TRUESDALE LAKE PROPERTY OWNERS ASSOCIATION
SOUTH SALEM, NY

2005 AQUATIC PLANT MANAGEMENT PLAN TRUESDALE LAKE

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I. Introduction

Truesdale Lake is an 83 acre lake situated in South Salem (Westchester County), New York. The lake has an average depth of six feet, and a maximum depth of 11 feet. The bottom substrate is predominately organic and silt deposits with select locations of sand and gravel. The watershed is approximately 2380 acres. The lake's shoreline is entirely residential in land use, and approximately 73% of the lake is considered littoral zone. The lake is used for swimming (there are two beaches), fishing, and non-motor boating, and is a focal point for the surrounding community. Located in the appendix is a map depicting Truesdale Lake, with important features labeled.

Truesdale Lake has two property associations. Members from both of these associations comprise the lake management committee, which has the authority to make lake management decisions. The committee maintains an excellent website (www.truesdalelake.com) to inform the residents on lake management projects, as well as posting various news articles and reports on water quality and aquatic plant issues. The Association meets monthly to discuss lake management issues.

II. Problem Statement

Aquatic Macrophytes in Truesdale Lake

According to the Truesdale Lake Property Owners Association, excessive aquatic plant growth has existed in Truesdale Lake since the late 1950's. Aquatic macrophytes that reach nuisance densities include pondweeds (leafy pondweed, and the invasive exotic curly-leaf pondweed) and the native waterweed (*Elodea*). Over the past ten years, the extent of plant growth and invasive plant growth has not increased significantly. This is due to seasonal plant management activities, and the fact that all areas of the lake inhabitable by said species are already colonized. Should other invasive species be introduced which are capable of growth in deeper water, total plant coverage would probably increase.

Any discussion of vegetation in Truesdale Lake must also include algae. As plants reach the surface in Spring, they are quickly colonized by filamentous algae. The lake also seasonally supports *Nitella* sp., a macroalgae. However, the most problematic algae growth occurs following plant management activities each summer, when the algal population shifts to produce extensive phytoplankton blooms. This is the most prolific type of algae in Truesdale Lake, and has been for at least the last decade. The frequency and intensity of algae blooms are influenced by both plant management techniques and summer weather trends.

Swimming and boating activities are the major lake uses impaired by excessive aquatic macrophyte and plankton densities. The lake does not allow motorized boats, but does host a Sunfish sailboat fleet with weekly events. Fishing is also listed as a lake use, though the Committee did not indicate fishing as an impaired use. However, with excessive macrophyte growth at the water's surface, it's likely this use would be impaired as well, should plants be left unmanaged. In addition, invasive exotic species (such as curly-leaf pondweed) tend to reduce overall aquatic macrophyte diversity. This is clearly seen in the results of the July 7th aquatic vegetation survey, as only three different species (and benthic filamentous algae) were observed. This reduced diversity will in turn reduce the diversity of other aquatic biota such as fish and aquatic macro-invertebrates.

In 2005, five aquatic macrophytes, along with benthic filamentous algae were observed by Allied Biological field crews. Observations occurred during all surveys and herbicide treatments. On July 7th, a detailed, DGPS-logged aquatic vegetation survey was performed. Located in the appendix are several maps depicting the sampling stations used during this detailed survey, water depths, and aquatic macrophyte density at each station. Please reference that report for more details of the survey and the results. It is important to note that this survey was conducted 10 days after a contact herbicide treatment, hence the relatively low densities of aquatic macrophytes observed. Had the survey been performed four weeks earlier, dense pondweed growth would have been evident throughout much of the lake. In fact, pictures also present in the Appendix will attest to the extent of Leafy and Curlyleaf Pondweed growth found in the lake prior to management in 2005. The height and density of plants were particularly troublesome this season since permit approval was delayed, and treatment occurred at least a full month later than normal.

Below is a table listing all species identified by Allied Biological during 2005 and recent seasons. Two species also appear which were identified by CSLAP volunteers*.

Scientific Name	**Common Name(s)**
Nitella sp.	Stonewort, nitella
Najas guadalupensis.	Southern naiad
Najas flexilis	Slender naiad
Elodea canadensis	Common waterweed, elodea
Potamogeton crispus	Curly-leaf pondweed
Potamogeton foliosus	Leafy pondweed*
Nuphar advena	Spatterdock*

Table 1. Truesdale Lake Aquatic Macrophytes

According to the Natural Heritage Report on Rare Species (January 19, 2005), no rare, threatened, or endangered aquatic plants, or animals are known to inhabit Truesdale Lake. Only one rare species is known to inhabit areas within 1 mile of Truesdale Lake. The species in question is the bog turtle, *Clemmys muhlenbergii,* which is listed as endangered in New York State, and threatened on the Federal listing. The appendix contains Natural Heritage documentation on this species.

Water quality monitoring of Truesdale Lake has been performed by the CSLAP program for the past five years. Samples were collected on 7-8 dates during the season for a variety of parameters. These include Secchi depths (visibility), total phosphorous, nitrate, ammonia, total nitrogen, nitrogen/phosphorous ratio, pH, conductivity, and chlorophyll *a*. In addition to the CSLAP program, Allied Biological has collected dissolved oxygen data from the past decade or more before all aquatic pesticide treatments. The last four year's oxygen data is presented in graph form in the appendix of this plan.

In Truesdale Lake, dissolved oxygen measurements on all sampling dates were suitable to support a diverse range of aquatic biota. The lowest measurement was 5.5 mg/L (in August 2002), but dissolved oxygen (DO) typically ranges from 7.0 mg/L to 12.0 mg/L. Generally, DO readings by Allied Biological are taken between the hours of 11am and 4 pm, when plant and algal photosynthesis would be high. DO readings in the early morning may provide better insight to the lower range of oxygen concentrations, particularly during algae blooms in late summer.

Both nitrogen and phosphorous are needed to fuel aquatic macrophyte and algae growth. However by calculating the ratio of these two nutrients, one of these can be considered the limiting factor regarding excessive macrophyte or algae growth. A total nitrogen/total phosphorous ratio <7 indicates nitrogen is the limiting nutrient. A total nitrogen/total phosphorous ratio >10 indicates phosphorous is the limiting nutrient. In recent years, the total nitrogen/total phosphorous ratio varied from a low of 7.56 in 2003 to a high of 17.16 in 2004. In 2002, the ratio was 14.25. These ratios reveal that nitrogen was probably the limiting nutrient in 2003, but phosphorous was the limiting nutrient in 2002 and 2004. (Average annual total phosphorous levels fall between 0.039 mg/L in 2004 and 0.069 mg/L in 2001). The impact of this 2003 reverse in N:P ratio is reflected in management activities that year, which deviated from the normal pattern. Control of plants was delayed until late June, 2003, and only two algaecide applications were required.

Chlorophyll a levels were high from 1999 to 2001, at 39.22 ug/l, 34.89 ug/l, and 34.41 ug/l, respectively. However, from 2002 to 2004, the chlorophyll a levels decreased significantly to 15.27 ug/l, 17.9 ug/l, and 18.67 ug/l, respectively. Spring chlorophyll a readings provide a key trophic status indicator. However, chlorophyll a does not differentiate between algae types, and therefore doesn't always provide a best data for seasonal lake management. Assessment of phytoplankton during sample dates would help to identify rising populations of cyanobacteria (blue-green algae) and might improve timing and results for copper sulfate applications.

Review of data and interpretation from the 2004 CSLAP report confirms field observations that water quality generally declines as the plant community shifts from macrophytes to plankton each year. This is reflected in the decreasing water clarity and increasing chlorophyll a readings found in mid-late summer.

III. Management History

Lake Associations do not have an endless supply of funds for conducting lake management activities. Although certain grants might be available to public-access lakes, most private Associations have tight budgets set aside for aquatic plant management. These budget restraints generally limit which aquatic plant management techniques can be employed. Since the late 1950's Truesdale Lake has been treated with aquatic pesticides to control nuisance densities of aquatic plants and algae. This at a cost of $10,000 to $15,000 a year over the past 10 years. As illustrated in Table 2, historical vegetation control in Truesdale Lake follows a pattern of Spring herbicide application, leading to summer plankton control. In most years, the herbicide Aquathol K is used since it provides excellent control of pondweeds, and can be applied selectively to areas of densest growth. The Spring timing of the application does not necessarily affect summer naiad growth, and in past years, secondary applications have occasionally been conducted when naiad has become problematic. Aquathol K is not effective on Elodea, therefore fluridone (Avast!, Sonar) is used periodically, as in 2004, and 1998, when elodea takes over the entire south end of the lake. This lake-wide application of liquid fluridone provides multi-season control of elodea, as well as seasonal control of pondweeds, and often naiad. Although the slower plant decomposition is expected to release less available phosphorus, this is mitigated by the lack of any substantial macrophyte growth, and phytoplankton still tend to be prevalent through the remainder of the summer.

The herbicide applications, both Aquathol K and fluridone, have been consistently successful in providing plant control, and have done so within a budget suitable to the lake Associations. Algaecide applications have also been successful at temporarily reducing algal density, but clearly have no long-term positive influence on plankton productivity. Since the community has a long-standing history of management with herbicides, they readily accept the various water use restrictions associated with certain herbicide use (Table 3). Indeed, the community sees herbicide use as necessary to guarantee recreational use of the lake. Were the herbicide Reward (diquat) not subject to regulatory restrictions in New York that the community considers prohibitive (14 day restrictions for all uses), this herbicide may be the preferred product for controlling Truesdale Lake plants, and probably at a lower cost. Reward is effective on the full host of plant species in Truesdale Lake, including elodea, which would eliminate the need for periodic fluridone use.

Table 2. Truesdale Lake Aquatic Pesticide Treatments 2001-2005

Date	Product	Target species
6/27/05	Aquathol K	*P.crispus, P. foliosus*
7/12/05	Copper sulfate	Unicellular algae
8/1/05	Copper sulfate	Unicellular algae
8/29/05	Copper sulfate	Unicellular and filamentous algae
5/17/04	Avast!	*P. crispus, Elodea canadensis*
6/28/04	Copper sulfate	Filamentous algae
7/12-13/04	Copper sulfate	Filamentous algae
8/2/04	Copper sulfate	Unicellular algae
8/23/04	Copper sulfate	Unicellular algae
6/30/03	Aquathol K	*P. foliosus*
7/17/03	Copper sulfate	Unicellular algae
8/18/03	Copper sulfate	Unicellular algae
5/9/02	Aquathol K/copper sulfate	*P. foliosus*/Filamentous algae
7/1/02	Aquathol K/Copper sulfate	*P. foliosus*/Filamentous algae
7/15/02	Copper sulfate	Unicellular algae
7/29/02	Copper sulfate	Filamentous algae
8/14/02	Copper sulfate	Unicellular algae

To aid in localized algae control, aeration systems were installed at the east beach area in 2004 and the west beach area in 2005. The goal of these systems is to reduce algae build-up on the sediment in and around each beach, and to generally provide better water circulation in the area. In Spring 2005, before plant control was completed (due to permitting delays), filamentous algae was present in both beach areas, although residents reported that the west beach aeration system was not run as frequently as it should be.

Truesdale Lake currently has no overall Lake Management Plan, but has completed a Lake Evaluation and Enhancement Plan in 2001. This Plan, completed by Land-Tech Consultants, focused largely on sedimentation and stormwater management. Its brief review of aquatic biology culminated in the comment that "The weed and algae control program employed at Truesdale Lake is effective in controlling the seasonal weed population". Of the nine recommendations presented in the Plan, none addressed any form of plant management with the exception the recommendation to dredge the southern cove. Most recommendations addressed stormwater management or typical lake best management practices such as vegetative buffers, phosphorus use reductions, and waterfowl discouragement. The Plan did outline methodology to reduce sediment and nutrient loading at six stormwater inputs around the lake. The Association is currently pursuing these recommendations through public funding sources, and hopes to set up a special tax district, in addition to pursuing grant money that is available for such improvements. A summary of this project appears in the Appendix.

Table 3. Water Use Restrictions for Aquatic Pesticides used at Truesdale Lake

	Swimming	Fish Consumption	Drinking	Irrigation	Livestock Watering	No Outflow
Avast!	1 day	1 day	1 day	14 days	1 day	14 days
Aquathol K	1 day	3 days	14 days	14 days	14 days	14 days
Copper sulfate	1 day	1 day	1 day	1 day	1 day	1 day

IV. Management Objectives

Extent of Preferred Management

As with many suburban lake communities, there is a small faction of membership that seeks a plant and algae free lake, either through ignorance or personal preference for the sterile environment of a swimming pool. Through long-term participation with NYSFOLA, and contact with Allied Biological, the majority of Truesdale Lake residents understand that the lake needs to maintain some measure of vegetation to support good lake ecology. Striking a balance between necessary and acceptable vegetation is challenging in a lake with a littoral zone exceeding 70%, and with a limited budget. The community wishes to control plants and algae, such that they do not detract from use of the lake in the summer, or from the value of their homes. Since the entire shoreline is fronted by home development, that leaves little area to maintain preserved beds of vegetation. Ideally, plants would be tolerated if they stayed 2-3 feet below the water surface, although this has historically not occurred. The community would also prefer to eliminate the summer plankton blooms that turn the lake green. In general, vegetation management is an issue from May through August. There has been some discussion of the use of alum to inactivate internal nutrients, however this has been placed on hold due partly to NYSDEC Region 3, Division of Water's policy prohibiting alum application.

Expected Use Benefits

The current Aquatic Plant Management Program has numerous benefits to the Association and the lake users. First, swimming at Truesdale Lake is greatly enhanced, perhaps even extending the length of the season, and increasing the amount of beach area. Second, boating access and movement throughout the lake is enhanced. This open water provides greater recreational use, including canoeing, sailing and fishing throughout the lake. Third, successful implementation of aquatic plant management methods to decrease invasive exotic and overall nuisance densities of single species will encourage the establishment of a much higher diversity of aquatic macrophytes. This higher diversity will benefit the entire lake's aquatic biota, by increasing the diversity and abundance of aquatic macro-invertebrates, and fish populations. These effects are highly desirable in creating a stable, flourishing aquatic ecosystem. Finally, Allied Biological's experience with 100+ lake associations strongly indicates that improved conditions in the lake lead to increased use of the lake and participation in community events.

Critical Areas to Protect

According to the Association, there are no critical environmental areas to protect on or in Truesdale Lake, other than the lake itself. There are no potable water draws on the lake. There are warm water fish species present, but no scientific study has identified any specific species of concern. Nearby Truesdale Lake are several locations classified as wetlands. These are depicted on a map in the appendix. Wetland Areas L-14 and L-15 are of particular concern, since they are downstream of Truesdale Lake.

IV. Aquatic Plant Management Alternatives

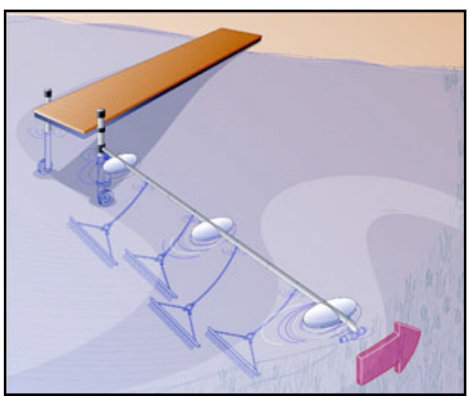
There are many different aquatic plant management techniques available to control nuisance densities of aquatic plants. No one single technique is better than all the rest, as each has its own advantages and disadvantages. Consult Table 4 for a summary of the different plant management techniques, estimated costs, and advantages and disadvantages.

Aquatic plant management techniques can be divided into two types: local control, and lake wide control. Local control targets a specific area of the lake, usually small, high use locations. Local control can be achieved with hand pulling/cutting, sediment agitation, or benthic barriers. Local control techniques are best used in conjunction with lake-wide techniques, to address specific locations or target specific species. Lake-wide techniques include physical/mechanical control (lake drawdown, mechanical harvesting, dredging), biological control (with grass carp or herbivorous insects), or chemical control (herbicides).

Local Control

Hand Pulling/Raking/Suction Harvesting: Hand pulling or raking is the most common weed control method used by lakeside property owners. It entails the use of small hand-held tools (or no tools in the case of hand pulling) to remove aquatic plants from a small area. If the workers can accurately identify aquatic plants, this method can be selective, targeting invasive or undesirable species. However, the process is labor intensive, and requires participants to be willing to roll up their sleeves, trudge into the water, and "weed the lake". Suction harvesting can be considered an adaptation of hand pulling. This technique uses a suction pump to contain and remove the plants after they have been dislodged by hand. Hand methods are useful to target small locations (such as at a beach, or property front), but are often cost effective only if volunteers are performing the pulling. This methodology can be very effective in preventing invasive exotic species from colonizing a new location.

Hand pulling has been demonstrated to be a successful selective technique to target local infestations of Eurasian water milfoil in some New York lakes. In Upper Saranac Lake, preliminary transect data demonstrates milfoil removal of 27% to 100% of the pre-harvested plants (Martin and Stager, 2005). In Lake George, hand pulling efforts in low density areas have been demonstrated to exceed 85% effectiveness (Lyman and Eichler, 2005). However, many factors play a role in the successful implementation of a hand pulling strategy, such as water clarity, target species and density, water depth, and the bottom substrate. At Eagle Lake, hand pulling activities have been performed by both volunteers and professionals with varied success. At densities of 100 plants per square meter or less, the process has been deemed useful, but removal of Eurasian watermilfoil beds with greater plant densities has been determined to be not cost effective (R. Tiedemann, pers. comm.).



Sediment Agitation: This method of local control involves disturbing the bottom sediments to remove aquatic plant growth, and prevent their re-growth. There are several commercially available products that achieve similar results, by rolling, dragging, or raking across the bottom substrate. The units are usually attached to a dock in the area to be maintained clear, and require electricity to power. Once the plants are cleared from the target area, these products can be used as infrequently as once a week to maintain control. Some models can be easily disassembled in an effort to target other locations. However, disadvantages include disturbing the benthic community and disrupting fish spawning in target area, sediment movement and creation of a depression in the target area, and plant fragmentation which could increase the spread of certain species. To prevent injury, the unit should be unplugged and stored under the dock if the area is to be used by swimmers. These products also need to be removed from lakes that freeze during the winter.

Benthic Barriers: A benthic barrier is a synthetic or organic sheet (i.e. Aquascreen®, Texel®) that is placed over the lake bottom to create a growth inhibiting barrier. This method is very effective in small areas (less than 1 acre), and thus is suitable for high use areas such as boat launches, beaches, or property fronts. Multi-year control is possible, if the barrier is properly maintained season to season. Benthic barriers have been effectively used at Lake George (Lyman and Eichler, 2005) and Ellis Pond, Dutchess County (Allied Biological). However, benthic barriers are expensive, labor intensive to install, and must be maintained. Over time, sediments will become deposited on top of the barrier, and if not removed, these sediments can actually become colonized by some aquatic plant species. In addition, sediments below the barrier can release gasses that will cause the barrier to billow up. If the barrier is constructed of an impermeable material, these gasses need to be relieved periodically, a process called "burping". Benthic macro-invertebrate communities are negatively impacted by the addition of a benthic barrier. Barriers are also non-selective in the types of plant species controlled.

Installation of benthic barriers is easier if the lake is drawn down, but in-water installation is possible. Many different anchoring techniques can be used, although Allied Biological has had success with weighing down the entire perimeter of the barrier. Ice installation entails laying the barrier on top of a frozen area. As the ice melts, the barrier sinks into place. This last method is not recommended. Most non-professional installations of benthic barriers are performed with cheaper, impermeable PVC materials (available at landscape supply stores), using this installation technique.

Local Control in Truesdale Lake

Hand pulling methods are applicable in Truesdale Lake to prevent new infestations of invasive exotic species from spreading, should they occur. This will necessitate some education and training in the identification of invasive plant species and their proper removal. This method also applies to shoreline species such as Common Reed and Purple Loosestrife, both of which are found at Truesdale Lake. Sediment agitation methods are also applicable for submersed weed control, but due to the cost and nature of the units, should be left to the individual property owners. Benthic barriers would be useful in the community beach areas at Truesdale Lake, although the cost and maintenance issues may be considered prohibitive.

Lake wide Control

Lake Drawdown: This lake-wide control method involves removing most of the water from the lake for an extended amount of time (at least one month). This technique is effective in northern regions when performed during the winter months as freezing sediments increases aquatic plant control in conjunction with drying. This method is very inexpensive, but requires some type of a water control structure. During a lake drawdown, other lake management methods can be performed such as dredging or benthic barrier installation. Lake-wide control of some species can be achieved for more than one season in some cases. Eurasian water milfoil, fanwort, elodea, coontail, curly-leaf pondweed and many floating aquatic plants (such as lilies and watershield) decrease in density following a lake drawdown. However, some submersed aquatic plants actually increase in density following a lake drawdown. These include several pondweeds (clasping-leaf, large-leaf, and sago), common naiads, and *hydrilla*. There are several disadvantages to a whole lake drawdown. These include reduced aesthetics and winter access, serious environmental impacts on other aquatic biota (such as fish), and concerns with the refill rate of the water body. A permit is required for most lake drawdowns.

Mechanical Raking: Mechanical raking, also called hydroraking, consists of a specialized paddle wheel propelled barge with a york rake mounted on a backhoe arm. The rake is lowered into the lake sediment, and pulled until full (usually about 0.5 cubic yards). The material is then placed on shore for dewatering, and eventual disposal. Although a slow process, this method does provide multi-year control since most of the plant is removed, not simply cut as in mechanical harvesting. Hydroraking is much more efficient at removing water lily and emergent plants, due to the root structures. Submersed aquatic plant root systems tend to be smaller and more delicate, and therefore not removed by the rake. Costs are significantly higher than mechanical harvesting due to the slow pace of the work, and a disposal site is needed for the removed material. The SmokeRise Club (Lake Kinnelon, NJ) has successfully utilized hydroraking the past few years to create open water in previously inaccessible coves. 120 hours of hydroraking was conducted in 2003, resulting in the removal of approximately 1,675 cubic feet of material, at a cost of $21,900.

Mechanical Harvesting: This method involves the mechanical cutting of aquatic plants with specialized boats equipped with cutting bars. Most operations include the removal of the clippings as well, either by another vessel or by the harvester itself. If performed by experienced individuals, this method can be quick and efficient. It is useful

in areas near launches and efforts to maintain open water channels through "topped out" aquatic vegetation beds. However, it's a short term solution at best, as root structures are not removed. Areas often need to be harvested multiple times per season to achieve desired control. Harvesting is non-selective, and includes a significant by-catch of aquatic and semi-aquatic macro-invertebrates, and forage fish. Harvesting activities can even increase the spread and density of aquatic plants that reproduce via fragmentation, such as Eurasian water milfoil, and fanwort. A suitable off-site disposal site is needed for the clippings. In the past, it was claimed that the removal of plant biomass reduced the amount nutrients in the lake system. However, numerous ecosystem studies, such as Lake Wingra in Wisconsin, concluded the removal of this plant biomass did not significantly remove nitrogen and phosphorous to offset the internal pools of those nutrients (Carpenter and Adams, 1978).

Dredging: This method is usually not solely used for aquatic plant control. Dredging is employed to deepen water that has been filled in from sedimentation (often sped up by man-made activities), remove excessive nutrients, or even remove toxic substances in the sediments. As a side benefit of these lake restoration projects, deeper water and nutrient removal often limits aquatic plant growth. Although long-term aquatic plant management control can be achieved (sometimes as long as a decade), the method is non-selective, and creates numerous environmental impacts. This method is very costly, and often the costs increase if the dredged material needs to be trucked off-site for disposal.

Following dredging activities, re-colonization of aquatic plants is species specific. In Fayson Lakes, NJ, Eurasian water milfoil was the first species to reestablish itself, returning to the lake 3 to 4 years after the dredging. This is probably due to Eurasian water milfoil's ability to colonize fine textured inorganic sediments, its ability to quickly grow in cool waters, and its canopy production (often shading other natives). Meanwhile, other native aquatic plants, such as naiads, took considerably longer (10+ years) to return to the lake.

Grass Carp: The most widely used biological control of aquatic plants is grass carp (*Ctenopharyngodon idella*), a non-native herbivore. Although a permit is required, grass carp are easy to implement into a lake system, and relatively inexpensive, once stocking costs are spread over several years. Results are slow, but multi-year control can be obtained. Grass carp are selective feeders, often feeding on preferred plant species until eradicated before moving on to less desirable species. For example, grass carp will only graze on Eurasian water milfoil and floating plants (such as lilies) as a last resort, removing all native (usually desirable) plants first. This selective grazing can have negative impacts on game fish populations, as suitable habitat for juveniles is removed. Second, in a large lake, the grass carp tend to establish feeding patterns in preferred locations. This location might not be consistent with areas the

Association wishes to be controlled. Barriers or other structures need to be constructed to prevent the fish from escaping the lake. Finally, grass carp grazing on aquatic plants tend to disturb the bottom sediments, which reduces water clarity and adds nutrients (once bound to the sediment) back into the water column. These two factors can cause a shift from an aquatic plant dominated community to an algal dominated community.

Grass carp stocking has been successful in several New York lakes, including Lake Walton in Orange County (NYSDEC, 2001). As in the case of Lake Walton, several supplemental stockings are often needed to achieve a suitable grass carp density to provide desired control, and replace fish that have died. Although Lake Walton did not experience a shift toward an algal dominated system, other New York Lakes, such as Lake Carmel and Bedford Lake, have seen a decrease in water visibility and an increase in unicellular and filamentous algae.

Herbivorous Insects: Insect bio-control of select species has been researched extensively over the past several years. For example two native insects, a moth (*Acentria ephemerella*) and a weevil (*Euhrychiopsis lecontei*) show a preference in feeding on Eurasian Water milfoil. Specifically, the weevil is capable of disrupting the flow of carbohydrates to the root crowns, reducing its efficiency in over wintering, and reducing the buoyancy of the canopy. To reduce stem densities, high densities of weevils are required, often needing successive stockings to supplement natural populations. Results are generally slow to appear, with varying degrees of success in New York Lakes. Lake Moraine in Madison County stocked 12,000 milfoil weevils in 1998 to supplement native populations. Despite restocking another 10,000 two years later, the program was consider a failure since weevil densities did not increase, and very little Eurasian water milfoil control was observed. The likely cause of this failure was annual winter draw downs affecting over wintering weevil populations, and high densities of sunfish populations, which prey on aquatic insects. These are factors that need to be considered before planning aquatic plant control with herbivorous insects.

Herbicides: The use of herbicides is the most commonly used method of aquatic plant management in the United States. Aquatic herbicides are classified as either "contact", or "systemic", and the distinction between the two types is significant in vegetation management planning. Contact herbicides (diquat dibromide, endothall, copper) are fast acting on plant tissue, leading to extensive cellular damage. Contact herbicides usually only provide seasonal control, but are very site-specific, and can be species selective as well. Systemic herbicides are translocated throughout the plant structure, which generally means that plant control takes longer. This slower knockdown of plants has a positive side, as slower decomposition has less effect on the lake's oxygen regime. Even though systemic herbicides are slower to act, often multi-year control of certain species can be achieved. Systemic herbicides also tend to be more species selective than contact herbicides. The most common systemic products (fluridone, 2,4-D, triclopyr) are generally more effective on broad-leaved plants. Proper selection and application of herbicides can result in control of target invasive species with minimal impact on desired natives. Herbicide use requires an extensive permitting process, and incurs water use restrictions, depending on the product selection.

No Action Alternative

All of the above aquatic plant management methods have some disadvantages and/or high costs. Therefore, it might be tempting to perform no aquatic plant management. However, in the case of invasive exotic aquatic plants (such as curly-leaf pondweed in Truesdale Lake) doing nothing may have dire environmental impacts on water quality, native plant abundance and diversity, and aquatic biota (such as fish and insects). Rampant growth of invasive exotic aquatic plants can also increase the chance of it spreading to other nearby lakes. Even uncontrolled growth of native submersed vegetation can have negative impacts on lake uses. This uncontrolled growth can make swimming impossible, and prevent access to shallow areas such as boat launches and prime fishing locations. This would be the case in Truesdale Lake, where 90% of the shoreline, and the entire cove south of the island would support plant growth reaching the surface. The upside would be a likely decrease in plankton populations and improved water clarity, but lake use would still significantly decline.

Lake-Wide Control in Truesdale Lake

Partial lake draw down is performed seasonally in Truesdale Lake to discourage aquatic plants and facilitate dock repairs. To date this has not led to a measurable reduction on overall submersed plant density, although Curlyleaf Pondweed growth may have been delayed in some seasons. A more comprehensive drawdown is not suitable, since there is no existing water control structure. There also seems to be concern within the Community of the lake's ability to refill adequately in time for the recreational season. This concern may be unsubstantiated, since the Land-Tech report estimates the lake's recharge interval at 22 days.

Mechanical raking is not well-suited for Truesdale Lake, due to an aquatic plant population primarily composed of submersed species. However, mechanical harvesting appears to be an appropriate plant control method, particularly considering the species composition. It is possible that harvesting could actually increase the area of Elodea due to fragmentation. In most cases, Elodea is considered a preferred native aquatic plant. Although it creates a nuisance in portions of Truesdale Lake, the long-term control achieved by periodic fluridone applications would mitigate any significant spreading of the plant. A harvesting operation could make use of the south beach area for removal of clippings, but the north area is inaccessible due to a smaller frontage and steeper slope. A suitable disposal site for the clippings is not evident, and would need to be located. The most significant benefit of harvesting would be an expected decrease in algal productivity and improvement in water clarity. This may lead to less copper sulfate algaecide use. The most obvious negative aspect of aquatic plant harvesting in Truesdale Lake would be the cost, which would probably exceed the typical lake management annual budget.

Grass carp would also be suitable in Truesdale Lake, since the target aquatic plants are consistent with grass carp feeding preferences. Barrier construction to prevent their escape would need to be investigated. The national organization B.A.S.S. has spoken out against the use of grass carp for vegetation control, since introduction of these species has spread uncontrollably through southeastern lakes and river systems. The Truesdale Lake community is also leery about grass carp, since control can be unpredictable and may take a few seasons to reach acceptable levels. Several lakes in the Truesdale Lake region employ grass carp as their primary vegetation control method, and results are mixed. Herbivorous insects are not suitable, since there is no Eurasian water milfoil present in Truesdale Lake.

Aquatic Herbicides have been used in Truesdale Lake since the late 1950's, and still today appear to be a suitable method to control aquatic plants. Part of the attraction is that herbicides provide consistent, predictable control over aquatic plants. No doubt cost is also a factor, since harvesting 60 acres of the lake could be substantially more expensive than herbicide use. With typically one herbicide application per year, the impact to the lake community is relatively low. If algae populations, and subsequent control applications could be reduced, that would make a significant reduction in the amount of pesticides applied to Truesdale Lake, and the overall cost of seasonal management. Elimination of copper sulfate would also benefit zooplankton populations.

Finally, dredging has been discussed, but has been deemed cost prohibitive at the moment, since grant money is not easily obtained for private lake communities. No doubt low-interest loans could be arranged, but the scope of the dredging would still put the cost of this type of project currently out of reach for the community. Planned sediment management improvements will address future siltation.

Integrated Management

Truesdale Lake already benefits from an integrated lake management approach. In-lake measures include the herbicide application program, seasonal lake drawdowns and the beach aeration systems. Water quality assessment is also done under the CSLAP program. Watershed measures include community focus on septic system maintenance, waterfowl control, phosphate management (refer to March 2002 newsletter sample) and the current stormwater management project. Of course, more could be done. A combination of mechanical harvesting and herbicide use could be done on an alternating year schedule. This is discussed further under Alternate Management Scenario 1. Additional study of nutrient loading could determine the feasibility of inactivating internal nutrients with alum. Properly dosed alum treatments could reduce plankton productivity and dependency on copper sulfate. Permits would be necessary from the Region 3 Division of Water, which might require input from Albany.

Table 4. Summary of Aquatic Plant Management Alternatives

Type	Management Option	Estimated Cost/acre	Advantages	Disadvantages
Mechanical	Hand-Cutting/Pulling	Variable	Low technology Can be inexpensive Very Selective	Labor-intensive Cost is labor-based Poor productivity
	Sediment Agitation	$2,000 - $3,000 per unit	Can be moved to other locations Homeowner friendly	Disturbs benthic community and fish spawning Fragments plants Requires a permit
	Harvesting	$500 - $800 per acre	Any size area May not require a permit. Removes some biomass/nutrients	Non-selective Disposal of harvested vegetation Partial season control Spreads plant fragments
	Mechanical Raking	$1,000 - $1,200 per acre	Any size area Can increase depth Removes lily tubers	Non-selective Slow Process Disposal of vegetation Inefficient for submersed plants
Biological	Grass Carp	$175 - $250 per acre	Relatively easy to implement Multi-year control	Permit required Selective on preferred plants No control of feeding area Slow results Unpredictable success
	Herbivorous Insects	$500 - $1,000 per acre	Easy to implement Multi-year control possible	Permit required Very selective (only milfoil) Slow results Unpredictable success
Physical	Dredging	$10,000 - $75,000 per acre	Can be long-term Creates other benefits Can improve trophic status	Very expensive Disposal of dredged sediments
	Lake Lowering	Negligible	Inexpensive Can be effective Moderate term control	Permit required Aesthetics and reduced winter access Can have severe environmental impacts
	Benthic Barrier	$5,000 - $35,000 per 1/2 acre	Multi-year control possible	Expensive Non-selective Only small areas Labor intensive (and needs to be maintained) Negative impacts on benthic communities
Chemical	Herbicides	$150-$200 per acre	Selective Consistent & predictable. Seasonal or multi-year control	Permit required Water use restrictions. Negative public perception

Preferred Management Scenario

The preferred method of aquatic plant management at Truesdale Lake continues to be herbicide use. Aquatic herbicides have been applied at Truesdale Lake since 1978 by Allied Biological, with a proven track record of successful, predictable control. The Truesdale Lake Association is familiar and comfortable enforcing the various water use restrictions involved with aquatic pesticide use. Despite increased permitting requirements, herbicide us is still a NYSDEC permitted use at Truesdale Lake.

In the short-term, the Committee will be relying on further use of Aquathol K to target pondweed infestations. As permitting becomes more streamlined, herbicide application can be made earlier in the Spring, potentially prior to Curlyleaf Pondweed turion formation, which may lead to seasonal reduction in this plant. The benefit of this needs to be balanced against the benefit of plant cover for fish during the early Spring. In the medium to long-term (3-5+ year), fluridone may replace Aquathol K for a season (2009?) to address Elodea. In the event NYS regulations are changed to remove Reward and allow its use according to the EPA label, this would become the preferred herbicide.

In an effort to minimize the shift to phytoplankton dominance, the Committee will be encouraged to preserve areas of vegetation in the lake. Coupled with external nutrient reductions, this may have some effect. Internal nutrient inactivation may still be necessary to significantly reduce phytoplankton productivity and decrease use of copper sulfate. Alternative algaecides may also provide some improvement in algae treatment duration, and a reduction in elemental copper applied. Chelated copper algaecides (Cutrine Ultra, Captaim, K-Tea) are formulated to stay in suspension longer and facilitate greater uptake by algal cells. They are generally lower in copper content (8-9%, vs. 25% for copper sulfate), and have less impact on zooplankton and macro-invertebrates. Their most obvious downside is an increased cost, generally 2-3 times the cost of a copper sulfate application.

Alternate Management Scenario 1

As mentioned earlier, an alternating program of aquatic plant harvesting and herbicide use could result in acceptable lake conditions, and possibly greater balance between macrophytes and algae. This assumes that invasive plants such as Fanwort and Eurasian water milfoil are not introduced to the lake. In the short-term, the Committee would follow traditional management employing Aquathol K, and copper sulfate or a chelated algaecide for the 2006 season. During this time, the Committee would a) arrive at an accurate cost-estimate for seasonal harvesting, b) identify a disposal location and c) educate the community on the change in management strategy, its cost and how it may affect lake use. Then, over the next 3-5 years, the Committee would alternate between harvesting and use of a herbicide, probably Sonar, depending on plant diversity and abundance. It is assumed that two harvests per season would be necessary to achieve the desired level of plant control. A reduction in seasonal plankton growth may be achieved as early as the first season of harvesting, but a single harvesting season is not likely to achieve any long-term plankton reduction. The cost of harvesting in a given season, and repeated over 2-3 seasons, is the most significant factor preventing this from being the preferred scenario.

Alternate Management Scenario 2

A second alternative management scenario would be the use of grass carp for plant management. By nature, this is a long-term management plan, since more than one season is needed to first achieve the desired level of plant control. In the short-term, a grass carp application would be submitted for Spring stocking, probably at 15 fish per vegetated acre. These fish are stocked at roughly 20% of their maximum size, so comprehensive plant control will not be immediate. During 2006, herbicide and algaecide use will be necessary in order to maintain lake use, and grass carp stocking will add $10,000+ to the 2006 budget. In the medium term (2-4 years), herbicide use may still be necessary but should decline as the fish grow. A supplemental stocking may be necessary during this time. Algaecide requirements are not likely to reduce, and may increase as fish cycle nutrients from plants and sediment back into the water column. In the long-term (5+ years), if stocking rates are ideal, herbicide use would be eliminated, and supplemental stocking should not be needed for 3-5 years. Algaecide treatments may span the full season as young plants are quickly removed by fish. This management scenario is not recommended.

V. Pre- and Post Treatment Actions Planned

Aquatic Plant Monitoring

In the previous five years, the aquatic plant populations in Truesdale Lake have been monitored by several methods. The CSLAP program uses a "semi-quantitative" method that was performed in 2000 (one date), 2001 (two dates), and in 2003 (one date, however no results were reported). These surveys, conducted by CSLAP volunteers, identified a total of three aquatic plants, including slender naiad (*Najas flexilis*), curly-leaf pondweed (*Potamogeton crispus*), and yellow water lily (*Nuphar advena*). However, the report authors make it clear other aquatic plants are present in the lake, just not observed by CSLAP volunteers. Results were presented in data tables.

Also in the previous five years, Allied Biological has conducted aquatic plant surveys several times during a season, usually in conjunction with aquatic pesticide treatments. All surveys were conducted by licensed aquatic pesticide applicators, using visual observations supplemented by a rake toss method. Results were reported in data tables as presence/absence.

In July 2005, Allied Biological performed a lake wide GPS-logged aquatic vegetation survey. The survey was conducted by biologists using a rake toss method based on protocols developed by Cornell University. Plant densities were assigned to all species observed, and presented in table and map format. The maps are included in the appendix of this plan.

Future aquatic plant monitoring will include the CSLAP program, and the continuation of visual and rake toss surveys by Allied Biological during aquatic pesticide treatments. In addition, it is recommended that lake wide GPS-logged aquatic vegetation survey be performed pre-treatment in 2006 to assess the full aquatic plant assemblage in late Spring. This is expected to show the true extent of Curlyleaf Pondweed and Leafy Pondweed range and density. It is recommended that similar pre and post-treatment surveys be conducted every three years.

Early Response

At this time, Truesdale Lake does not have an early response program to address an aggressive invasive species invading the lake. It is suggested a short plan be formed to monitor the lake, and outline a course of early intervention. The first step is the creation of an educational program for the lake users. This can be as simple as a pamphlet or a link on the Association's website, describing common NY State Aquatic Invasive species including how to identify them, vectors of transport, and notes on their life history. Or a detailed as a workshop can be organized by a professional to train lake users in aquatic plant identification and rapid response techniques.

The second step is the implementation of an educational program and establishment of early response protocols. This could include posting pamphlets at all launch sites and beach areas, and hosting boat inspections and cleaning methods. Getting the lake users involved in monitoring the lake for evidence of invasive species is crucial, as well as developing a schedule for this monitoring activities. These can be established on the Association's website to facilitate communication between lake users. This schedule should work in conjunction with Allied Biological's field observations. Finally, if an invasive exotic aquatic macrophyte is discovered in the lake, a rigid plan needs to be in place to address the situation as quickly as possible. If the plant is established in a local location (typically near the boat launch), it can be removed by hand pulling.

Source Management

To manage sources of aquatic macrophytes, consult the early response discussion above. The Association boasts a well-designed website to communicate with its members. This resource should be tapped to established the above plan, and continue the educational process.

Truesdale Lake has embarked on an ambitious plan to address the storm water drainage and nutrient flow into the lake. Six sites have been selected for the improvements (see the map in the appendix for the locations of these sites). All engineering plans have been completed for these projects, and efforts to raise the needed funds are underway. The creation of a special tax district, and pursuit of grant opportunities will provide the funding. The Association hopes that work will begin in the fall of 2006. Below is a short description of each planned activity. Full details are included in the appendix.

Site 1: At the south end of the lake, sediment will be excavated, and a forebay will be installed to trap sediment. A new curb and catch basin will intercept runoff, and emergent vegetation will be planted for nutrient uptake, stabilization, and habitat enhancement.

Site 2: Adjacent to site # 1, existing pipes will be replaced and upgraded. Catch basins will be added, and a hydrodynamic separator will be installed, reducing sediment and nutrient flow into the lake.

Site 3: At this site, two drainage paths flowing into the lake will be improved with the installation of stone lining and check dams, plus a hydrodynamic separator. The shallow water will be planted with emergent vegetation for stabilization, nutrient uptake, and habitat enhancement.

Site 4: At this site, 3200 cubic yards of sediment from an impoundment will be excavated, to restore its sediment trapping capability.

Site 5: The boulder-strewn drainage corridor at this site will be stabilized and lined with vegetation. A forebay will be constructed at the water's edge and the shallow water will be planted with emergent vegetation for stabilization, nutrient uptake, and habitat enhancement.

Site 6: At this site, a storm water outlet pipe will be stabilized, a new curb, catch basin, and hydrodynamic separator will be installed and emergent vegetation will be planted for stabilization, nutrient uptake, and habitat enhancement.

Evaluation of Efficacy

Several methods could be employed to assess if the aquatic plant management plan was a success. First, follow-up aquatic vegetation surveys will provide hard data regarding the future assemblage of aquatic plants in the lake. These surveys will be performed by Allied Biological during all aquatic pesticide applications. In addition periodic lake-wide GPS-logged aquatic vegetation surveys will be used to track the aquatic plant assemblage changes over time. Both of these surveys will be available to the DEC for review. In addition, the Association is encouraged to get feedback from the lake users regarding the status of the lake uses impaired by aquatic plants. Again, the Association's website is a fine tool to encourage this type of communication.

CSLAP Question	1999-2004 Mean
A	2.7
B	2.0
C	2.8

Second, the CLSAP program includes survey questions A, B, and C, which apply to the physical condition of the lake, aquatic plant populations of the lake, and recreational suitability of the lake, respectively. Consult the table below for a summary of these questions, and the numerically ranked answers. The lower the average value of this answer, the better condition the lake is in, based on these three questions. The 1999-2004 averages for each of these questions are summarized in the table to the right. Over the next few years, the future averages can be examined to determine if the conditions are improving, stable, or declining.

Table 6. CSLAP Survey Questions and Answers

CSLAP Question	1	2	3	4	5
A. Physical condition of the lake.	Crystal clear	Not quite crystal clear	Definite algae greenness	High algae levels	Severely high algae levels
B. Aquatic Plant population of the lake.	None visible	Visible under the surface	Visible at lake surface	Dense growth at the lake surface	Dense growth completely covering the nearshore lake surface
C. Recreational suitability of the lake.	Couldn't be nicer	Very minor aesthetic problems but excellent overall use	Slightly impaired	Substantially impaired, although lake can still be used	Recreation impossible

Third, in addition to evaluating aquatic macrophytes by performing surveys, other aquatic biota can be surveyed to assess the ecological balance of the Lake Truesdale system. This can include fishery surveys using electroshock equipment to assess the populations of forage fish vs. game fish, as well as overall fish diversity and abundance. Zooplankton surveys can be performed in an effort to determine if biomanipulation of zooplankton populations by stocking game fish can actually reduce unicellular algal blooms. Benthic macro invertebrate surveys can be performed to calculate community metrics to assess the overall health and robustness of the benthic community. Finally, phytoplankton population surveys via identification and enumeration can be performed to assess the bloom conditions, and increase the efficiency and timing of copper sulfate treatments.

VI. References

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VII. Photograph Credits

Nitella: Kerry Dressler, Washington State Department of Ecology

Southern Naiad: Texas Cooperative Extension, Department of Wildlife and Fisheries Sciences.

Elodea: Allied Biological, Inc.

Curly-leaf Pondweed: Vic Ramey, University of Florida, 2001.

Leafy Pondweed: USDA, NRCC, 1997.

Mechanical Harvesting: Allied Biological, Inc.

Herbicide Treatment: Allied Biological, Inc..

Hydroraking: Allied Biological, Inc.

Dredging: Aquatic Control Technologies.

Grass Carp: USGS, Florida Integrated Science Center, Gainsville.

Milfoil Weevil: Robert L. Johnson, Cornell University, www.forestryimages.org.

Milfoil Moth: Robert L. Johnson, Cornell University, www.forestryimages.org.

Benthic Barrier: Allied Biological, Inc.

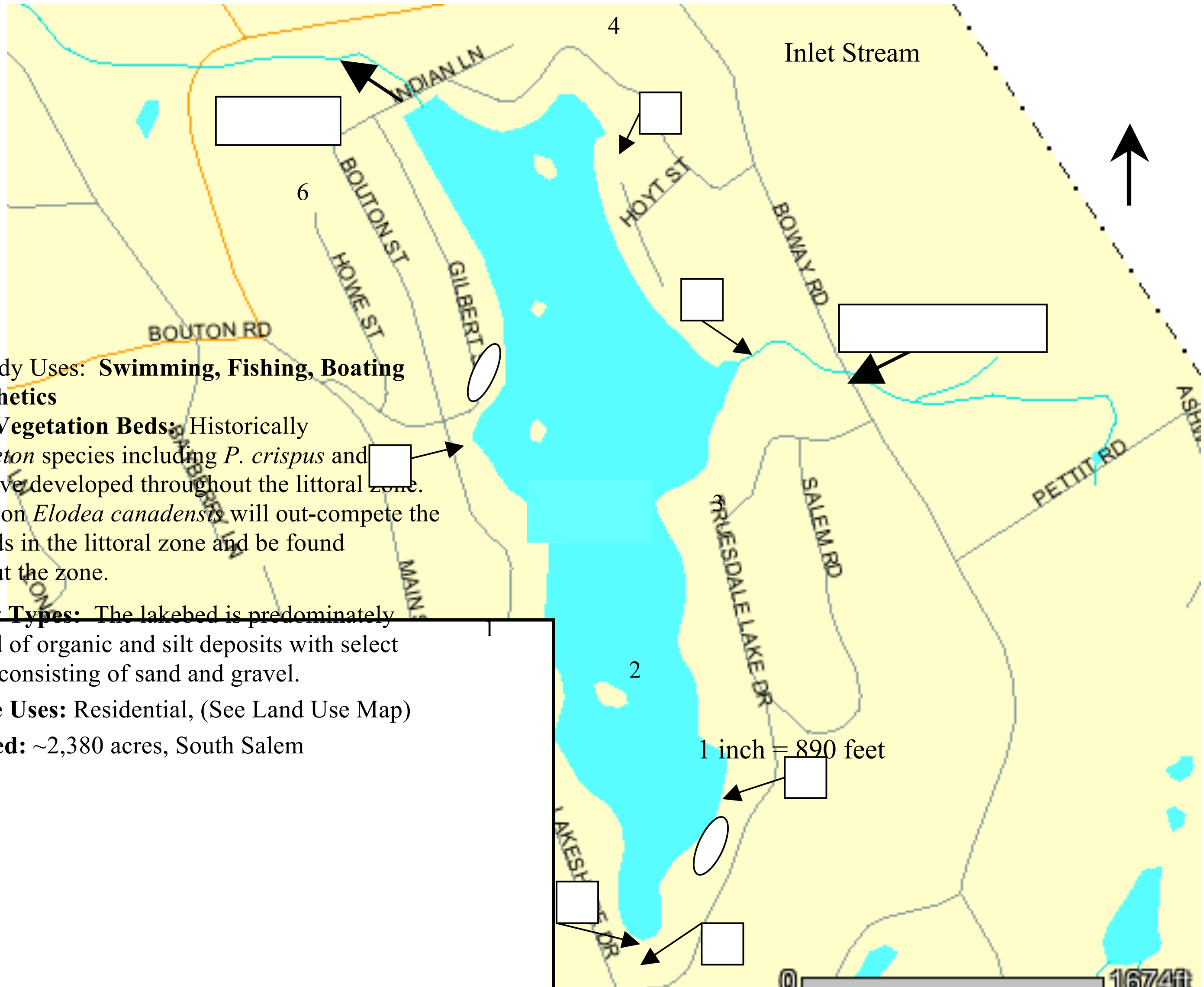
Lakesweeper: Lake Restoration, Inc.

Appendix

Aerial Photo of Truesdale Lake
May 2005 photos of Truesdale Lake
July 2005 Aquatic Vegetation Survey Report & Maps
1999-2004 Water Quality Data and Charts
Wetlands Map
National Heritage Documentation
Truesdale Lake Map Depicting Sites #1-6
Proposed Storm Water and Nutrient Improvements

O 5

Truesdale Lake



'ater Body Uses: **Swimming, Fishing, Boating**
ıd Aesthetics
quatic Vegetation Beds: Historically
otamogeton species including *P. crispus* and
lious have developed throughout the littoral zone.
n occasion *Elodea canadensis* will out-compete the
ondweeds in the littoral zone and be found
roughout the zone.

ediment Types: The lakebed is predominately
omposed of organic and silt deposits with select
cations consisting of sand and gravel.

horeline Uses: Residential, (See Land Use Map)

'atershed: ~2,380 acres, South Salem

TRUESDALE LAKE

South Salem, New York
83 Acres, 6 ft. AD

Sites #1 to #6 represent locations of storm water and nutrient flow remediation.

= Beach

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