

March 15, 2011

Ms. Joanna Bilotta, President
Lake Shirley Improvement Corporation (LSIC)
PO Box 567
Shirley, MA 01464

Re: Report on Post-Treatment Inspection and 2010 Project Completion Report

Dear Joanna:

This report provides an overview and summary of the past year's Aquatic Management Program at Lake Shirley. Attached to this report are also included; our pre-treatment watermilfoil survey report/memo; a map showing the area of herbicide weed treatment in 2010. We're also providing two plots (graphs) showing algal density, algal composition and Secchi Disk water clarity during the late June –Sept. period in both the north and south basins of the lake. A chronology of the 2010 Management Program activities follows:

- ◆ *Issuance of License to Apply Chemicals permit from MA DEP* April 21st
- ◆ *Pre-treatment milfoil & aquatic plant inspection with LSIC* June 5th
- ◆ *Herbicide (Reward/Diquat) treatment* June 23rd
- ◆ *Periodic lake inspections (a minimum of 5 separate and additional visits to the lake)* May-Sept.
- ◆ *Monitoring of microscopic algae and Secchi Disk water clarity* Jul y - Sept.
- ◆ *Post-treatment & late summer plant inspection* Sept.25th

Pre-Treatment Survey & Herbicide Weed Treatment:

The timing/date for our pre-treatment milfoil survey on June 5th was set after the LSIC Board members (whom were actively checking and looking for milfoil during May and June) began to see some significant rooted plant growth in the lake.

During the pre-treatment survey on June 5th and the final late summer survey of Sept. 26th, I was again accompanied by several LSIC Board members, including, Earl Graves, Jackie Ramondelli, Mike Mandella and Joanna Bilotta. It's helpful that they also see and can confirm my field observations in addition to our exchange of information and coming to agreement as to those areas of the lake that warrant herbicide treatment. During both surveys, we spent the morning into the afternoon, traveling around the perimeter (shoreline) of the lake and into the coves, in search of milfoil and other aquatic plants. Plant survey techniques that were employed in the field, included; visual observation; use of a "throw-rake" and; use of an "Aqua-Vu" underwater camera system.

The pre-treatment survey determined that the overall area of invasive watermilfoil and curlyleaf pondweed warranting herbicide treatment this past summer amounted to 68 acres. This acreage (68 ac.) was slightly less than 2009 (at about 70 acres) and substantially less than our very first herbicide treat of Lake Shirley performed in 2007 when we chemically treated approximately 102 acres of invasive watermilfoil. Some reduction in treatment area is typically seen in the year

following treatment with Reward (active ingredient “Diquat”), however, Reward being a “contact” acting herbicide, it doesn’t necessarily kill the roots of the milfoil. In 2008, we were pleasantly surprised to see very little re-growth of milfoil. Herbicide treatment was performed in just one cove (referred to as Millionaire’s Cove) in 2008, encompassing just ~ 10-12 acres out of the total lake area.

The 2010 Diquat herbicide treatment performed on June 23rd proceeded smoothly. As with previous year’s treatment’s, the lake community and towns were again notified prior to treatment by LSIC, employing several means of notification, including; placement of a written notice in the newspaper(s); placement of large, printed signs at major road intersections/locations around the lake; posting of numerous 8.5” by 11” orange colored, printed signs around the lake shoreline and; other means of communication/notification as well.

The treatment was again performed from one of our 18 foot Airboats equipped with a tank, pump and a special chemical injection system. The diluted chemical was again applied sub-surface through weighted hoses that trail the Airboat, in order to eliminate the potential for aerial drift of the herbicide. GPS guidance was employed on the Airboat to track the location and passes of the boat during the treatment process. The dose of Reward herbicide applied this year was approximately ~ 0.75-1.25 gals/acre or similar to 2009 but somewhat less than first applied in 2007, given the high sensitivity of the milfoil to Reward previously observed in Lake Shirley. The dose applied was/is substantially less than the maximum permissible dose on the Reward/Diquat label of 2.0 gals/acre. I was again present to perform and oversee the chemical treatment with assistance from one of our other Biologists. Board members from LSIC followed our Airboat at a safe distance to insure that all targeted areas were treated and to advise anyone whom may have been out on the water that day that the lake was closed.

Post-treatment Well Sampling/Testing for Herbicide Residues:

Water samples were again collected from two wells (the Bowen & Holman wells) by LSIC at three and five days post-treatment. The Bowen well is located at 28 Oakridge Rd., and Holman at 885 Flat Hill Rd.. These well water samples were again analyzed for Diquat (the active ingredient in Reward herbicide) by Chem. Serve Laboratories in NH. During the previous three years of Diquat treatment at the lake, all sample test results were reported at less than 5 ug/l or essentially “non detect”. This year’s test results surprisingly reported 21 ug/l three days post-treatment at the Holman well but declined to 6.4 ug/l five days post-treatment. The Bowen well results were <5ug/l at three days post-treatment and 6.4 ug/l at five days. The drinking water limit for Diquat is < 20 ug/l, therefore, the initial test results on the Bowen well at three days post-treatment was slightly greater than the 20 ug/l upper limit for Diquat but this level declined to well below the maximum permissible limit at 5 days post-treatment.

Interestingly this year, the Laboratory had a footnote of (LH) as a “Qualifier” on the written lab report. for all four lab test results LH is reported by the Lab to mean “*Laboratory control spike (s) was high. Results may be biased high.*” This qualifier makes the validity of these test results suspect.

It’s well established in the literature and from testing performed elsewhere, that Diquat is readily bound by soils and does not leach/move in groundwater. There’s no verified occurrences (to the best of our knowledge) of Diquat ever contaminating well water following an aquatic treatment to a level where the well was not potable.

Algae & Water Clarity Monitoring & Algaecide Treatments:

Water clarity was again monitored and measured with a standard Secchi Disk between June and September by Earl Graves. Measurements were taken from both the north and south lake basins. As clarity declined in early July, water samples were also collected by Earl and delivered to Aquatic Control. July and August are when microscopic blue-green algal densities typically peak and recreational use of the lake is at its maximum. The water samples that we received were examined microscopically by Biologists with Aquatic Control. Fresh samples were generally examined shortly after receiving the samples and then preserved for further analyses at a later date if found to be necessary.

Water clarity can be affected by not only algae type and size but also by non-living particulate or colloidal matter. This may include suspended silt and organic matter in addition to naturally occurring dissolved tannic/humic acids that tend to impart a darker “tea color” to the lake water.

Separate plots/graphs are provided for both the north and south lake basins. From these plots, one can see the relationship during the period between mid-July to the end of August, among Secchi Disk transparency (water clarity), total algal density (count) and the density/count for blue-green algae alone. During this monitoring period, clarity was generally greater and the algal cell count lower in the south basin, as has been the pattern seen in the prior years of monitoring Lake Shirley. This can likely be attributed to the fact that the majority of surface water flow and the stream inlets enter the lake’s north basin. As the plant nutrients (phosphorus and nitrogen compounds) are first assimilated by the weed and algae growth found in the north basin, along with some further reduction due to settling of suspended matter, nutrient concentrations entering the south basin are probably lower, resulting in less algae growth and therefore, somewhat better water clarity.

Prior to early July, water clarity was good and typically ranged between roughly 6 and 9 feet. Clarity declined to slightly less than 5 feet in mid-July in the north basin, therefore, an algaecide treatment was tentatively scheduled. For maximum effectiveness and to avoid oxygen loss post-treatment, it’s best to treat the algae before water clarity has plummeted to say just 2-3 feet and the water surface has formed a dense surface film of algae. Furthermore, timely treatment is necessary to preserve the recreational quality of the lake for swimmer enjoyment and safety, along with other water contact activities.

Close, continued monitoring of water clarity by Earl throughout July and multiple inspections/visits to the lake by me continued. Fortunately and somewhat surprisingly, water clarity stabilized and began to increase with a continued dominance of “green algae” types as opposed to the “blue-green” species of algae. We therefore, postponed the algaecide treatment that had been previously scheduled. Water clarity continued to improve and was comparatively good for Lake Shirley during most of August. By late August, however, clarity again began to decline as the density of blue-green algae had sharply increased. Clarity remained acceptable, however, through the busy Labor Day weekend. Based on discussions with LSIC it was jointly decided not to perform an algaecide treatment in September, considering that swimming and recreational use on the water would soon be on the decline and come October and beyond, the algae would naturally die-off as the water temperatures began to cool.

The far lower amount of rainfall occurring this past June and July as compared to the previous two “wet” summer’s, may well have resulted in a lower nutrient loading to the lake in 2010. While June and July water temperatures were very high/warm this past year, it’s been our observation at Lake Shirley that in those years with higher rainfall amounts during the May through July period, there’s a greater potential for nuisance algal blooms to soon follow. We also recall previous mention of this by others.

While both “green and blue-green” algae types can bloom and reduce water clarity in a waterbody, it is the blue-green species such as *Anabaena*, *Microcystis* and *Aphanizomenon* that typically form the dense surface blooms of algae visible on the water surface.

Most species of blue-green algae are generally sensitive and respond well to the copper sulfate algaecide, however, there are some exceptions. A number of unicellular and colonial species of green algae and other algal types (ie; diatoms and flagellated algae) on the other hand, tend to be more tolerant to the low dose of algaecide used and permitted at Lake Shirley. Species belonging to the group referred to as “green algae”, therefore, may not respond as well to the copper treatments. In addition, many of these non-blue-green algal cells are small in size, therefore, a higher total algae count but with few if any blue-greens may actually represent a lower total biomass of algae suspended throughout the water column.

The buoyant blue-green algae are more apt to form the surface “scums” of algae sometimes seen throughout the lake. When blue-green algae dominate the algal counts and their numbers are rapidly increasing and approaching “bloom” densities, that is the time to perform an algaecide treatment.

A surface water sample collected from the lake’s north basin was collected on September 20th and sent to Greenwater Laboratories for analyses of two potential algal toxins - microcystin and Anatoxin-a. This sample was collected at the time of a blue-green algal bloom with poor water clarity and a high algae count dominated by two common blue-green types, *Anabaena* and *Microcystis*. While it was good to see the results for both tests come back as “non-detect,” lake residents and other users of Lake Shirley are still advised not to swim or have other water contact when a “film or slick” of blue-green algae are visible on the water surface.

In summary, it was encouraging to see that no algaecide treatment was warranted or performed in 2010. Careful monitoring of the lake through the combined efforts of LSIC and Aquatic Control proved to be effective in reaching prudent decisions relative to the lake’s management. In future year’s, when blue-green algae dominate the algae counts and their density reaches pre-bloom levels, that is the time to treat with an algaecide. On the other hand, should water clarity be getting somewhat reduced and :”green algae and other non-blue-green algae” dominate the water sample, then a more cautious approach to proceeding with treatment should be followed.

..
Final Post-Treatment Survey:

We know that from our interim inspections in July and August that the June herbicide treatment effectively controlled and reduced the invasive watermilfoil, European naiad and curlyleaf pondweed in those areas that were targeted and sprayed. While we also check these treatment areas again, our late summer aquatic plant survey of Lake Shirley is generally qualitative in scope. We are interested in identifying potential new areas of invasive plant growth (ie; watermilfoil, fanwort, spiny naiad and curlyleaf pondweed) and examining the lake’s overall plant community including native vegetation.

We travel around the entire shoreline and littoral area (the shallow area of a lake that supports plant growth) of the lake, taking special note of invasive plants along with other native plants as well. Given the increase in curlyleaf pondweed seen in early June of this past year and European (spiny) naiad seen in September 2009, we try to identify areas of the lake where management and

treatment may be required in the coming year. We're also constantly on the look-out for possible new invasive plants that may not have been previously found or identified at Lake Shirley. Early detection and timely eradication/control measures may prevent a new invasive plant from becoming firmly established in the lake.

Other non-native and invasive plants are also noted and recorded as are the more dominant native plants. Relative plant abundance that we report is based on percent bottom cover of the different plants. These abundance/cover ratings range from; sparse (<5%); frequent (>5-25%); common (>25-75%) and abundant (.75-100%).

In comparison to our late summer survey results of 2007 and 2008, the 2009 and 2010 surveys showed greater plant cover in many areas of the lake and somewhat higher biomass (i.e.; the extent that plants fill the water column). Like Geosyntec, we also noted a large increase in the distribution and abundance of muskgrass/stonewort and tapegrass (wild celery) throughout the lake in September 2010. European or spiny naiad was probably the third most frequently encountered and abundant plant that was encountered. Both naiad and tapegrass are known to be relatively tolerant to "drawdowns" and may even increase some following drawdown. Naiad is an annual plant that reproduces from seed, therefore, it relatively unaffected by drawdown. These three plants in particular, are filling the void left by the invasive watermilfoil. None of these species, however, impairs habitat and recreational uses quite to the extent that the dense surface canopy of milfoil does. The European (spiny) naiad and curlyleaf pondweed, however, are also invasive and both warrant aggressive. Management.

The greater dominance of muskgrass observed this past year is a positive change in the lake's plant community. Muskgrass provides valuable cover for aquatic invertebrates and juvenile fish while on the other hand helping to reduce wind-driven and motorboat induced turbidity and the release of nutrients (phosphorus and nitrogen) from the sediments. Where the muskgrass forms a dense blanket on the lake bottom it acts somewhat like a mulch in a vegetable garden and the muskgrass also prevents or at least slows down the spread of non native invasive plants. Fortunately muskgrass generally grows low to the bottom and is generally not affected by the Reward herbicide or the low dose of algaecide's that are applied to the lake. Wild celery or tapegrass is generally a desirable plant but can become locally dense and problematic to swimming and other recreation in some areas.

While in 2009 we found an obvious increase in the distribution of highly invasive and problematic fanwort (*Cabomba*), we fortunately did not see much of a change in its overall distribution this past year. *Cabomba* distribution deserves close watching but it hasn't appeared to spread to the extent that we might have anticipated. Continuing with fall/winter drawdowns of the lake's water level to maximum drawdown depth that can be permitted will be important to trying to prevent fanwort from becoming a significant problem weed in Lake Shirley. Seeking to restore permit approval for a fall/winter drawdown of at least eight feet is strongly recommended, assuming the obstacles that led to drawdown being discontinued at Lake Shirley can be resolved. There is currently no aquatic herbicide registered in MA that will effectively control fanwort other than the costly Sonar (Fluridone).

Our observations on September 25th follow. These observations correspond to the accompanying map/figure, which is also attached.

Plant Survey Findings – Late Summer

| <i>Area No:</i> | <i>Plants Observed:</i> |
|-----------------|---|
| 1 | spiny naiad (sparse); frequent tapegrass (wild celery) |
| 2 | fanwort (frequent and patchy throughout this area) ; muskgrass/stonewort (common) |
| 3 | tapegrass (frequent); muskgrass/stonewort (common). |
| 4 | tapegrass (sparse); muskgrass/stonewort (frequent) |
| 5 | tapegrass (sparse); muskgrass/stonewort (common) |
| 6 | tapegrass (common); muskgrass/stonewort (common) |
| 7 | tapegrass (common); muskgrass/stonewort (abundant); Note: tapegrass widely distributed along shore between locations 6 and 7. |
| 8 | spiny naiad (common); tapegrass (frequent) |
| 9 | spiny naiad (frequent); muskgrass/stonewort (abundant); tapegrass (frequent) |
| 10 | thinleaf pondweed (abundant); tapegrass (frequent); muskgrass/stonewort (frequent) |
| 11 | tapegrass (common) |
| 12 | muskgrass/stonewort (abundant) |
| 13 | Eurasian watermilfoil (sparse); tapegrass (common); ribbonleaf pondweed (common) |
| 14 | tapegrass (common); bladderwort, muskgrass/stonewort and fanwort (all frequent) |
| 15 | tapegrass & muskgrass/stonewort (common); bladderwort & spiny naiad (frequent) |
| 16 | tapegrass (abundant); spiny naiad & muskgrass/stonewort (frequent) Note: |

- tapegrass common to abundant throughout this area.
- 17 tapegrass (common); spiny naiad & filamentous algae (frequent)
- 18 tapegrass (common); spiny naiad and thinleaf pondweed (frequent)
- 19 pondweed tapegrass and spiny naiad (common); muskgrass/stonewort & thinleaf
(frequent)
- 20 spiny naiad; muskgrass/stonewort & tapegrass (all sparse)
- 21 muskgrass/stonewort & spiny naiad (sparse)
- 22 muskgrass /stonewort & tapegrass (common & widespread)
- 23 tapegrass (common); muskgrass/stonewort (frequent)
- 24 tapegrass (abundant & widespread)
- 25 tapegrass (common & widespread)
- 26 fanwort (frequent); spiny naiad (common)

Anticipated Management in 2011:

Based on the results of our late summer 2010 plant survey/inspection, we anticipate seeing a moderate amount of invasive milfoil re-growth next spring. We also expect that areas of the lake will warrant treatment for the invasive and non-native curlyleaf pondweed which had expanded some this past spring, along with European naiad (aka; spiny naiad) weed. We anticipate that treatment of roughly 70 acres may be required again in 2011, however, there's no way of knowing just what the invasive and nuisance plant growth will actually be until the pre-treatment survey is performed.

The two plant surveys (June and September) continue to work well to monitor the lake's plant community and to guide the aquatic herbicide treatment program. Monitoring of water clarity and algal populations as has been done in 2010 and in prior years, provides timely information to guide algaecide treatments should such treatments be warranted.

We recommend LSIC continue to pursue an integrated approach of in-lake management, utilizing drawdown and herbicide/algaecide treatment as required and appropriate. Naturally, watershed

management and public education are also very important and they must be ongoing as well. We hope this report will be of help to LSIC in planning for 2011 and beyond. Thank you.

Sincerely,

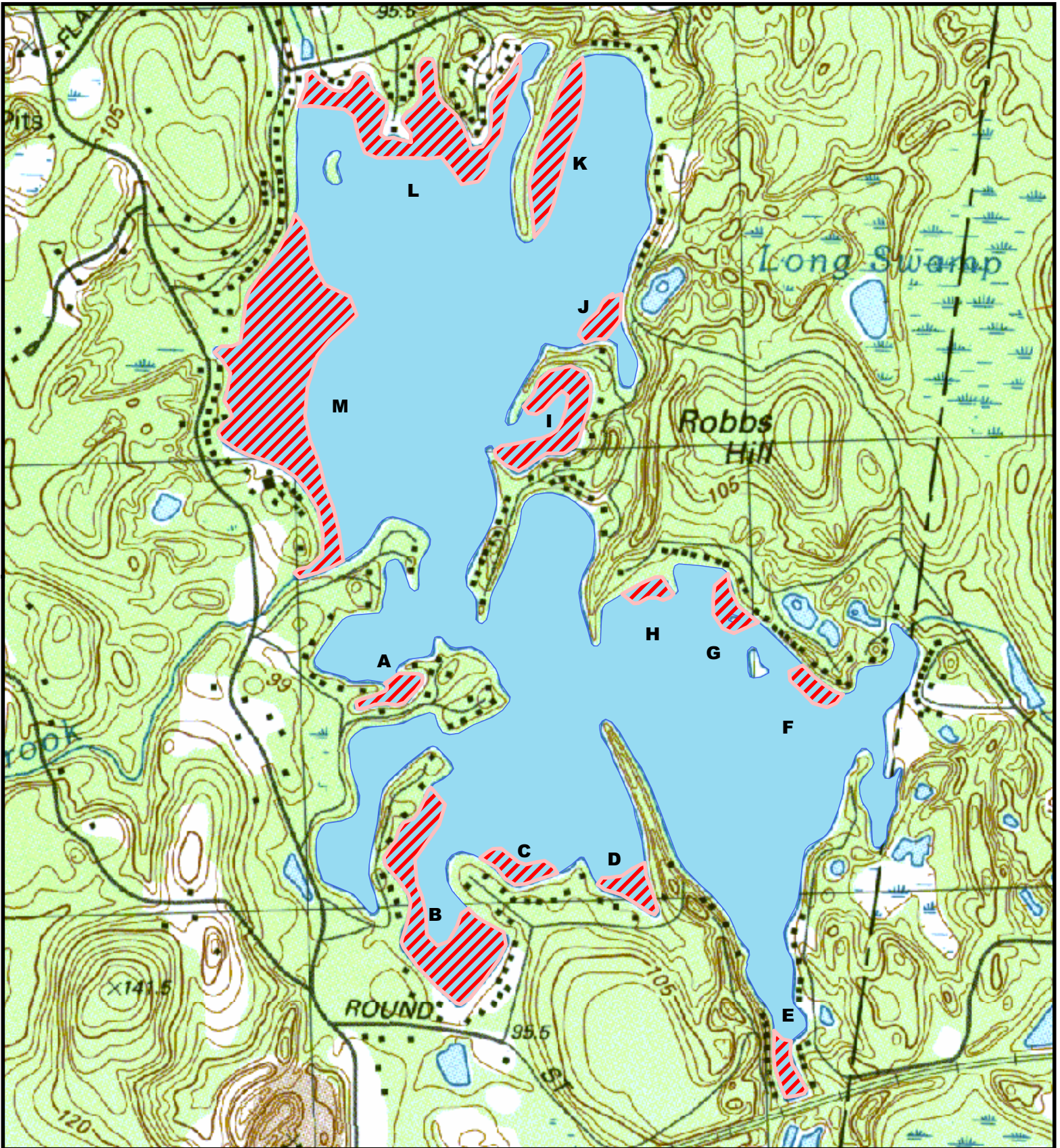
AQUATIC CONTROL TECHNOLOGY, INC.



Gerald N. Smith
President/Aquatic Biologist

Enclosures:

- >Treatment Area Map 2010
- >Water clarity & Algae Count Comparison Charts
- >Aquatic Plant Sampling Locations – 9/25/10
- >2010 Pre-treatment Survey Report



Lake Shirley

Lunenburg/Shirley, MA

2010 Treatment Area

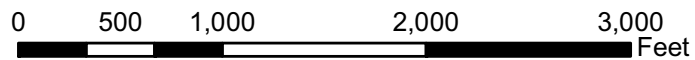
| FIGURE: | SURVEY DATE: | MAP DATE: |
|---------|--------------|-----------|
| 1 | 6/2010 | 6/9/10 |

Legend:



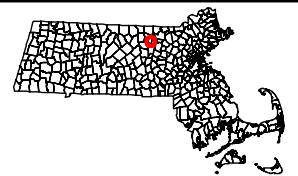
Treatment Area

Total Treatment Area: 68.4 acres

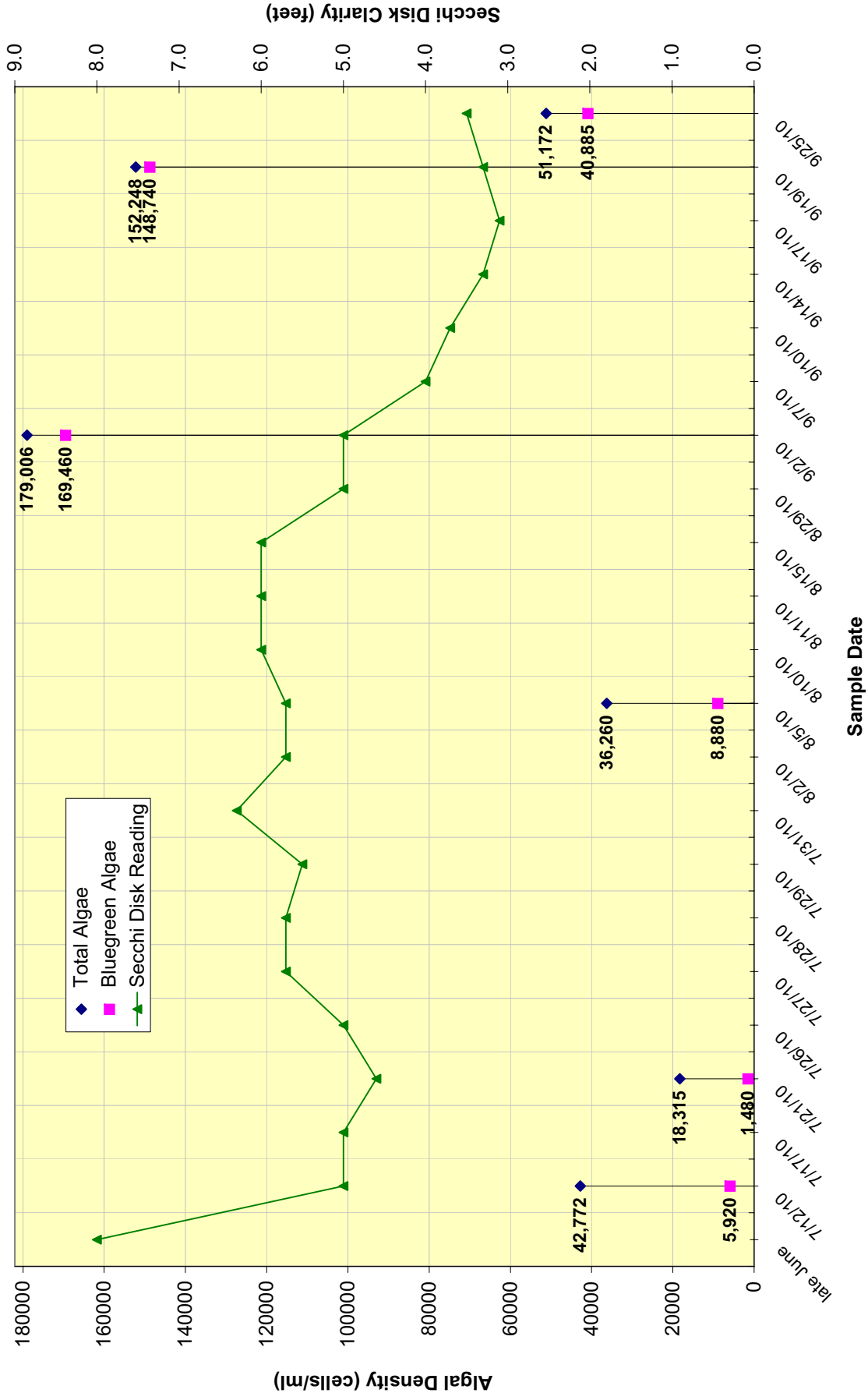


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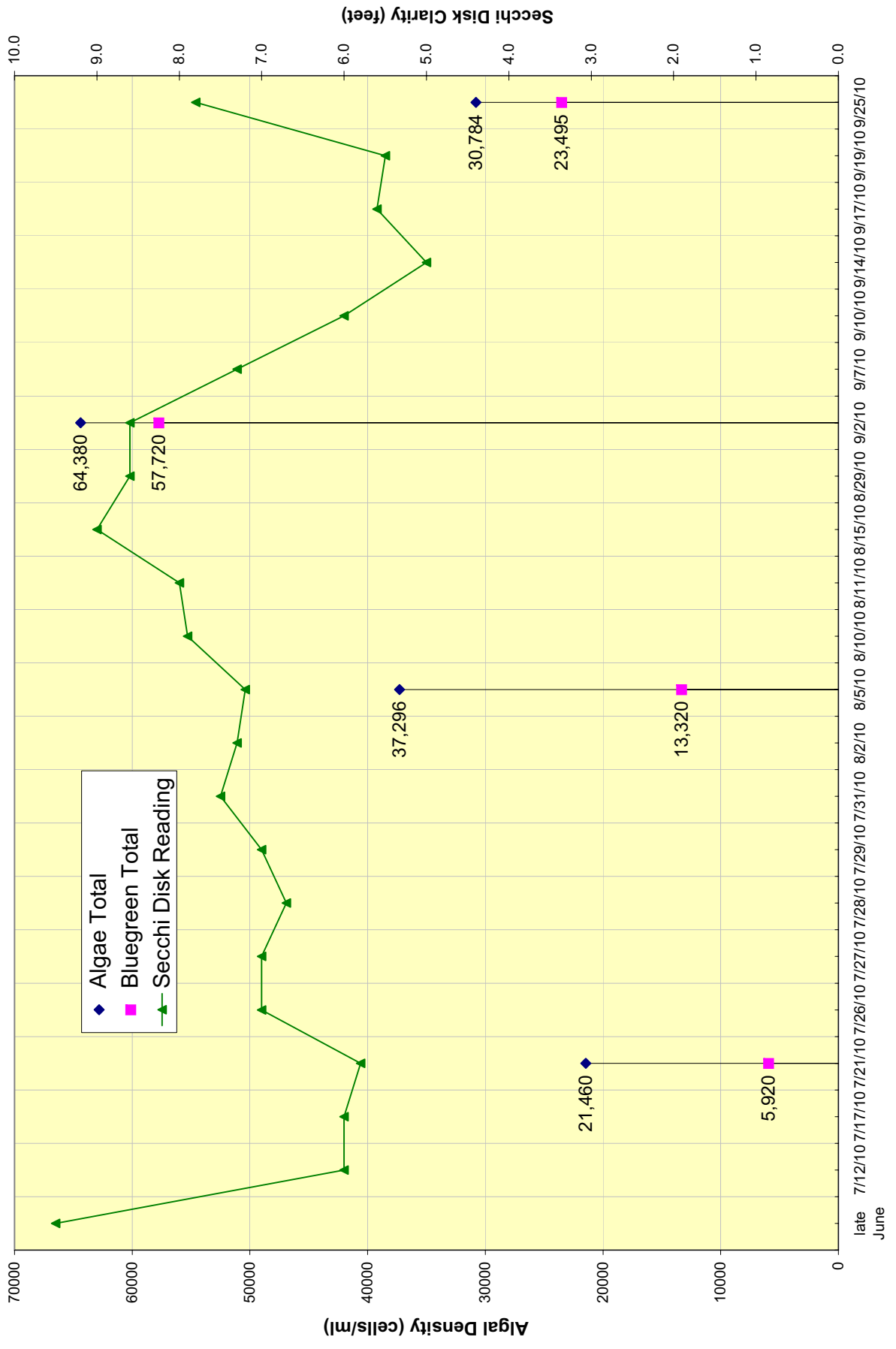
11 JOHN ROAD
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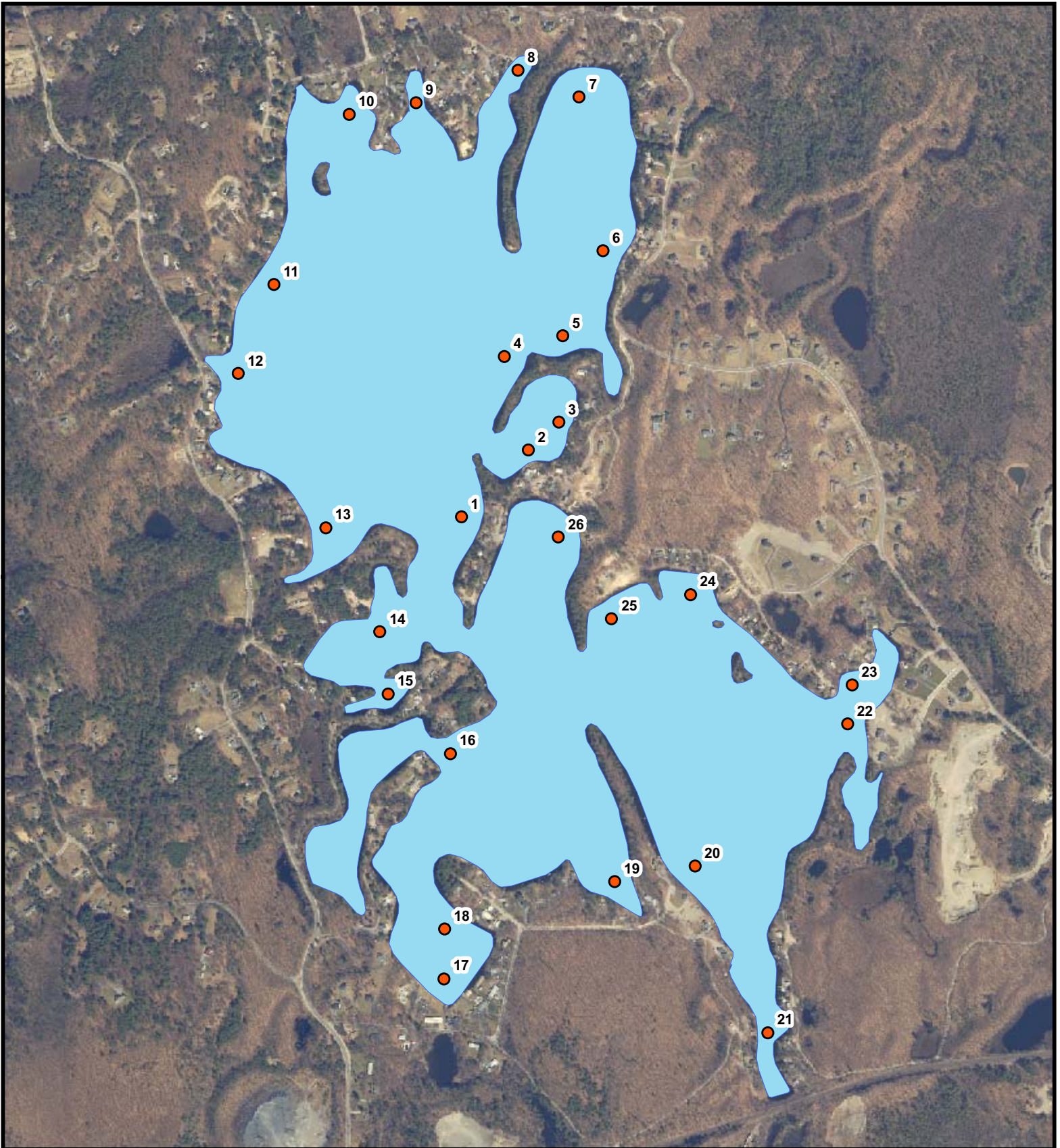
Secchi Disk Water Clarity and Algae Count Comparison for North Basin - Lake Shirley 2010



Secchi Disk Water Clarity and Algae Count Comparison for South Basin - Lake Shirley 2010



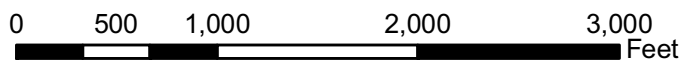
Sample Date



Lake Shirley
Lunenburg/Shirley, MA
Plant Sampling Locations

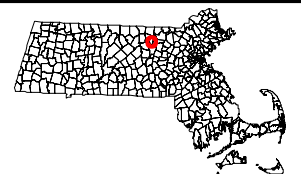
Legend:

- Plant sampling locations during 9/25/10 survey



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| FIGURE: | SURVEY DATE: | MAP DATE: |
|---------|--------------|-----------|
| 1 | 9/25/10 | 2/24/11 |

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Date: June 5, 2010

To: Joanna Bilotta; President, Lake Shirley Improvement Corporation

From: Gerry Smith; President/Aquatic Biologist

Re: **Plant Survey & Aquatic Plant Inspection of June 5, 2010 – Lake Shirley**

This memo summarizes the findings of our Milfoil Survey and Aquatic Plant Inspection of Lake Shirley performed on the morning of Saturday June 5th. Previous cursory inspections of the lake over the Memorial Day weekend by LSIC Officers and Board members, indicated that the milfoil and other plants were actively growing and visible from the water surface. I performed this survey/inspection accompanied by yourself and two other Board members of the LSIC. The water clarity was very good for Lake Shirley at between ~ 8.5 and 9.6 feet. The water surface was calm and the skies were generally sunny. These conditions allowed for good visibility into the water to identify and locate milfoil and other aquatic plants.

The survey was performed from a Pontoon Boat, while traveling around the entire shoreline and littoral (shallow water) zone of Lake Shirley. Given the overall shallow depth of the lake, additional transects were made across the coves and open-water portions of the lake to also survey for and characterize the distribution of milfoil and other invasive plants. A combination of survey techniques were utilized, including; visual observation, use of a "throw-rake and an Underwater View Scope. Milfoil and other aquatic plants were noted and recorded.

We observed milfoil growth in water depths of up to about 9 feet. Of the two invasive and non-native milfoil species found in Lake Shirley, Eurasian watermilfoil comprised 95% or more of the milfoil we observed, with approximately 5% or less of the milfoil, being variable watermilfoil. We also observed considerable cover of another invasive, submersed plant, curlyleaf pondweed. The growth of invasive European naiad was just beginning and evident, whereas this is an annual plant that grows from seed. Invasive fanwort was still low in the water column whereas its growth lags far behind the watermilfoil species during late spring and early summer. As the summer progresses, fanwort will be come more evident.

Some of native aquatic plants also observed during the survey, included, coontail, bushy pondweed, bladderwort, sago pondweed, wild celery, ribbonleaf pondweed, waterlilies and two macro-algae called muskgrass and stonewort. The growth for many of these native species was just beginning and typically lags behind the early season and aggressive growth of milfoil and curlyleaf pondweed.

A map of proposed Treatment Areas is attached. Based upon our survey findings, we recommend approximately 68 acres of the total lake area be chemically treated with Reward (Diquat) herbicide. This 68 acres is just under the 70 acres treated last year and still substantially less than the approximate 102 acres that were treated in 2007. No chemical treatment will occur within Shirley. The attached map represents milfoil cover, in most treatment areas, of generally between > 5% and 100% and was judged by myself and other participants during the survey to represent an impairment to the normal uses of Lake Shirley and not feasible to manage with "hand-pulling" or other non-chemical

techniques. Aggressively managing these invasive species now, is especially important in trying to reduce their further spread throughout Lake Shirley, to prevent degradation of fish and wildlife habitat

We are targeting chemical treatment of Lake Shirley for Wednesday, June 23rd. The lake will be closed to all water uses, including swimming, fishing and boating on that day. There will be an additional restriction on water use for irrigation, watering livestock and drinking purposes for 5 days. We have recently sent you a written "notice of treatment" for you to publish in the local paper(s) and we will also mail you printed signs for you to post around the lake shoreline a few days prior to treatment.

We'll again be treating with the Reward (Diquat) herbicide as we have in prior years. Considering the high sensitivity of the milfoil and curlyleaf pondweed in Lake Shirley to the Reward herbicide, we'll be treating at a low rate (dose) of ~ 1.0 gal per treated acre of vegetation. In areas which have mixed populations of invasive milfoil and/or curlyleaf pondweed along with invasive naiad, we'll need to treat at ~1.25-1.5 gals/acre. Maximum USEPA label rate for Reward is 2.0 gals/acre.

I hope this information is helpful to LSIC. Feel free to forward this memo to the Conservation Commissions and other appropriate parties. Thank you.