperature and dissolved oxygen profile May 30, 2012

Depth (meters)	Temperature (°C)	Dissolved Oxygen (mg/L)
Surface	23.2	9.14
1	22.6	9.25
2	19.8	10.34
3	15	10.74
4	12.5	8.25
5	10.9	8.31
6	9.5	4.92
7	8.2	2.01
8	7.0	1.50
9 (off bottom)	6.6	1.34

During the May survey a temperature and dissolved oxygen profile was recorded for Whitney Pond at the deep spot location (figure 4). The results indicate that Whitney Pond is stratified; the thermocline was located between 3 and 4 meters below the surface on the day of the survey. Good oxygenation was observed through the epilimnion of Whitney Pond and moderate to low oxygen levels were observed through the hypolimnion. The increase in oxygen levels at the 2 and 3 meter depths was likely due to algal concentrations at those levels.

Management Options and Recommendations:

The conditions in Whitney Pond are similar to many other waterbodies in the region. Commonly referred to as “eutrophic”, the waterbody is characterized by high biological productivity, excessive aquatic plant growth, increased sedimentation, and a nutrient-rich mucky bottom. Eutrophication (or “aging”) of a pond is a natural process but can be accelerated due to pollution, invasive species expansion, development and wildlife activity.

In broad terms, lake management can be broken down into in-lake and watershed management techniques. In addition to active management, it is also recommended to conduct on-going monitoring of vegetation and water quality.

At the points sampled in our 2012 survey, the average percent of area covered by invasive species was 28 percent. These invasive species are impeding recreation and adding to the annual decomposing biomass in the pond. As such the focus of our recommendations is on the management of nuisance aquatic plant species.

In-Lake Management Techniques:

In-lake management techniques are typically broken down into mechanical, physical, chemical and biological methods. The following is a discussion on the applicability of each technique to Whitney Pond.

Mechanical Techniques:

Mechanical techniques include mechanical cutting/harvesting and hydro-raking. Harvesting involves cutting the nuisance weed growth below the water’s surface and collecting the cut plants for removal from the pond. In most cases, harvesting provides only short term control of the target plants and multiple cuttings over the course of a season may be required to maintain desirable conditions. Repetitive annual harvesting of some annual (seed producing) plants such as water chestnut or certain pondweed species, however, may result in long-term control.

In general, as compared to other vegetation control techniques, harvesting will be more expensive per unit area and will provide shorter term control. It should also be noted that while curlyleaf pondweed populations could be reduced through annual cutting because they are seed producing plants variable milfoil spreads by fragmentation and as such harvesting will likely lead to an increase in density and distribution of this species over time.

Another mechanical technique is hydro-raking. A hydro-rake can be described as a floating backhoe. The hydro-rake rakes the pond bottom and removes the plants including the root systems and associated hydrosoils. The Hydro-Rake is powered by hydraulic paddle-wheels and is capable of working in as little as 1.5-feet of water. Hydro-raking is typically not recommended for control of submersed plants especially those species that can reproduce through vegetative fragmentation, but rather for emergent plants, like cattails, and floating leaf plants, like waterlilies. Control of submersed plants is seasonal at best, while control of plants with significant root-systems can be 2-3 years or more. Hydro-raking would not be the method of choice for widespread control of submersed plants, but could be effective on areas of emergent vegetation and waterlilies and would be a valuable tool to clean individual shorefronts of waterlilies, leaf litter and other debris.

Chemical Treatment:

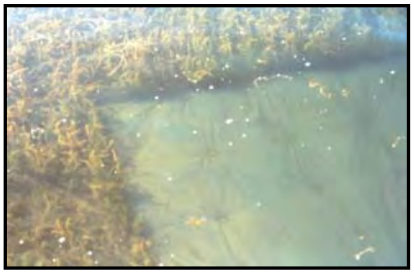
Chemical treatment is a recommended approach for control of invasive submersed weeds in Whitney Pond. Treatment with USEPA / State registered aquatic herbicides and algaecides does not pose an unreasonable risk to the environment or human health when used by licensed applicators in accordance with the product label.

Assuming the outflow could be held or retarded, the herbicide of choice for control of nuisance plant growth would be Reward (diquat). The density and distribution of fanwort has reportedly increased over the last several years. During our survey the high impact of the species on recreation and wildlife habitat was apparent. In areas of mixed assemblage (fanwort and milfoil) if the milfoil were controlled and fanwort were left to grow unabated, then fanwort would likely fill in the gaps where milfoil had been.

Prior to any treatment, the shoreline would be posted with signs warning of the temporary water use restrictions in effect. These restrictions include closing the waterbody to all uses, including boating, fishing and swimming on the day(s) of treatment. If Sonar (fluridone) herbicide were used, there would be a 60-90 day irrigation restriction, depending on the timing of applications. Effective control of the targeted invasive plants may be challenging considering the rapid rate of water exchange in Whitney Pond and the limited ability to hold outflow.

Area selective control of waterlilies to allow for better pond access and a few casting lanes may be desired. If this were the case we would recommend either hydro-raking, as previously mentioned or area selective treatment with AquaPro (glyphosate). Glyphosate is a systemic herbicide that is sprayed over the foliage of the plants to be controlled. It become inactivated on contact with the water and as such can be area selective.

Physical Control Techniques:



Benthic weed barriers are used to cover the bottom of the Pond and control weed growth by shading and compressing the plants. Benthic weed barriers are typically used in small beach or dock areas and are not economical for control of large infestations. Barrier costs are in the range of \$1.00-\$1.50/ft^2 installed. Barriers would not be appropriate for widespread control of plants due to the lack of selectivity of this technique for plant control and the potential for the widespread hindering of access to the sediments by macro-invertebrates. However they would a good tool to clear small areas around docks or swim areas, if chemical treatment is not selected as a management option. We have seen some success with placing a barrier in an area for approximately six weeks to kill the plants below and then moving it to another location. The length of time required to kill the vegetative portion of the plants varies from lake to lake with sediment thickness, infestation size and density and water chemistry. This method would allow access to the lake bottom for aquatic organisms and would save the cost of buying enough barrier to cover the whole bottom. That said, barrier can be left in one location for the entire season, if desired. It should be noted that bottom barrier is a high maintenance technique. We recommend cleaning the silt off annually at a minimum to prevent plants from growing on top of the barrier. Moving the barrier can be labor intensive and requires scuba divers for waters deeper than five feet. Although the barrier can be left in over the winter, we generally recommend removing it in the fall, cleaning it off, storing it over the winter and then redeploying it in the spring.

Pond dyes are intended to color the water and reduce the amount of sunlight that is available to feed weed and algae growth. These dyes are only marginally effective and not generally recommended for natural ponds with a flowing outlet.

Aeration of the water provides many good benefits, including oxygenation and circulation, but properly designed systems for large waterbodies can be prohibitively expensive and will not control rooted plant growth. Large waterbodies are also usually naturally well-oxygenated unless severely polluted and/or very deep. Oxygen levels observed in Whitney Pond would not justify the installation of an aeration system.

Dredging is usually a very costly technique and planning/permitting alone can often cost in the range of \$20,000 or more. Since there is a moderate amount of sediment collected in the Pond, it would probably benefit somewhat from dredging, however the cost of such a project would likely be very high, with no guarantees that additional vegetation management would not be required. Based on an approximate unit cost of \$20-\$40 per cubic yard, dredging just 2-feet of sediment over a 2-acre area would cost in the range of \$125,000-\$250,000. A dredging feasibility study would be required to provide more details about a possible dredging project.

Drawdown is a commonly used and typically low-cost technique that can provide control of rooted plants in some waterbodies. The principal mechanism through which water level drawdown controls aquatic plants is exposure to unfavorable climates for an extended period of time. This is accomplished by lowering the water level of the waterbody and exposing the target plants to the open air, essentially killing the plants and certain reproductive structures, due to the combined effects of sustained freezing and/or drying. Water level drawdown can be performed during the summer or winter months, but due to several factors, including environmental impacts, waterbody usage, ability to refill and the added benefit of freezing temperatures, drawdowns are usually performed throughout the fall and winter months. The outlet of Whitney Pond does not appear to have the necessary structures in place for a deep drawdown.

Biological Control Techniques

There are no plant specific biological agents known to be effective on the nuisance aquatic species present in Whitney Pond that are permitted in Massachusetts.

<u>Watershed Management:</u>

Only limited water quality data (chemistry, temperature, dissolved oxygen and clarity) was collected as part of this survey and a more detailed investigation would be necessary to identify watershed nutrient sources and assess the potential methods for mitigation.

Watershed management involves identifying and mediating or eliminating sources of nutrients and/or pollution in the watershed. The process of identification involves a thorough survey of the watershed area and further water testing, including sampling upstream tributaries and waterbodies. Samples are taken throughout the year to reflect both base flow and storm flow conditions. Calculation of the potential nutrient load can be made from land-use data using accepted coefficients. "Nearby" watershed areas must also be evaluated and include the residential lots around the ponds and direct runoff from the surrounding streets and other impervious areas.

Such a study is normally referred to as a "diagnostic/feasibility" study and can cost upwards of $20,000 or more. The ultimate goal of such as study is a review and cost vs. benefit analysis of "best management practices" (BMP's) which can be implemented by the Town and pond residents. The following list describes a selection of some common watershed management options broken down into two categories:

Source Control

<u>Limit impervious area</u> – Impervious areas such as parking lots, driveways, buildings and roads interfere with the natural absorption and filtering of storm water through soils. Limiting impervious areas will reduce flow volumes and mitigate plug flow of nutrients into the watercourse.

<u>Minimize contaminant exposure</u> – Regulating the use of potentially hazardous chemicals and other nutrient sources in the watershed area.

Control of fertilization, pet & yard wastes – Educational campaigns or ordinances to increase awareness of proper processing of pet & yard wastes and the control of fertilization practices (use low or no phosphorous fertilizers and only if necessary) and other activities which introduce nutrients in the watershed (ex. car washing). Establishing practices to limit nuisance waterfowl, such as signs warning against feeding, can also eliminate a significant source of nutrients.

Land Management – Minimizing introduction of land uses that have potential to negatively impact the ponds and preservation of natural woodland areas through review of the zoning laws in the watershed will prevent increases in nutrient loading. Possible development and adoption of a Town watershed protection by-law will also aid in this endeavor.

Street Cleaning – Frequent cleaning of any paved roadways in the watershed and maintenance of catch basins will promote cleaner storm water runoff.

Transport Mitigation:

Where substantial impacts have already been identified, some method of transport mitigation can be employed to minimize the pollution load from these sources.

Buffer Strips – Vegetated buffer strips of grass and/or shrubs can act as a biofilter to mediate nutrients from non-point sources before they enter the waterbody.

Catch Basins/Grease & Grit Traps ,Detention Basins, Infiltration Systems, Rain Gardens – For point source runoff from drainage systems, construction and/or improvement of catch basins, detention basins or infiltration systems can significantly reduce the nutrient load of stormwater inflow.

Constructed Wetlands – For larger areas, simulated wetlands can act as both settling/detention basins and help to process nutrients from runoff.

Watershed management and source control are important to the long-term health of the pond system. While there did not appear to be major nutrient concerns during our survey, it is always a good idea to monitor the watershed for changes in land-use and potential sources of nutrient loading. The simplest techniques can be implemented right away through education, including proper septic system maintenance, proper fertilization procedures, maintenance of buffer strips and minimizing use of potential contaminants/nutrients.

Even if a watershed management plan is enacted, actual improvement of the pond condition will be a slow process. This would be particularly evident in a pond like Whitney Pond where the watershed is so expansive relative to the size of the pond itself. Nutrient recycling within the system will likely support growth of nuisance plants and algae indefinitely. Eutrophication is a natural process and although we can attempt to slow its progress, some type of in-pond management is usually necessary.

Monitoring:

To maintain surveillance of the water quality and vegetation in Whitney Pond, we recommend initiating an annual monitoring program to include one to two rounds of water quality data and a mid-late summer vegetation survey. Samples should be collected late in the season both at the surface and within the hypolimnion for phosphorous to determine if internal nutrient cycling may be an issue. A temperature/dissolved oxygen profile and Secchi Disk transparency measurement should also be taken.

Permitting:

Whitney Pond is located within a rare species priority habitat area. As such a MESA form will need to be filed with the Notice of Intent. We will want to seek advice from NHESP in order to make final recommendations regarding the species. Whitney Pond is also located within a Zone II Area. All of the herbicides proposed have been approved by MA DEP for use within Zone II areas.

Summary of Management Recommendations:

In summary, we recommend the following:

- Formulate long-term management objectives and develop and integrated plan to be implemented

- File a Notice of Intent with the Conservation Commission that conveys all objectives and management techniques that may be implemented including but not limited to:

    - Partial-lake Reward treatment to control non-native invasive aquatic plant species

    - Area selective treatment of water lilies with glyphosate to increase recreational access to the pond

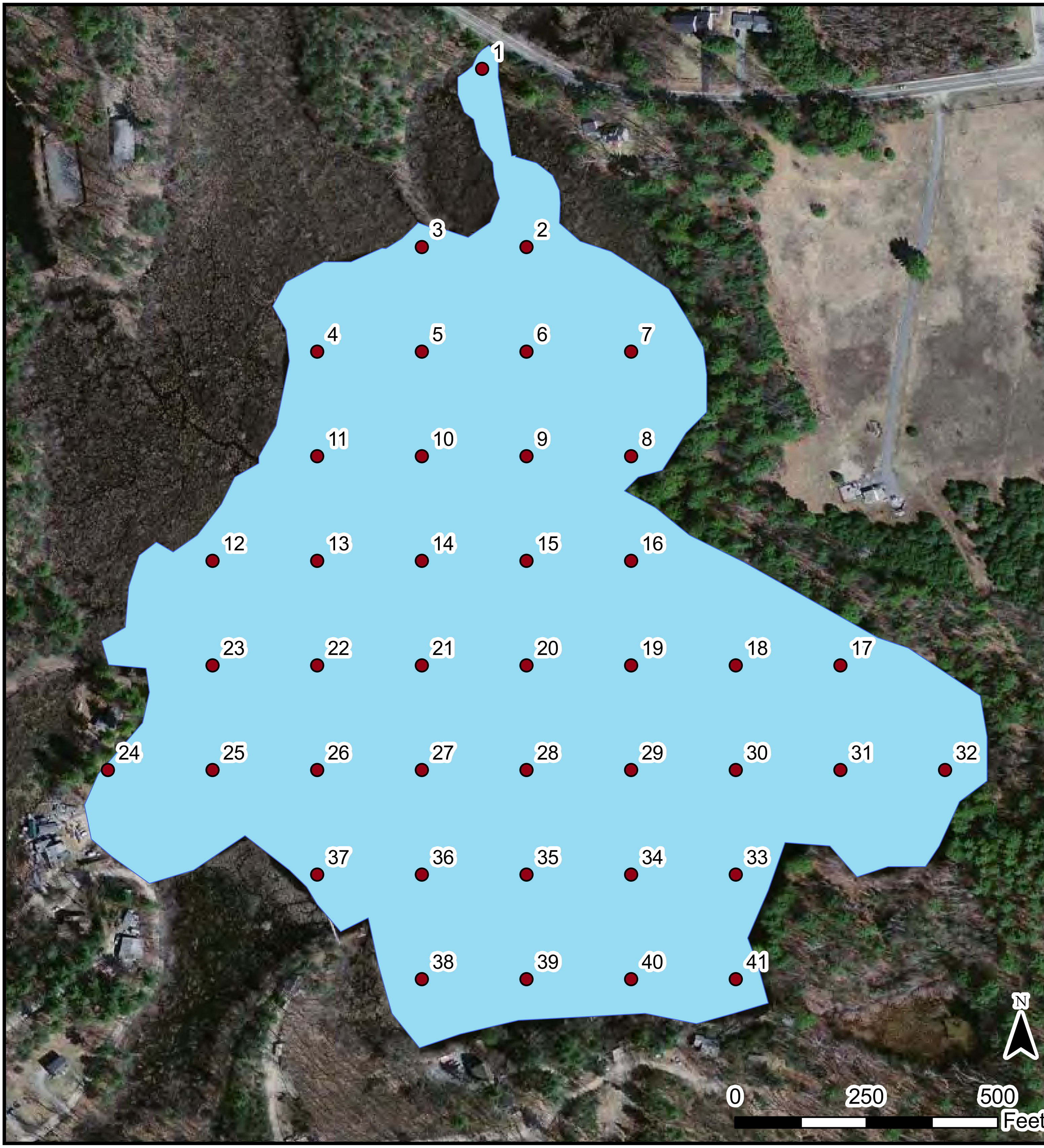
    - A volunteer monitoring effort to search for new invasives through the Massachusetts Weed Watcher program

    - Annual water quality and vegetation monitoring

We hope that this information will aid you in future management decisions. If you have any questions or require additional information, please do not hesitate to contact our office.

APPENDIX

- Figure 1 – Survey Point Locations
- Figure 2 – Vegetation 2012
- Figure 3 – Watershed Land Use
- Figure 4 – Water Quality Sample Sites
- Field Data Table



Whitney Pond

Groton MA
Survey Point Locations

FIGURE:	SURVEY DATE:	MAP DATE:
1	5-30-12	5-29-12

Legend

Survey Point Locations

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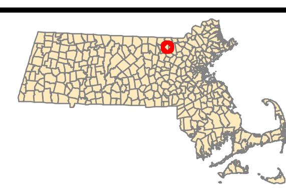

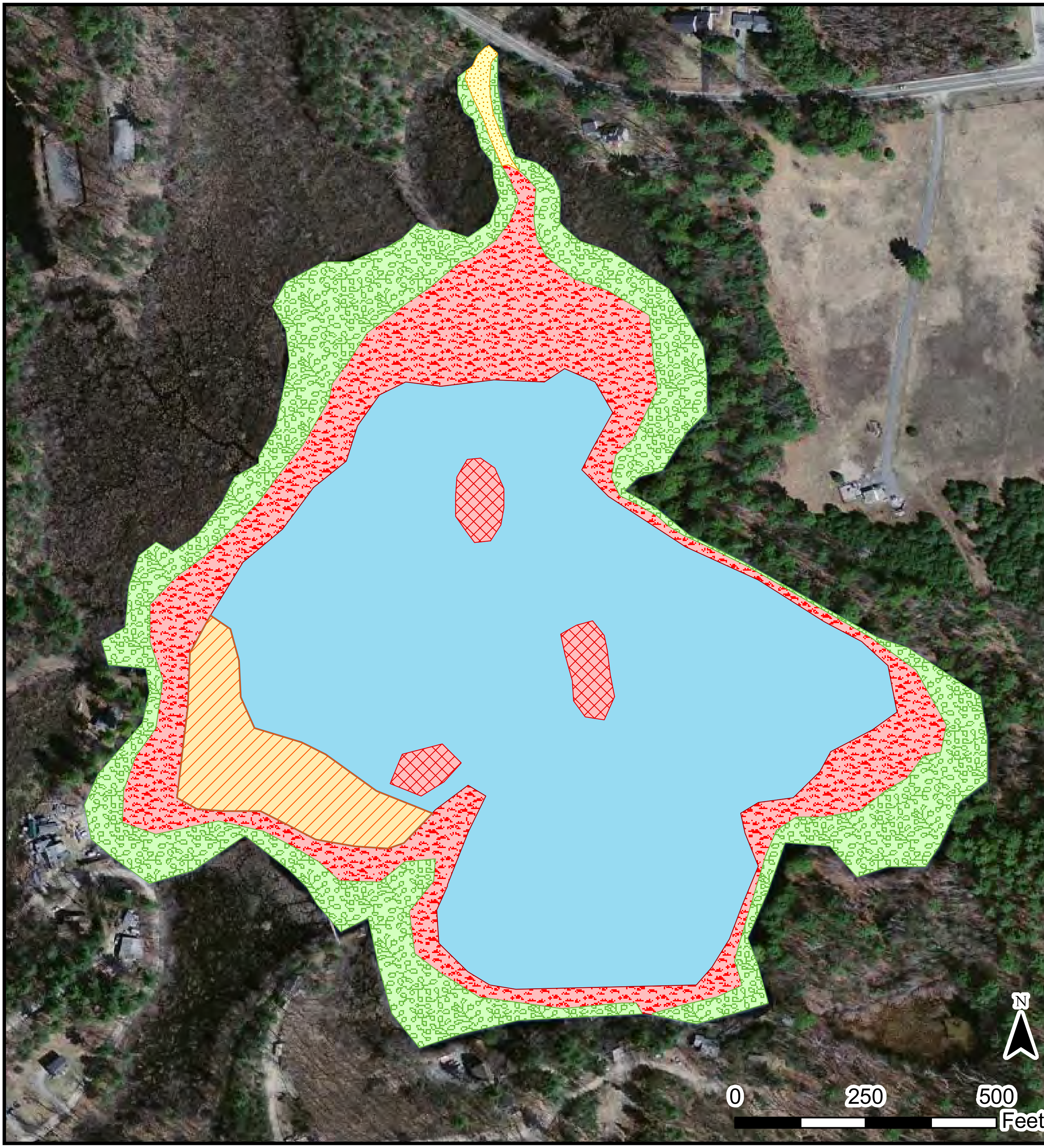

	Variable Milfoil dominant, dense and reaching the surface
	Coontail dominant
	Variable milfoil dominant with lesser amounts of coontail, bladderwort, ribbonleaf pondweed and curlyleaf pondweed
	Ribbonleaf and curly-leaf pondweeds dominant with lesser amounts of variable milfoil and largeleaf pondweed
	Variable milfoil dominant with lesser amounts of white and yellow water lillies, coontail, bladderworr, floatingleaf pondweed, and largeleaf pondweed.

Whitney Pond

Groton MA
General Vegetation Assemblage Map

FIGURE:	SURVEY DATE:	MAP DATE:
2	5-30-12	5-29-12

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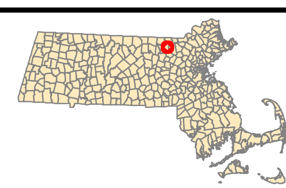

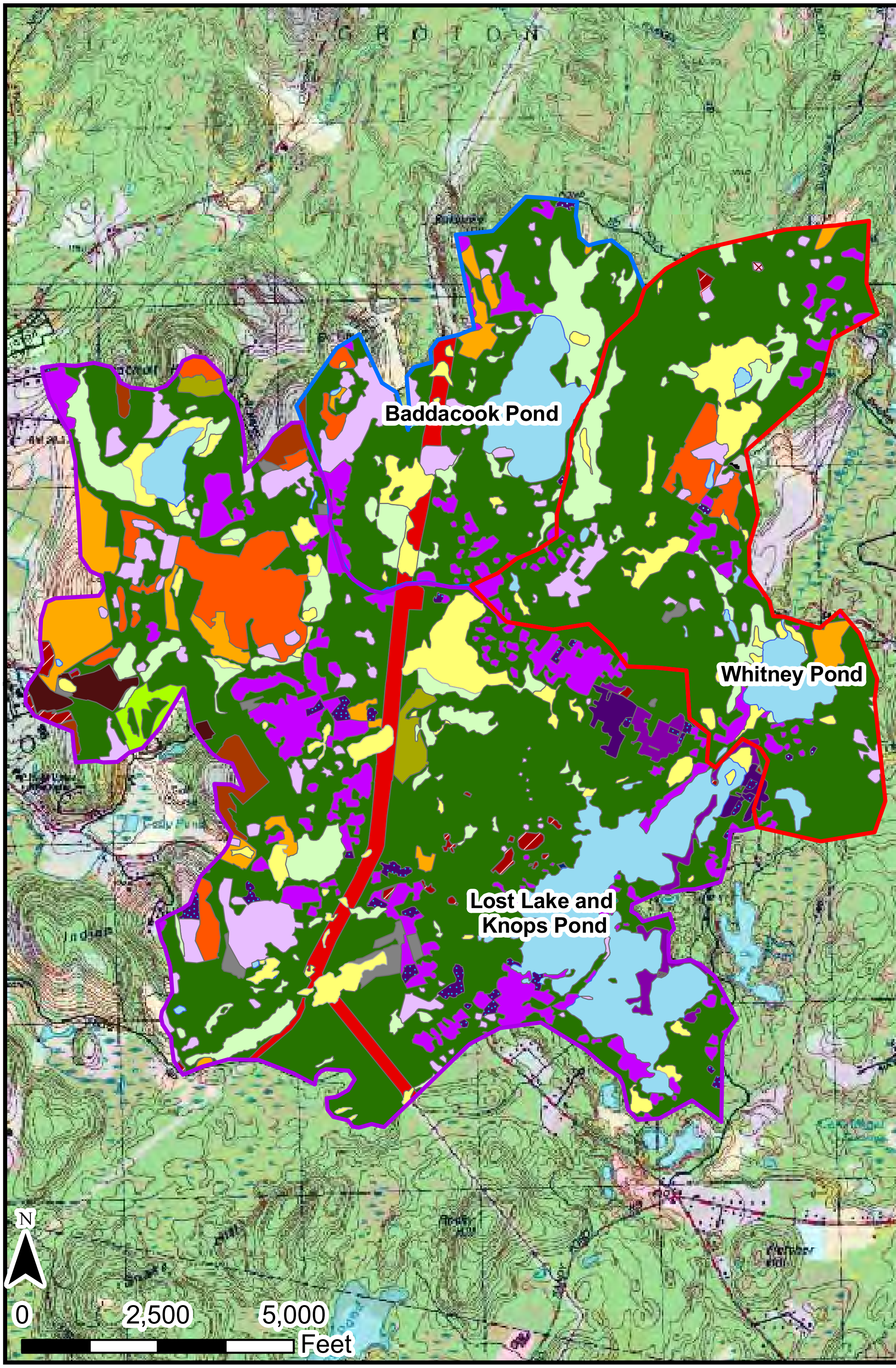

Legend

Sub-basins

- Whitney Pond
- Lost Lake and Knops Pond
- Baddacook Pond

Land Use

- Non-Forested Wetland
- Pasture
- Cropland
- Orchard
- Golf Course
- Brushland/Successional
- Transitional
- Forested Wetland
- Forest
- Very Low Density Residential
- Low Density Residential
- Medium Density Residential
- Multi-Family Residential
- High Density Residential
- Participation Recreation
- Water
- Water-Based Recreation
- Powerline/Utility
- Mining
- Urban Public/ Institutional
- Commercial
- Open Land

Whitney Pond Watershed

Groton MA

Land Use within Estimated Watershed

FIGURE:	SURVEY DATE:	MAP DATE:
3	5-30-12	6-29-12

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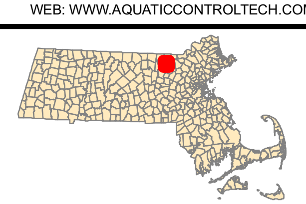

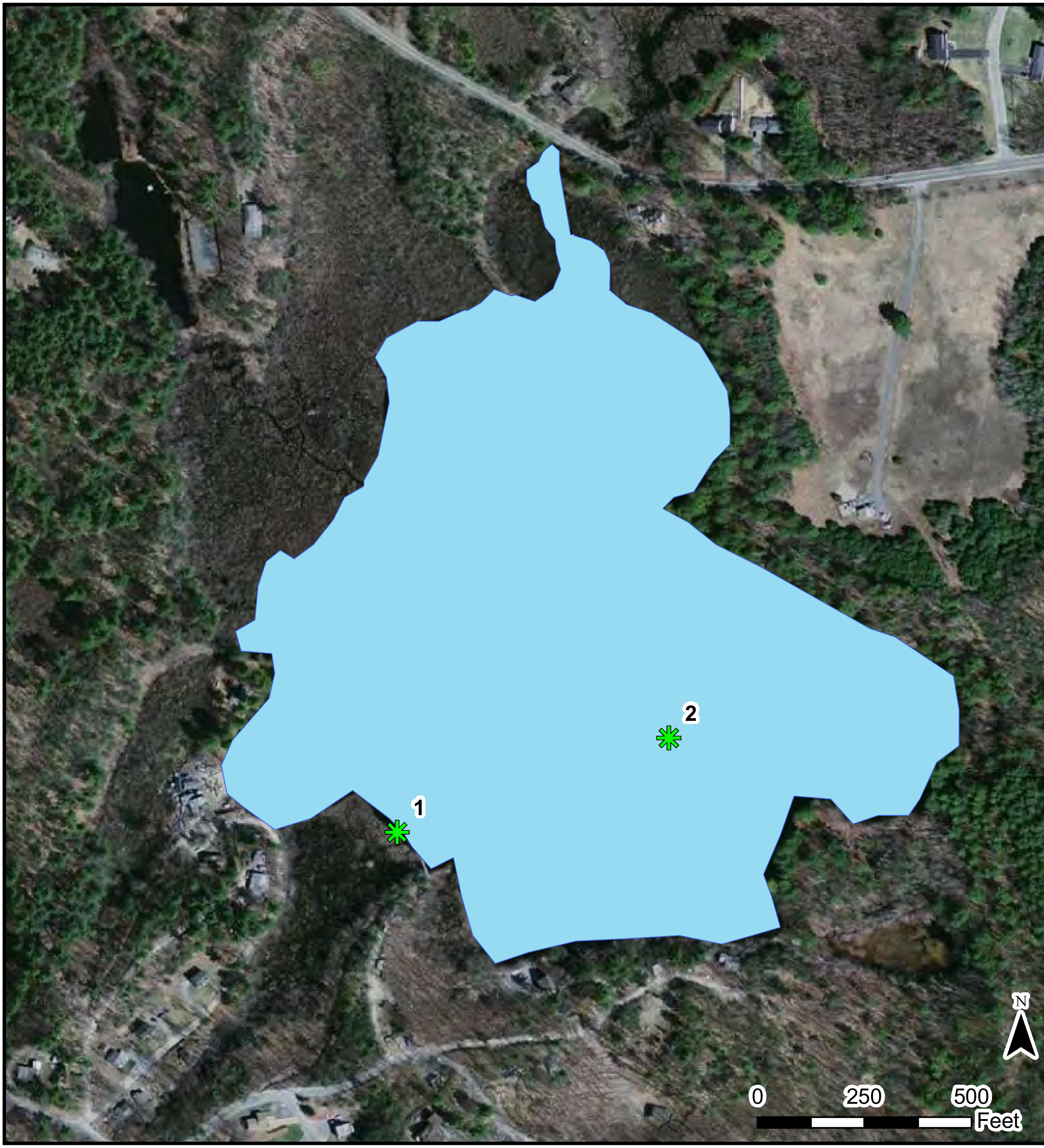

Whitney Pond

Groton MA
Water Quality Sampling

FIGURE:	SURVEY DATE:	MAP DATE:
4	5-30-12	6-25-12

Legend

✳ Water Quality Sample Locations

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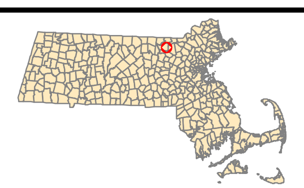

Point Number	Water Depth	Biomass	Percent Cover	Invasive Species Percent Cover	Plant Species Present													
					Myriophyllum heterophyllum	Potamogeton crispus	Ceratophyllum demersum	Potamogeton amplifolius	Potamogeton epihydrus	Potamogeton pusillus	Potamogeton robbinsii	Potamogeton zosterformis	Potamogeton natans	Utricularia Sp.	Isoetes sp.	Nymphaea odorata	Brassenia schreberi	Nuphar variegatum
1	2.3	3	100	80	X	X	X		X	X								
2	2.3	4	100	30	X		X	X						X		X		X
3	0.8	4	100	40	X	X	X	X		X		X						
4	5.7	3	100	100	X													
5	4.9	3	100	75	X		X							X		X		
6	14.3	1	0	0														
7	7.3	3	100	80	X				X	X				X				
8	9.9	3	90	80	X						X			X				
9	16.8	1	0	0														
10	15	1	0	0														
11	11.9	1	30	20	X							X		X				
12	5.3	3	100	75	X	X	X	X			X					X		X
13	13.4	0	0	0														
14	15.7	0	0	0														
15	20.6	0	0	0														
16	22	0	0	0														
17	17.8	0	0	0														
18	22.8	0	0	0														
19	28.2	0	0	0														
20	25.1	0	0	0														
21	14.4	0	0	0														
22	16.8	0	0	0														
23	12.8	2	20	0			X											
24	5.8	3	100	90	X		X				X			X				X
25	12.3	2	50	0			X											
26	4.9	2	10	0			X											

Point Number	Water Depth	Biomass	Percent Cover	Invasive Species Percent Cover	Plant Species Present													
					Myriophyllum heterophyllum	Potamogeton crispus	Ceratophyllum demersum	Potamogeton amplifolius	Potamogeton epihydrus	Potamogeton pusillus	Potamogeton robbinsii	Potamogeton zosterformis	Potamogeton natans	Utricularia Sp.	Isoetes sp.	Nymphaea odorata	Brassenia schreberi	Nuphar variegatum
27	13.8	3	50	30	X		X											
28	23.5	0	0	0														
29	30	0	0	0														
30	29.3	0	0	0														
31	13	3	100	100	X													
32	2	4	100	60	X		X	X							X	X		
33	22.6	0	0	0														
34	25.6	0	0	0														
35	21	0	0	0														
36	4.8	4	80	70	X								X			X		
37	4	0	0	0	X			X								X		
38	4	4	100	90	X								X			X		
39	12.4	0	0	0														
40	18.6	0	0	0														
41	4	4	100	75	X	X	X						X					