January 16, 2013

Long Sought For Pond Protective Association
Mr. Douglas Bell, President
98 Dunstable Road
Westford, MA 01886

Re: 2012 Year-End Report for the Aquatic Management Program at Long Sought For Pond

Dear Association Members:

Please accept this as our Year-End Report for the 2012 Aquatic Management Program at Long Sought For Pond. Since the successful 2004 whole-lake treatment with Sonar herbicide to control Eurasian watermilfoil (*Myriophyllum spicatum*), the annual management program has focused on vegetation/water quality monitoring and control of invasive curlyleaf pondweed (*Potamogeton crispus*).

Treatment Program

The Sonar (fluridone) herbicide treatment conducted in 2004 continues to provide excellent control of the Eurasian watermilfoil in Long Sought For Pond. With the exception of a few individual milfoil plants, there has been no other evidence of milfoil re-growth through this season. Another non-native, invasive plant curlyleaf pondweed (*Potamogeton crispus*) became the primary target of management in 2006. Early season treatments have been shown to be the key to managing curlyleaf pondweed. Although complete eradication is rarely achievable, aggressively treating all occurrences of curlyleaf pondweed with treatment in late April/early May has brought the infestation to a minimal level. Two consecutive years of "spot" treatment with Reward (diquat) herbicide (totaling ~ 20-acres out of the 100-acre pond) in 2006 and 2007 were performed to bring the infestation under control. Another treatment was conducted in 2009, but since then growth of curlyleaf pondweed has been minimal. We continue to monitor growth each spring and will recommend treatment as necessary.

Monitoring Program

This year, planned sampling visits were conducted on April 25th, July 26th and September 13th. This was the first year that three sampling visits were included in the program and the new mid-summer round was initiated to investigate algal blooms and dissolved oxygen conditions related to recent trout mortalities.

During the April and September visits, the pond's aquatic vegetation was documented using a combination of visual observation, an underwater camera and sub-surface collection with a specially designed throw-rake. During each round, water samples were collected from three surface stations and a temperature/dissolved oxygen profile, Secchi disk water clarity reading and deep water (hypolimnetic) sample were collected at the deepest point in the pond.

Vegetation Distribution

Figure 1 & 2 depict the distribution of plants as observed during the April and September surveys, respectively. The spring vegetation assemblage was fairly sparse and consisted mostly of a bottom cover of stonewort (*Nitella sp.*) and very scattered occurrences of Robbins pondweed (*Potamogeton robbinsii*), ribbonleaf pondweed (*Potamogeton epihydrus*), largeleaf pondweed (*Potamogeton amplifolius*) and bladderwort (*Utricularia sp.*) Small to moderate sized patches of white waterlilies (*Nyphaea odorata*) were observed to be emerging in the coves. No Eurasian milfoil was observed. A small patch of sparse curlyleaf pondweed was observed in the southeast corner of the lake.

In the fall, most shoreline areas exhibited sparse to common growth of tapegrass (*Vallisneria americana*) and bladderwort, again with the same scattered pondweed growth described above. The stonewort growth appeared to have died back some, but was still observed in deeper portions of the pond. The same areas of waterlilies were also noted and coontail (*Ceratophyllum demersum*) was observed in one of the northeast coves. No curlyleaf pondweed or Eurasian milfoil was observed.

Water Quality Observations

Water quality samples were collected at four stations (see Figure 1). The following section presents the results of the laboratory testing with interpretation:

TABLE 1 - WATER QUALITY RESULTS (2012)

Station	Date	PH (S.U.)	Alkalinity (mg/L)	Turbidity (NTU)	Total Kjeldal Nitrogen (mg/l)	Nitrate Nitrogen (mg/l)	Ammonia (mg/l)	Phosphorus (mg/l)	Apparent Color (NTU)	True Color (NTU)	Total Coliform Bacteria (CFU/100 ml)	Fecal Coliform Bacteria (CFU/100 ml)
# 1 (North End)	April 25th	6.73	22.0	0.970	0.500	<0.030	0.200	<0.0100	10.0	10.0	<50	<10
	July 26th	6.54	5.0	0.890	0.900	<0.400	<0.100	0.0140	20	15	<50	<10
	Sept 13th	5.83	2.50	0.580	0.600	<0.100	<1.00	0.0100	5	5	800	<10
# 2 (South End)	April 25th	6.73	14.0	0.750	0.200	<0.030	0.200	<0.0100	15	10	<50	<10
	July 26th	6.43	5.00	0.840	0.600	<0.400	<0.100	0.0230	15	10	150	<10
	Sept 13th	5.90	3.0	0.620	0.600	<0.100	<1.00	0.0130	10	5	600	<10
# 3 (Inlet)	April 25th	5.66	14.0	0.500	0.300	<0.0300	<0.100	0.0400	100	90	450	<10
	July 26th	6.17	39.0	23.6	0.500	<0.400	6.18	0.380	3200	1600	300	270
	Sept 13th	Not Sampled – Stream Dry										
Hypo-limnion	April 25th	6.15	19.0	0.620	0.200	<0.0300	0.200	0.0400	10	5	Dissolved P – 0.0300	
	July 26th	6.11	22.5	7.50	6.40	<0.400	0.587	0.0640	850	100	Dissolved P – 0.0580	
	Sept 13th	6.18	32.5	2.40	1.30	<0.100	<1.00	0.0410	50	30	-	

pH – The pH measurement scale is from 0 to 14, where zero is extremely acidic, 7 is neutral, and 14 is the most basic. pH is related to the concentration of H^+ (hydrogen ions) in solution and can affect many different aspects of water chemistry. The values obtained at LSFP were slightly acidic in April and July and then became noticeably more acidic in the September round. Slightly acidic water is typical for the pond, however the low values in September are unusual and may have beeen caused by the lack of rainfall later in the summer and the low alkalinity of the water (see below). The pH of the inlet water is historically more acidic and this may indicate influence from the surficial geology of this stream's watershed or possibly due to decomposition of humic material in the stream bed. A pH range of about 5.5 – 8.5 is desired for maintaining a healthy fishery. The hypolimnetic sample pH was steady throughout the summer at just over 6.0 S.U.

Total Alkalinity – Alkalinity is a measure of the buffering capacity of a waterbody against acid additions such as acid rain and pollution, which can be detrimental to wildlife populations. Total alkalinity measures the presence of carbonates, bicarbonates and hydroxides. Values below 20 mg/l are a signal that the pond may be susceptible to fluctuations in pH. Alkalinity at LSFP is low, like many ponds in the region owing to the natural geology and soils in the area. Hypolimnetic and inlet water samples showed higher alkalinity values likely due to the presence of dissolved and particulate matter.

Turbidity - Turbidity is a relative measurement of the amount of suspended material in the water. It is measured through a process involving light diffraction of the pond sample as compared to a series of prepared samples. Turbidity values can range from less than one to thousands of units, however, values in most ponds and lakes rarely rises above 5 NTU. The turbidity values at the pond were desirable and show a low-level of suspended material. This value can vary significantly with stormwater influence and algae growth. Again, the inlet and hypolimnetic samples showed higher values due to higher suspended solids.

Nitrogen - Nitrogen is a vital nutrient in the pond environment for plant and algae growth. Nitrogen exists in water as various compounds, with relative amounts governed by such things as atmospheric influence, precipitation, biological activity and water chemistry. Total Kjeldal nitrogen (TKN) is a measure of the nitrogen contained in organic compounds, such as proteins and amino acids, and as ammonia. It is created from biological growth and decomposition. A concentration of 1.0 mg/l or below is considered desirable. Both the in-lake and tributary samples were within this desirable threshold. The hypolimnetic sample was fairly high in TKN during the July and September round, likely due to un-decomposed organic material that settled to the bottom of the lake.

Nitrate is another form of nitrogen in the water. Nitrate nitrogen is usually the most prevalent form of inorganic nitrogen in the water and results from such things as natural aerobic bacterial activity and fertilizer use. For most lakes, levels of nitrate over 0.3 mg/l is considered elevated. This year's values at LSFP were all desirably below this threshold. Ammonia is a transitional byproduct of the conversion from organic nitrogen to nitrate and is relatively short-lived in oxygen rich environments. There should be no detectable ammonia in surface lake water, although it may be expected in the bottom layer of stratified lakes. The hypolimnetic sample collected in September did show ammonia due to the lack of oxygen. The July inlet sample showed extremely high ammonia, possibly due to contamination or collected detritus material as the stream was nearly stagnant.

Total Phosphorus – Phosphorus is generally considered to be the limiting nutrient for plant and algae growth, with concentrations of 0.03 mg/l or more being sufficient to stimulate algae blooms. The phosphorus level in LSFP was desirably below this level at all the surface in-lake stations although the sampling at the inlet showed slightly elevated levels. Water column phosphorus does not generally relate to rooted plant growth as they obtain most of their nutrients from the pond sediment. In the hypolimnion, low oxygen levels can promote the release of phosphorus from the bottom sediments, which may build up over the summer due lack of transfer to the upper layer of the lake. Under prolonged layering and highly organic substrates, the build-up can be significant (on the order of 0.5-1.0 mg/l or more) and later cause algae blooms when the lake mixes in the fall. The hypolimnetic sample showed evidence of some buildup of phosphorus as compared to the surface samples but the concentrations were not indicative of severe phosphorus release.

Total & Fecal Coliform Bacteria – Coliform bacteria are naturally occurring in pond systems as well as resultant from human and animal inputs. While total coliform can be partly attributed to naturally occurring bacteria, fecal coliform is an indicator of the presence of human or animal waste inputs. In general, acceptable values in "swimmable waters" for total coliform is less than 1000 organisms per 100 ml, while for fecal coliform its 200 organisms per 100 ml. Bacteria tests were well within these acceptable limits, except for the July fecal coliform counts from the inlet.

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

Temperature/dissolved oxygen profiling at LSFP was performed in the southern end of the pond over the "deep hole". Measurements taken during the April survey showed that the lake was still mostly mixed with only a slight decrease in oxygen right near the bottom. The July measurements showed a strong temperature stratification between 4 and 5 meters and the dissolved oxygen levels were lower in the hypolimnion but not completely anoxic. During the September survey, the lake was strongly stratified with the boundary layer (thermocline) set up between 5-6 meters. The lake water below the thermocline was essentially devoid of oxygen while oxygenated water was at a temperature of ~72°F. While stratification and oxygen loss was clearly evident again this year, it was not as severe as in past years.

It is highly likely that past trout mortality is being caused by a lack of suitable coldwater habitat. Coldwater species like trout prefer water temperatures in the 50°-65°F degree range and may tolerate higher temperatures even up to 70-75°F for shore periods of time, although this does cause significant stress. Low or no oxygen in the cold water hypoliminion cause trout to escape to warmer layers which under high temperature conditions (like what was experienced the last couple of summer) can cause mortality. With less severe temperatures and oxygen loss this year, there were no reports of trout mortality.

Water clarity measurements were taken with a standard Secchi disk during each of the sampling rounds. Water clarity was ~ 10' 2" in April, 5' 8" in July and 17' 4" in September. Clarity was somewhat poor in April as compared to other years while the poor water clarity in July clearly indicated the presence of an algae bloom. Clarity in September was excellent.

Microscopic examination of samples collected during each visit to the pond is used to identify algal species presents and estimate cell density. The sample collected in April showed a low level of algae (~18,500 cells/ml) in the water column dominated by a variety of chlorophyte (green) species, diatoms and surprisingly some blue-green species. The July samples showed higher levels ~75,000 cells/ml dominated by green and blue-green species. While higher than usual for LSFP, the July count is still relatively low and not indicative of severe bloom conditions. Algae density decreased in Septmeber to ~25,000 cells/ml was dominated by a variety of green algae species.

Management Recommendations

After observing the continued milfoil control this year from the 2004 treatment, we see little chance of milfoil re-growth in 2013. In the event that some localized milfoil growth is observed, we may recommend some alternative methods of control including diver handpulling and/or benthic barrier. These methods are much more suitable for small infestation (<1/2 acre) and may help to prolong the duration of control before another treatment is required. More sizable infestations (> 1-acre) or ones located along with curlyleaf pondweed should be "spot" treated with the Reward (diquat) herbicide. If the Association decides to manage smaller areas of re-growth with hand-pulling, barriers or treatment, you may want to budget a contingency amount of ~$5,000-$7,500 to do so.

Past experience suggests that the curlyleaf pondweed population should be kept in check with periodic treatments. Continued periodic treatments of curlyleaf pondweed, performed before the plant produces its reproductive structures (called "turions") has shown at some waterbodies to result in a gradual, long term reduction of this highly invasive plant. A pre-treatment survey will be used to confirm if treatment is required in 2013. If needed, we estimate the cost of such a treatment to be in the range of $6,500-$7,500.

For 2013, we also strongly recommend continuing with an early & late summer vegetation surveys and three rounds of water quality sampling. The vegetation surveys will be important to monitor for re-growth of milfoil and document the presence and extent of other species in the pond. We recommend that you budget $3,500 for the two vegetation surveys and water quality monitoring sampling rounds. Continued monitoring of the pond is not only prudent but was also alluded to, if not required, by the Order of Conditions permit issued by the Town for this project. In the event that the Association moves forward with treatment of the curly-leaf pondweed, the cost of monitoring will be somewhat reduced as we can perform some of the monitoring tasks during our visits to the pond as part of the treatment program.

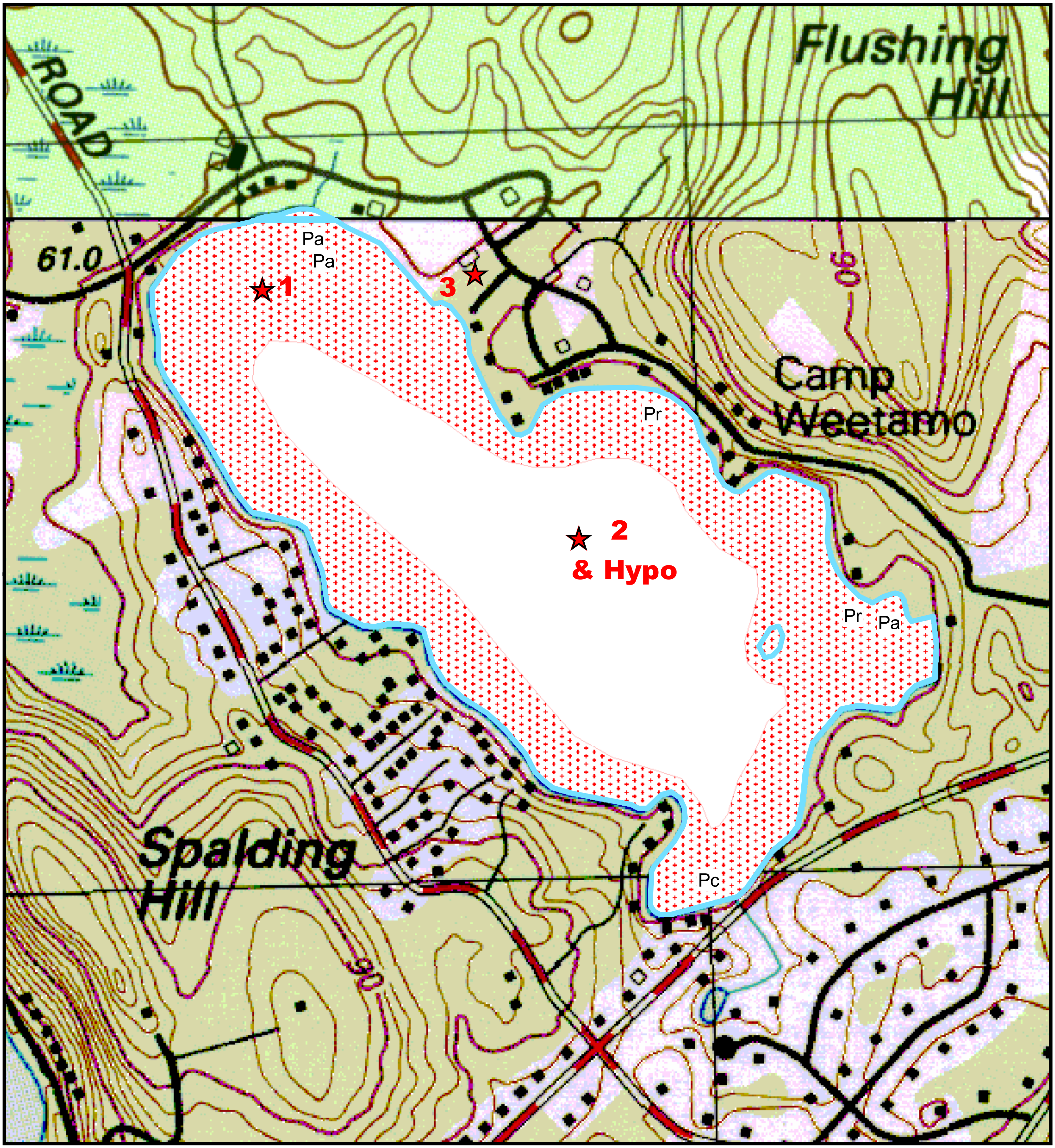
In regards to the depletion of oxygen in the hypolimnion and the potential for trout mortality and phosphorus release, we recommend continued assessment of the situation by again including a July sample round in the program and including hypolimnetic testing during all sample rounds. There are potential remedies for the situation, but it will be necessary to collect more data before any recommendations can be made. Remediation of this type is typically complex and costly.

We appreciate your cooperation with this past year's program and look forward to working with you again next year. If you have any questions, please feel free to give me a call. Please be sure to forward a copy of this report to the Conservation Commission.

Sincerely,
AQUATIC CONTROL TECHNOLOGY

Dominic Meringolo

Dominic Meringolo
Senior Environmental Engineer



Long Sought For Pond

Westford, MA

Spring Vegetation Distribution (2012)

FIGURE:	SURVEY DATE:	MAP DATE:
1	4/25/12	11/2011

Legend:

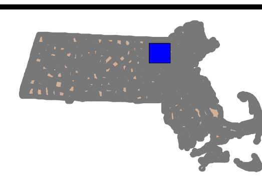
Sparse to moderate cover of stonewort with scattered Robbins pondweed

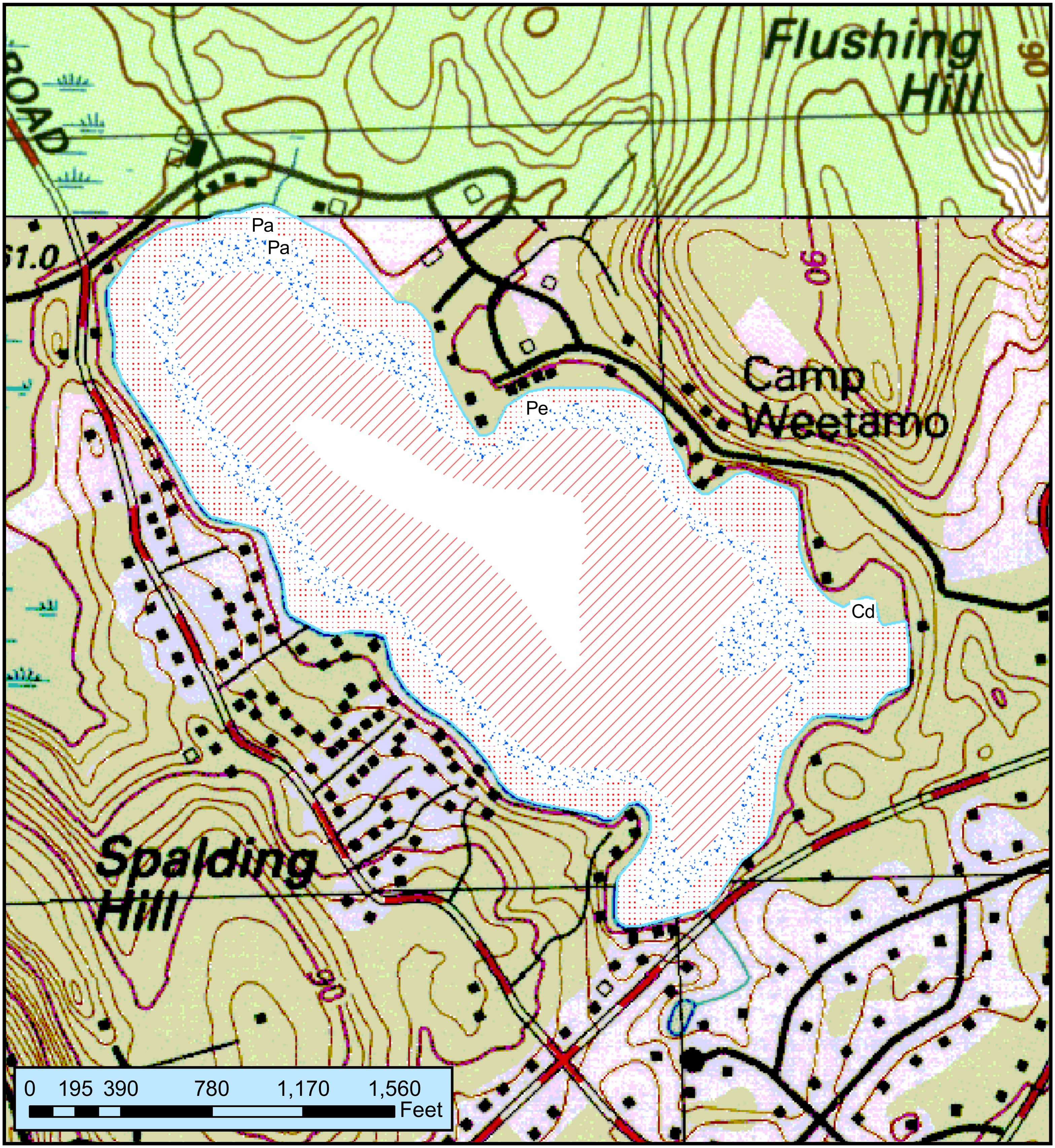
Pc - curlyleaf pondweed
Pa - largeleaf pondweed
Pr - Robbins pondweed

0 195 390 780 1,170 1,560 Feet

N

AQUATIC CONTROL TECHNOLOGY, INC.
11 JOHN ROAD
SUTTON, MASSACHUSETTS 01590
PHONE: (508) 865-1000
FAX: (508) 865-1220
WEB: WWW.AQUATICCONTROLTECH.COM





Long Sought For Pond

Westford, MA

Fall Vegetation Distribution (2012)

FIGURE:	SURVEY DATE:	MAP DATE:
2	9/13/2012	1/2013

Legend:

Generally sandy with sparse growth of tapegrass and Robbins pondweed

Moderate to dense growth of tapegrass with bladderwort and robbins pondweed common

Robbins pondweed common with sparse bladderwort and stonewort

Pa - largeleaf pondweed
Pe - ribbonleaf pondweed
Cd - coontail

N

AQUATIC CONTROL TECHNOLOGY, INC.
11 JOHN ROAD
SUTTON, MASSACHUSETTS 01590
PHONE: (508) 865-1000
FAX: (508) 865-1220
WEB: WWW.AQUATICCONTROLTECH.COM