Hundred Acre Pond

Plant Mapping and Lake Services

9/27/2022

Hundred Acre Pond Five-Year Management Plan

Prepared For:

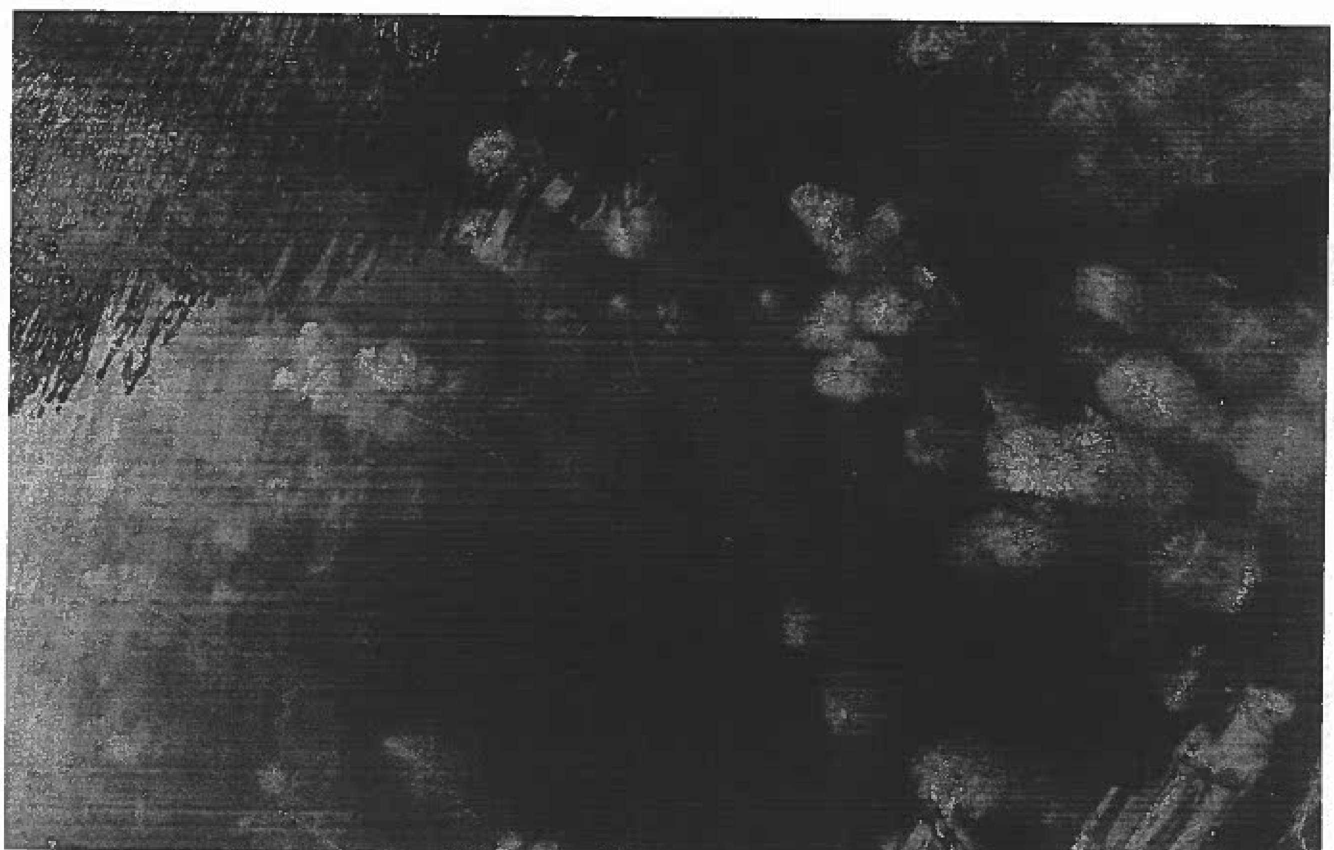
Hundred Acre Pond Association
c/o Steve White
126 Hundred Acre Pond
West Kingston, RI 02892

Prepared By:

TRC
10 Hemingway Drive
2nd Floor
East Providence, RI 02915

Prepared by:

Reviewed and Approved by:



2

TABLE OF CONTENTS

TABLES

FIGURES

ATTACHEMENTS

1.0 Introduction

TRC Companies (TRC) is pleased to present the Hundred Acre Pond Association (HAPA) with this final report lake consulting services in Hundred Acre Pond. It must be stated up front, that despite its name, the pond is under 100 acres (~94 acres). Water flows in from the Chipuxet River and out to "Thirty Acre Pond" downstream. The pond has been impacted by non-native rooted plants including fanwort and variable-leaf milfoil for several years and these plants are now found in all of the coves and in a ring around the shoreline. TRC studied this pond during 2022 as follows in Table 1:

Table 1: Project Timeline

Date	Action
June 21, 2022	TRC conducted pre-treatment aquatic plant mapping and water quality assessment at Hundred Acre Pond
June 22, 2022	The Pond and Lake Connection completed a Diquat and Flumioxazin treatment
September 7th, 2022	TRC conducted post-treatment aquatic plant mapping at Hundred Acre Pond

2.0 Aquatic Plant Mapping

2.1 Methods

TRC conducted pre-treatment aquatic plant mapping on June 21st, 2022 and Post-treatment monitoring on September 7, 2022. The plant community within the lake was assessed at approximately 50 points along appropriately spaced transects. Plant surveys were conducted using aquatic plant rakes and direct observation, and the location of each data point was recorded using a sub-meter accurate handheld GPS unit (Trimble Geo7X DGPS). At each sampling point, TRC staff noted all submergent, floating, and emergent aquatic plant species; recorded the presence of any aquatic invasive/non-native plant species; assessed which plant species were dominant in the community; and estimated plant cover (the percent aerial coverage of the lake bottom) and biovolume (the percent of space in the water column taken up by plants based on density and height of plants). All vascular aquatic plants were identified to genus or species level in the field by qualified staff. Percent cover was visually ranked using the

Figure 1: Pre-treatment plant mapping, rake with variable-Leaf milfoil

following scale: 0% (no cover), 1-24%, 25-49%, 50-74%, and greater than 75%. All observed species, percent cover, and biovolume were recorded at each point and positions were collected with a sub-meter accurate GPS receiver.

2.2 Results

A total of ten species were identified during these surveys (Table 2). Eight native species were found, along with two invasive species, fanwort (*Cabomba caroliniana*) and variable-leaf milfoil (*Myriophyllum heterophyllum*). During the pre-treatment survey in June, fanwort was found along most of the shoreline, covering approximately 36.5 acres of the pond. Variable-leaf milfoil was found in approximately 12.8 acres, mostly in areas closer to the inlet and outlet of the pond.

The Pond and Lake Connection, the lake treatment company hired by HAPA, performed a diquat and flumioxazin treatment of Hundred Acre Pond on June 22, 2022 for control of fanwort and variable-leaf milfoil. TRC conducted our second plant survey (post-treatment) on September 7th, 2022, well after the treatment occurred.

During the September 7th monitoring event, variable-leaf milfoil and fanwort density were observed to have decreased. While still present, variable-leaf milfoil went from about 12.8 acres of coverage in June to 10.3 acres after the treatment. Fanwort decreased a from 36.5 acres in June to about 23.3 acres. In addition to the areal reduction, the invasive plant densities were reduced to the 1-25% range for plant cover.

Some areas of the pond were clearly not showing the degree of control anticipated by HAPA (Figure 2).

Figure 2: Variable-leaf milfoil, fall 2022. Picture by Steve White, HAPA

Table 2: Aquatic Plant Species Observed on June 21st, 2022 and September 7th, 2022

Common Name	Scientific Name	Pre-Treatment	Post-Treatment
Watershield	*Brasenia schreberi*	X	
Fanwort*	*Cabomba caroliniana*	X	X
Common water moss	*Fontanalis antipyretica*	X	X
Variable-leaf milfoil*	*Myriophyllum heterophyllum*	X	X
Stonewort	*Nitella spp.*	X	
Yellow water lily	*Nuphar lutea*	X	X
White water lily	*Nymphaea odorata*	X	X

Table 2: Aquatic Plant Species Observed on June 21st, 2022 and September 7th, 2022

Common Name	Scientific Name	Pre-Treatment	Post-Treatment
Pickerel weed	*Pontederia cordata*		X
Robbins' pondweed	*Potamogeton robbinsii*	X	X
Spiral pondweed	*Potamogeton spirillus*	X	X
Common bladderwort	*Utricularia macrorhiza*	X	X

*Indicates non-native species

3.0 Pre-Treatment Water Quality

TRC conducted water quality measurements on June 21, 2022, at one location in the deepest portion of the waterbody. During the water quality monitoring event, TRC measured the following parameters in the field: dissolved oxygen, temperature, turbidity, pH, and water clarity (Secchi disk).

All parameters were within normal range, and results are listed in the tables below.

Table 3: Water Quality Parameters

Depth	Secchi (m)	pH (SU)	Color	Turbidity (NTU)
Surface	2	8.1	10	0.27

Depth (m)	Temp (°C)	DO (mg/L)	DO (%)	Spec Cond
0.5	21.9	7.84	89.2	128.4
1	21.9	7.85	89.3	129.0
2	21.2	7.64	85.7	128.9
3	18.8	3.56	38.1	129.4
4	14.8	3.06	30.3	122.4
5	12.9	3.19	30.1	122.6
6	12.5	3.00	28.1	122.7
7	12.0	2.11	19.5	123.1
8	11.7	1.38	12.6	124.1

As can be seen in Table 3, the water clarity, as measured by Secchi disk, was 2 meters on June 21, 2022, which is acceptable for a Rhode Island pond (>1.25 meters), but could be improved with improved water quality conditions. Color and turbidity can impact the clarity number with colored water decreasing the ability of light to pass through the water column and turbid water refracting light. Hundred Acre Pond has slightly colored water, but turbidity was low at the time of our survey.

Of particular concern is the significant drop in dissolved oxygen (DO) levels in the lake with increasing depth. Oxygen levels below 5.0 mg/L are stressful for fish, and if sustained for a prolonged period, can even result in fish kills. Data collected show that DO dropped below 5.0 mg/L somewhere between 2 and 3 meters and continued this way to the pond bottom. This oxygenated zone is roughly the extent of the photic zone where sunlight can penetrate. This lower oxygen level significantly reduces the habitat available to the fish community and would be expected to decrease even further during the late night and pre-dawn hours when sunlight is not available to allow plants and algae to photosynthesize and produce oxygen.

Reducing the overall plant and algal biomass will help to improve oxygen conditions within the pond and will thus improve the overall habitat quality for aquatic organisms.

4.0 Management Recommendations

There are a wide range of management options that can be considered for implementation at Hundred Acre Pond. The range of options we have considered for aquatic weed management in the coming years includes several of the more proven approaches such as herbicides, mechanical harvesting, diver assisted suction harvesting (DASH), and bottom barriers. Other approaches we have considered but are not recommending for rooted weed management include dredging, drawdown, insect herbivores, aeration, shading, sediment augmentation, P-pod bottom phosphorus extraction, barley straw and enzyme/bacterial additions.

In addition to the various approaches to address rooted plants, there are a range of approaches to be considered for improving water clarity and reducing the potential for algal blooms. More traditional approaches evaluated in this recommended program include the use of a low-dose phosphorus binding agent (alum) and algaecides. Alternative algal management options we have evaluated for potential use in the future years include lanthanum clay treatment (alternative phosphorus binding treatment), innovative stormwater solutions for the watershed, the algae skimming A-pod approach, aeration/circulation technologies, sonic disruption and biomanipulation of the plankton community. TRC is not able to make specific recommendations for water quality improvements at this time (e.g. stormwater improvements vs. groundwater improvements) as we have only assessed the lake one time and we do not have data on potential sources of phosphorus that may be impacting the pond. Additional study would be needed. However, we were able to make recommendations on improving the water quality through in-pond water quality management actions.

Given the limited nature of this assessment, additional study of the water quality of the pond and its watershed are warranted to identify potential sources of phosphorus loading to the pond. Beyond the additional study, other watershed improvements can be undertaken now including resident education on proper lawncare, pet waste management, and goose population management. A wide array of available information on these topics is available online.

A summary of potential management actions considered for Hundred Acre Pond over the next five years is presented in Table 4.0. These management options are described in detail in the following sections. Section 4.1 includes actions that can be undertaken to improve water clarity with a focus on algal growth management while Section 4.2 focuses on the management of rooted aquatic plants with emphasis on targeting non-native species which at this time include both fanwort and variable-leaf milfoil.

Table 4. Management Actions Recommended for Hundred Acre Pond

Management Approach		Potential Applicable Management Concern			Recommended Usage				
		Fanwort	Variable-Leaf Milfoil	Algae Blooms	2023	2024	2025	2026	2027
Chemical Controls	Phosphorus Binding (alum)			X	-	✓*	-	-	✓*
	Algaecides			X	✓*	✓*	✓*	✓*	✓*
	Fluridone (Sonar)	X	X		✓	-	✓*	-	-
	Diquat Dibromide		X		-	✓*	✓*	✓*	✓*
	Flumioxazin (Clipper)	X			-	✓*	✓*	✓*	✓*
Physical Controls	Mechanical Harvesting				-	-	-	-	-
	DASH	X	X		-	-	-	-	✓*
	Diver Hand Harvesting	X	X		-	-	-	-	✓*
	Aeration/circulation Technologies			X	-	-	-	-	-
Monitoring	Monitoring WQ and Plants				✓	✓	✓	✓	✓

✓ = Recommended, - = not recommended for use, * = if necessary

4.1 Water Quality Management

4.1.1 Water Quality Monitoring

Although water quality monitoring is not a management action, *per se*, given the relationship between water quality and lake biology it will be an essential component of a successful long-term management plan for Hundred Acre Pond. Monitoring provides continuous data for the purpose of detecting changes in pond conditions that might encourage algae blooms, as well as tracking the effectiveness of any future management practices that may be implemented.

TRC recommends that the HAPA implement a water quality monitoring program to track in-pond conditions during the summer growing season. This could be used to identify any emerging negative trends in water quality before they become more problematic as well as to document any improvements in water quality that may be realized through ongoing management actions. Phosphorus levels would be important in this regard, along with easily measured field parameters (pH, dissolved oxygen, temperature, specific conductance, and clarity [Secchi depth]). At a minimum, samples should be collected during the late spring and late summer at the surface and bottom of the pond at its deepest location. Phosphorus samples should be sent to a certified laboratory that can achieve a phosphorus detection limit of 0.01 mg/L or better.

Additionally, detailed lab analysis of the algal community by a taxonomic algal lab, with one sample taken from the surface of the deepest location during spring and late summer.

The monitoring program developed by TRC for 2023 and beyond was based on the results of the limited 2022 testing. The annual water quality monitoring program would likely cost $1,500 per year assuming the work would be performed in combination with the annual aquatic plant mapping that is also recommended (below).

4.1.2 Resident Education (Recommended as Optional)

Although not likely to make a significant improvement in water quality on its own, an education program can increase awareness of easy, low-cost actions that residents can take to improve lake water quality by reducing nutrient runoff from their property. These actions include minimizing the impact of yard care (particularly fertilization), managing pet waste, developing rain gardens, and maintaining or planting buffers at lake and stream margins. A brochure to raise awareness among residents could be made available by HAPA and distributed to watershed residents at minimal cost by mailing out with regular correspondence (e.g., dues) or electronically.

The cost for the resident education program depends on the programs undertaken but will likely cost less than $2,500 to have a professional brochure developed with additional costs for printing and distribution. If developed by volunteers, the cost could be essentially zero to develop and distribute electronically.

4.1.3 Phosphorus Binding (Recommended if Necessary)

Nutrient inactivation typically involves the addition of aluminum (alum, aluminimum sulfate or polyaluminum chloride) to surface water or sediment, with the intention of binding available phosphorus, thereby effectively "inactivating" it. Alternatives to alum, such various ferric compounds and a lanthanum-based proprietary agent called Phoslock are also available on the market. During treatment, bound phosphorus precipitates out of solution and settles into sediments, where it remains unavailable for biological activity. Inactivation agent that does not immediately bind with available phosphorus settles into the sediments, helping to capture additional phosphorus that may be released from sediments over time.

An in-pond low-dose alum treatment could be applied as needed to prevent or control an incipient algae bloom. This approach is the most appropriate for addressing occasional algae blooms and, due to the low dosage applied, can be implemented with minimal risk of undesired impact. Although low-dose alum treatments carry a higher cost than algaecide treatments, they provide an added benefit of removing phosphorus from the water column and may provide control over a longer period than algaecides. Algaecides target the algae, while alum targets the phosphorus which is fueling the growth of the algae. Low-dose alum treatments should be preceded, accompanied, and followed by sampling of the water body targeted for treatment. Sampling should minimally include analysis of dissolved phosphorus, aluminum, pH, and alkalinity and the locations sampled should be representative of the area/s to be treated.

TRC

TRC recommends the application of a low-dose alum treatment at Hundred Acre Pond in future years, if needed, to control algae and improve water clarity. Such treatment would most likely be needed in late June or July. Additional costs would be likely if the treatment were to be repeated in a single season and to cover necessary monitoring costs. We are currently recommending that a low-dose alum treatment be performed in 2024 to see how the system responds to these treatments and to see if there may be any carry-over effect of the application.

Nutrient inactivation will require a wetlands permit from the State or at least a Preliminary Determination.

4.1.4 Algaecides (Recommended if necessary)

Algal blooms can be associated with aquatic vegetation control due to the reduced competition for light in managed areas. Registered algaecides are primarily copper-based and result in almost immediate control of a broad spectrum of planktonic and filamentous algae. Algaecide treatments can be expected to cost on the order of $250 to $500/acre for most formulations, although some specialty formulations may exceed this cost.

Algaecides are only recommended if algal growth were to reach nuisance levels (>20,000 cells/mL) as confirmed by assessment of the algal community during the annual monitoring program. Application of a copper-based algaecide to the central portions of the pond or targeting problem areas would likely be required two to three times each summer. Assuming an area of up to 25 acres would be treated this cost could exceed $6,000 per treatment.

Algaecide application requires a Commercial Applicator License and approval from the State prior to treatment.

4.1.5 Aeration/Circulation Technologies (Not Recommended at This Time)

Aeration/circulation systems increase mixing within the water column and increase dissolved oxygen concentrations in the water. Mixing and increased oxygenation may improve water chemistry, decrease stratification, and make dissolved nutrients less available to algae and aquatic plants. Additionally, most pathogens (aerobic and anerobic) are killed by ultraviolet (UV) light emitted by the sun. UV light does not penetrate deeply into the water column (typically < 1m with impacts falling off rapidly with depth), so only surface waters are exposed to significant levels of UV radiation under normal conditions.

Aeration for Hundred Acre Pond would be beneficial given how low oxygen levels were just below the surface. There are technologies available that could provide aeration to the entire lake, but such systems would be expected to exceed $100,000 in cost for design, permitting and installation. Additional costs would need to be budgeted for annual electricity usage and maintenance for such a system. Given this cost, oxygenation is not recommended for further consideration until excessive plant and algal growth can be brought under control.

4.1.6 Algae Skimming A-pod (Not Recommended)

The A-pod is a physical structure designed by Jon Higgins, a locally based innovator, to trap suspended cyanobacteria and algae. This system utilizes a collection barrier to intercept and concentrate algae that are driven into the device by wind or water currents. The design has benefits in that it does collect and remove surface floating algae if there is sufficient wind and the device is positioned to be facing into the direction of the wind. Unfortunately, the practicality of such an approach would not be reliable enough to ensure that algal densities were reduced to a level below a threshold of concern (e.g., to prevent a toxic bloom from developing).

Although this system has been deployed as a proof-of-concept demonstration in Massachusetts, it is not currently available for commercial sale. If the system could be purchased, it would require routine, perhaps daily, removal of the accumulated algae by volunteers. Because of these logistical and efficiency challenges TRC does not recommend the use of A-pods at Hundred Acre Pond.

4.1.7 Sonic Disruption Technologies (Not Recommended at This Time)

Sonic disruption technologies utilize ultrasound for the control of algae. These devices generate specific ultrasound frequencies (inaudible to the human ear), that are emitted from a transducer located under the water surface. Ultrasound can control algae growth by causing damage to internal cell structures and cracking gas vesicles due to structural resonance. Damage to inner cell walls prevents nutrient transfer in green algae and diatoms and disrupts the mechanisms by which cyanobacteria control their buoyancy and position in the water column. These changes inhibit growth, reproduction, and toxin formation, and lead to a gradual loss of algae viability over the course of several days to several weeks. Ultrasound does not cause lysis (splitting) of algal cells, so does not result in the release of residual toxins.

Sonic disruption offers less immediate results than chemical or aluminum compound controls and is not effective against macroalgae. Sonic disruption technology is best implemented in a lake system by suspending the sonic device in the water from a solar powered buoy anchored to the lake bottom. Each buoy has the ability to treat up to a maximum of 50 acres so at least two buoys would be necessary for Hundred Acre Pond. Cost to purchase and install each buoy is approximately $60,000 with additional costs for annual maintenance ($16,000 for the entire system).

The systems are relatively new and unproven across a wide range of aquatic systems. They require a significant amount of exposure time to the algae over days or weeks to disrupt their biological systems so use in a system with significant water movement would not be feasible. They also are only effective on waters that are in "line-of-of sight" to the buoys. Therefore, any islands, peninsulas, or other shoreline irregularities would minimize their effectiveness and may require additional buoys to achieve full coverage of the pond.

We would only recommend this option if a non-chemical option were required to control planktonic algal growth.

4.1.8 Biomanipulation of the Plankton Community (Not Recommended at This Time)

Biomanipulation involves the introduction of top-down (predators/herbivores) or bottom-up (prey/plants/pathogens) biological controls to effect changes in the pond food web. At Hundred Acre Pond, the ultimate target of a biomanipulation program would be the algal community.

One way to influence phytoplankton is by changing the structure of the zooplankton grazing community to favor species that are more effective grazers. Stocking of zooplankton is not a widely used approach due to the difficulty and cost that would be involved in harvesting or culturing a large enough population sufficient to influence the community within Hundred Acre Pond. Rather, stocking of top-level piscivorous (predatory) fish would likely be the preferred approach. Such an introduction would be expected to increase predation pressure on planktivorous forage fish (e.g., sunfish, minnows). Since forage fish are important predators on zooplankton (with a preference for large-bodied species), a reduction in forage fish populations could relieve predation pressure on zooplankton, thereby resulting in more large-bodied zooplankton to graze on phytoplankton. An alternative approach would be to directly harvest planktivorous fish from the pond. Neither of these approaches can be fully recommended without more direct study of the desired target organisms, as well as potentially sensitive non-target species (e.g., river herring).

Biomanipulation relies on very complex relationships that are highly sensitive to random disturbances. Therefore, success of a biomanipulation program requires a thorough understanding of biological community and population structure prior to implementation. Monitoring would also be required to ensure that adjustments could be made in a timely matter.

Biomanipulation can be cost-effective and result in secondary benefits (e.g., improved recreational fishery), but manipulating a complex food web within a variable natural environment leads to low predictability of outcome. Biomanipulation is likely to require a Wetlands Permit from the State. Releasing fish to public waters requires a public stocking license.

Before this can be considered further or recommended, a biomanipulation feasibility study to better understand the existing fish and plankton community structures should be conducted.

4.2 Aquatic Vegetation Management

There are quite a few options for managing rooted aquatic plants and some of these have already been tried to varying degrees at Hundred Acre Pond. Most recently, HAPA has been using herbicides to focus on controlling non-native fanwort and variable-leaf milfoil for several years.

Prior work was performed by Solitude Lake Management using a combination of the contact herbicides diquat and flumioxazin to "spot treat" targeted areas each year. Approximately 36 acres of the pond has fanwort or milfoil growth each season while less than 12 acres of this area are being treated annually. This approach has had good seasonal control, but a single contact herbicide treatment has not been enough to make any long-term progress toward getting the weeds under control. This prior approach can be likened to the game "Whack-a-mole".

In 2022, HAPA hired a contractor, The Pond and Lake Connection (TPLC), to treat 7 acres of fanwort and milfoil at the northernmost end of the pond with the contact herbicides flumioxazin and diquat with an additional 5 acres of "spot" treatment around other shoreline portions of the pond for a total of 12 acres of treatment at a cost of about $7,000. This approach is similar to the work that had been done in prior years and was performed during the season between the two TRC plant surveys.

Although this approach is totally appropriate and would be appropriate to continue if HAPA is satisfied with the results, additional options for plant management are also worth consideration that may be more comprehensive and lasting and that may allow the lake to move away from herbicide use over the long-term. TRC has recommended an approach for 2023-2027 that includes lake-wide herbicide treatment with a systemic herbicide (rather than a contact herbicide) to "re-set" conditions within the pond and allow spot treatment efforts in subsequent years to be much more targeted and focused at combating minor fanwort and milfoil regrowth with the goal being to eventually transition to non-herbicide approaches such as Diver Assisted Suction Harvesting (DASH) or basic diver harvesting. Details of the approach we are recommending along with other recommended management practices for 2023-2027 are described below.

4.2.1 Aquatic Vegetation Monitoring

Although monitoring is not a management action, per se, it is recommended as part of the holistic management plan for Hundred Acre Pond. The key monitoring element associated with any vegetation management program is the mapping of aquatic plant species distribution, cover, and biovolume with focus on the distribution of non-native plant species. Monitoring provides continuous data for the purpose of detecting new infestations, as well as tracking the effectiveness of any management practices that may be implemented. Monitoring is essential if management efforts are to be cost efficient since early detection and control of any future infestation can save tens of thousands of dollars in management costs.

TRC recommends that aquatic vegetation surveys of Hundred Acre Pond be performed in early summer (June) every year to assess re-growth of fanwort, variable-leaf milfoil, and any other potentially threatening non-native species. These efforts should be able to be performed more efficiently with a focus on mapping just the beds of fanwort regrowth.

Costs for the mapping of fanwort and variable-leaf milfoil two times during the season and collecting the recommended water quality data would be under $5,000 per year if performed by a qualified consultant and would include preparation of GIS maps as part of the reporting that could be used to guide management efforts. Mapping of the plants without the water quality assessment would be about $3,500.

4.2.2 Herbicides

Options for chemical control of invasive aquatic plants are presented in Table 4.0 and are detailed individually in the following sections.

Herbicide treatment is usually the most cost-effective means by which to rapidly achieve the goal of reducing aquatic biomass over a large area. Herbicides may also be used over the long-term as part of a comprehensive management plan to treat areas of recurring infestations that are not readily controllable through other means. Over time, as control of the target species is achieved, management may be re-focused on other non-chemical methods, if desired.

The three most appropriate herbicide options with potential for aquatic plant control at Hundred Acre Pond are fluridone, diquat dibromide, and flumioxazin. Other herbicides were evaluated but are not being recommended. These are included in the report for informational purposes. Information about each herbicide and its specific applicability is presented in the sections below.

4.2.3 Fluridone – Systemic Herbicide (Highly Recommended)

Fluridone (trade name Sonar) is a systemic herbicide that reduces photosynthesis in affected plants (by inhibiting the formation of the plant pigment carotene which causes the rapid degradation of chlorophyll by sunlight in the plan), leading to eventual starvation of the entire plant. Fluridone is the only systemic herbicide that is highly effective on fanwort. A systemic herbicide is one that can kill the plant and its roots whereas a contact herbicide only controls the exposed surface growth of the plant and thus the roots survive to regenerate stems and leaves later in the season or during the following year. To date, only contact herbicides have been used at Hundred Acre Pond which is why the fanwort and milfoil continue to return each year.

Fluridone can also be used in the control of Eurasian milfoil and variable-leaf milfoil and can be used to manage some other native pond weeds at higher doses. Fluridone will not impact most native plant species at the dose recommended for treatment of fanwort and milfoil in Hundred Acre Pond.

Fluridone may be applied as a liquid formulation or as a slow-release pellet formulation. Fluridone concentrations must be maintained at treatment levels (5 to 20 ppb) for as long as 90 days to achieve effective treatment. This treatment is most effective when applied in late spring or early summer, when targeted fanwort plants are expected to be rapidly maturing. Fluridone will be absorbed by the targeted plants, providing complete control of the vegetation and root structures after two to three months of exposure.

The primary advantages of fluridone include the following:

- As a systemic herbicide, fluridone should result in multiple seasons of control.
- Due to the slow action of this herbicide, plant dieback is gradual and dissolved oxygen sags and algal blooms are rarely problematic.
- Impacts to native plants tends to be minimal or none.
- Label restrictions are minimal.

The primary limitations of fluridone include the following:

- Concentrations must be maintained at treatment levels for as long as 90 days to achieve effective treatment. This can be difficult in water bodies with rapid flushing rates, although use of granular formulations or advanced liquid formulations (e.g., Sonar Genesis) may significantly improve treatment success.

Fluridone is one of the more expensive herbicides on the market and treatments typically cost $700 to more than $1,000/acre, depending on the formulation used and the need for one or more "booster" treatments to maintain the concentration of the herbicide at an effective level over the treatment period.

A few notes on the fluridone treatment:

1. Fluridone treatment is likely to be at a dose of between 5 and 20 ppb. The USEPA allows for fluridone to be safely applied to aquatic systems at a dose up to 150 ppb.

2. Fluridone impacts carotene and thus has shown few impacts to animals at tested levels as high as 1,000 ppb to 10,000 ppb.

3. Fluridone has been extensively tested and found to not be a carcinogen or mutagen.

4. Using fluridone to manage the fanwort will result in a very prolonged die off and decay of the plants and will thus not result in a spike in phosphorus being released from the plants that might otherwise lead to algal blooms or drops in oxygen levels. A study by the Ramsey-Washington Metro Watershed District in 2014 found that aquatic plants contain approximately 0.0313% phosphorus or 36 lbs. of phosphorus in 115,000 lbs. of aquatic vegetation harvested. This amount of phosphorus is not insignificant. Much of the nutrient being released during the decay of the plant enters the water column slowly and passes downstream with outflowing water, like what occurs during the fall senescence.

5. Fluridone use will kill the rooted plants as well as any floating fragments within the water column.

6. Swimming and boating and other recreational used will not be allowed during the day of the initial application or on days in which a booster treatment is required. Use of pond water for irrigation will not be allowed for up to 14 days post application.

7. Fluridone has been used in several locations to eliminate a target weed for extended periods of time. Ashmere Lake in Hinsdale, MA was successful in keeping milfoil growth at bay using fluridone alone for over 10 years while South Pond in Sturbridge, MA was able to treat fanwort and milfoil once using fluridone once and then kept in check for over 16 years, and counting, with continued follow-up using hand-pulling and spot herbicide treatments.

Fluridone is the recommended method for control of fanwort and milfoil in Hundred Acre Pond. This systemic herbicide should be used in 2023 to reset the pond with follow-up spot-treatments for any regrowth being done in 2024 and beyond. Costs for implementing a fluridone treatment at Hundred Acre Pond should be on the order of $60,000 including the initial treatment and booster treatments to maintain a concentration between 5 and 15 ppb for up to 90 days, if possible. The use of liquid and pellet formulations of fluridone may be the most effective way to control costs while ensuring that the treatment is effective with inflowing waters.

This herbicide should not be required for use in the pond for several years if spot-treatments and/or hand harvesting or DASH are implemented annually thereafter. Any sources of fanwort or milfoil upstream of the pond could reduce this potential benefit or make it challenging to maintain without an annual effort allocated to the continued control of these plants.

4.2.4 Imazamox - Systemic Herbicide (Not Recommended)

Imazamox is a relatively new herbicide with very low toxicity to animals or humans. Imazamox is the common name of the active ingredient ammonium salt of Imazamox (2-[4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl]-5-(methoxymethl)-3-pyridinecarboxylic acid. It was registered with the EPA in 2008 and is a systemic herbicide currently marketed for aquatic use under the brand name Clearcast. Imazamox moves throughout plant tissue and prevents target species from producing a necessary enzyme, acetolactate synthase (ALS), which is not found in animals. Susceptible plants will stop growing soon after treatment, but plant death and decomposition will occur over several weeks.

The primary advantages of imazamox include the following:

- Very favorable environmental profile with extremely low toxicity risk.
- Is a systemic herbicide that is ideally suited to control emergent plants such as phragmites and water chestnut, but also effective against many emergent pondweeds, water lilies and watershield.
- Imazamox is relatively slow acting which minimizes the potential for low oxygen levels following treatment that could result from the decay of the plants.

The primary limitations of imazamox include:

- It is not effective against fanwort or milfoil.
- Imazamox is a newer product and is one of the more costly herbicide options.

The cost of imazamox is significantly higher than most other herbicides, ranging up to $1,000/acre for treatment. This herbicide is ideal for control of lilies and watershield in areas of Hundred Acre Pond that are impacted by nuisance levels of these native species. These species do not have to be controlled but having this herbicide as an option under the permit will allow for it to be applied as appropriate based on the needs of the lake users.

4.2.5 2,4-D – Systemic Herbicide (Not Recommended)

2,4-D is a systemic herbicide that prevents affected plants from being able generate new tissue, resulting in eventual death of the plant. This herbicide is not effective on fanwort, pondweeds, or watershield but would impact milfoil in Hundred Acre Pond. Various formulations of 2,4-D are approved for aquatic use under multiple tradenames (e.g., Navigate) in Rhode Island.

The primary advantages of 2,4-D include the following:

- As a systemic herbicide that can achieve multiple seasons of control for some species such as milfoil.

- 2,4-D is selective for dicots, which means that it is effective on milfoil while having less impact or no impact on desirable plant species such as most native pondweeds.
- The required contact time for 2,4-D is significantly less than fluridone. Therefore, it may be easier to achieve effective control of target species in waterbodies with high flushing rates.

The primary limitations of 2,4-D include the following:

- The potential for migration through soils means 2,4-D should not be used without significant additional hydrologic or hydrogeologic assessments. Additionally, setbacks from private wells are recommeded to minimize the potential for 2,4-D treated water to be drawn into these wells.
- The fanwort would not be impacted for multi-year control as these are not impacted by 2,4-D.

TRC does not recommend 2,4-D over other herbicide options given its lack of impact on one of the plants of primary concern in Hundred Acre Pond, and the potential for this herbicide to impact groundwater.

4.2.6 Diquat Dibromide – Contact Herbicide (Recommended as a Spot-Treatment)

Diquat dibromide, also known as diquat or by its tradename Reward, works quickly by interrupting the photosynthetic process, resulting in the dieback of leaf and stem cells. It offers immediate control of milfoil and pondweed but is not effective against fanwort or watershield.

The primary advantages of diquat include the following:

- Provides rapid control of targeted plants.
- Minimal contact time is required for diquat to be effective.

The primary limitations of diquat include the following:

- Diquat is not effective against all species of concern (e.g. fanwort) in Hundred Acre Pond.
- As a contact herbicide, diquat only kills the exposed parts of the plant (leaves and stem). The seeds, roots, and crowns typically survive and put out another flush of growth in the following year (or even later in the same season). Long-term control requires consistent reapplication over the same treated area over several years.
- Application should be limited to no more than one-half of total lake area per label restrictions. This is required to prevent impacts to aquatic life due to rapid dieback of treated plants, which could result in temporary reductions in dissolved oxygen levels.

Diquat will be useful for control of pondweeds and other species in areas of Hundred Acre Pond where milfoil and/or native vegetation has reached nuisance levels. Diquat is one of the least expensive herbicides on the market on a per-treatment basis but would need to be used on an annual basis to be effective. Treatment of up to 20 acres of high-density nuisance native plants in Hundred Acre Pond with diquat would cost about $5,000 (minimum of 20 acres, additional acres priced at $250 per acre) if such efforts are deemed necessary.

4.2.7 Flumioxazin – Contact Herbicide (Recommended for Spot-Treatment)

Flumioxazin (trade name Clipper) works by inhibiting protoporphyrinogen oxidase (PPO), an enzyme necessary for photosynthesis. Inhibition of PPO causes destruction of plant cell plasma membranes in the presence of sunlight, resulting in rapid dieback of plant tissues. Treatment is most successful when applied in late spring or early summer, when targeted fanwort plants are expected to be rapidly maturing.

The primary advantages of flumioxazin include the following:

- Flumioxazin is the only contact herbicide that provides rapid control of both fanwort and exotic milfoils.
- Minimal contact time is required for flumioxazin to be effective.

The primary limitations of flumioxazin include the following:

- As a contact herbicide, flumioxazin only kills the exposed parts of the plant (leaves and stem). The roots and crowns typically survive and put out another flush of growth in the following year (or even later in the same season). Long-term control requires consistent reapplication to the same beds over several years.
- Because flumioxazin requires sunlight to work, it is less effective once a significant vegetative canopy has developed in the water column, due to the shading that develops.
- Flumioxazin degrades rapidly in water, so it may result in poor control if not precisely applied to the targeted beds.
- The treatment should not be reapplied to the same area for at least three consecutive years. This is required to protect non-target species populations and prevent the development of resistant plant populations. It is possible that a resistant population of fanwort has developed at Hundred Acre Pond as evidenced by the healthy growth observed by TRC in the fall of 2022 post treatment.

The cost of flumioxazin is significantly higher than most other contact herbicides, ranging up to $1,000/acre for treatment. Treatment costs can sometimes be reduced if flumioxazin is used in combination with diquat. In Hundred Acre Pond, flumioxazin may be potentially useful for spot or partial-lake control of fanwort and variable-leaf milfoil.

4.2.8 Florpyrauxifen-benzyl – Systemic Herbicide (Not Recommended)

Florpyrauxifen-benzyl, known more commonly by its tradename ProcellaCOR, is a systemic herbicide that is taken up by aquatic plants. The herbicide is a relatively new herbicide registered with the US EPA in 2017 and is a member of a new class of synthetic auxins that differ in binding affinity compared to other currently registered synthetic auxins. The herbicide mimics the plant growth hormone auxin that causes excessive elongation of plant cells that ultimately kills the plant. Susceptible plants will exhibit deformed growth (larger, twisted leaves, stem elongation) and fragility of leaf and shoot tissue. Initial impacts will occur within hours to a few days after treatment with plant death and decomposition occurring over 2 - 3 weeks.

ProcellaCOR should be applied to plants that are actively growing. This herbicide has relatively short contact exposure time requirements (12 - 24 hours typically). The rapid action may be advantageous for early infestation and localized treatments of submersed aquatic plants such as has occurred with milfoil in Hundred Acre Pond.

The primary advantages of ProcellaCOR include the following:

- Provides rapid control of targeted plants, very effective on Eurasian milfoil, and to a lesser degree on variable-leaf milfoil.
- Minimal contact time is required to be effective.
- Systemic herbicide should provide multiple years of control (as compared to the diquat alternative).
- Effectively treats smaller weed beds rather than require whole lake applications such as with fluridone.

The primary limitations of ProcellaCOR include the following:

- As a relatively new herbicide, the costs per acre are high (~$1,000/acre) so reserving its use on smaller weed beds or stubborn locations may be more appropriate.
- Relatively non-selective and could impact a broad spectrum of native plants (e.g. pondweeds, bladderworts, etc.) at higher doses; however it is not effective against fanwort.
- Application should be limited to no more than one-half of total pond area per label restrictions. This is required to prevent impacts to aquatic life due to rapid dieback of treated plants, which could result in temporary reductions in dissolved oxygen levels.

Use of ProcellaCOR is not recommended for Hundred Acre Pond since the pond is dominated by fanwort, which is not impacted by ProcellaCOR. It could be considered in future years if fanwort is brought under control, and it is used to spot-treat smaller beds of milfoil.

4.2.9 Permitting Herbicides

Costs for permitting an herbicide treatment in Rhode Island are typically low ($350) because all that is usually required is a DEM permit to apply herbicide which is typically applied for by the licensed herbicide contractor.

4.2.10 Mechanical Harvesting (Not Recommended)

Mechanical harvesting, which involves cutting and pulling aquatic plants from a specially equipped watercraft, is an effective short-term approach to control plant biomass. As mechanical harvesting simply sets plants back for the season and may allow plant fragments to break free and colonize new locations, its use should be reserved for scenarios where there is an immediate but temporary need for widespread reduction of nuisance macrophyte cover. This may include reservoir areas near water intakes or locations where seed-propagated nuisance species (e.g., curly-leaf pondweed or water chestnut) have spread beyond the scale of hand harvesting methods. Harvesting of these seed producing species is effective when the plants are large enough to be efficiently cut but *before* the seeds have matured. Use of harvesting for species of plants that spread via fragmentation, such as fanwort and milfoil found in Hundred Acre Pond, is typically discouraged unless no other viable options exist or when there is no hope of ever regaining control of an infestation of these species.

Mechanical harvesting typically results in only single season control. Due to physical limitations of the harvester, this method is also typically most effective on plants growing in less than ten feet, but more than two feet, of water. These limitations should be carefully considered before proceeding with a mechanical harvesting program.

This technique has a secondary benefit of depleting nutrients from the sediments over time. However, this usually occurs very slowly and, in some cases, may not keep up with nutrient loading from the watershed. TRC would not recommend the use of mechanical harvesting specifically to address nutrients.

Mechanical harvesting may encourage the spread of fanwort and milfoils. Therefore, this approach should not be considered as a means for controlling nuisance native vegetation within Hundred Acre Pond due to the presence of fanwort and variable-leaf milfoil in the waterbody.

4.2.11 Hydroraking (Not Recommended)

Hydroraking is another form of plant harvesting that involves use of a backhoe-like machine mounted on a barge to remove plants directly from pond sediments. Depending on the attachment used, plants are scooped, scraped, or raked from the bottom and deposited on shore for disposal. Hydroraking is most useful for local control of plants with large rhizomes or tubers, as these methods can physically remove or destroy the bulky portions of the plant, along with some of the seeds. Costs to perform hydroraking vary depending upon a number of factors, including plant density, distance of the target beds from shore, and size of the area to be managed but a cost on the order of $4,000 - $5,000 per acre should be anticipated.

Hydroraking is relatively non-selective and has the potential to facilitate the spread of milfoil and fanwort within Hundred Acre Pond due to fragmentation of these plants during hydroraking operations. Given this consideration and the high cost, hydroraking is not recommended at Hundred Acre Pond.

Hydroraking is accomplished using a backhoe-like piece of equipment, fitted with a special rake and modified for aquatic use.

4.2.12 Diver Assisted Suction Harvesting (Recommended)

Diver assisted suction harvesting (DASH) technology has been around for decades but has been refined in recent years to make it more efficient and accessible. An advantage of DASH over other mechanical harvesting methods is that divers can directly confirm removal of entire individual plants.

Costs for implementing a DASH program can vary substantially dependent upon such factors as plant bed density, visibility, water current, availability of dewatering locations, and disposal. Particularly dense and extensive weed beds are likely to require multiple rounds of harvesting per season over several years to exhaust the beds. In situations where DASH is being implemented to control early infestations or to manage a lake following treatment with herbicide, such as is the case with Hundred Acre Pond, the DASH operation should also include the use of floating mesh curtains to contain the work area and prevent the spread of plant fragments to areas outside of the DASH operation. These curtains should be inspected and cleared of fragments before moving to the next work area.

Commercial DASH rates are typically in the range of $2,250 to $3,000 per day for small efforts. A DASH team may clear more than an acre per day, but the actual rate achieved depends on diver expertise and the density of the weed beds. Under difficult conditions, the clearance rate may be as little as 0.1 acre per day. Particularly dense and extensive infestations may require two harvesting passes per year to maximize effectiveness.

Controlling small, targeted beds using DASH can extend the length of time between the larger and more expensive whole-lake fluridone treatments and limit the need to apply herbicides such as flumioxazin or diquat for spot treatment.

4.2.13 *Hand Harvesting (Recommended for Long-term Maintenance)*

The simplest form of harvesting is hand harvesting of selected plants. Depending on the depth of the water at the targeted site, hand harvesting may involve wading, snorkeling, SCUBA diving or pulling from watercraft. The slow and intensive nature of this work makes practical implementation most feasible for small areas of shallow water, typically less than one acre in size or when plant regrowth is relatively sparse and a kayak or canoe can be used.

Hand harvesting is a viable option for managing small beds of fanwort and milfoil regrowth and should be considered as a cost-effective approach for the long-term maintenance of Hundred Acre Pond following implementation of the recommended herbicide program. Hand harvesting is recommended once the fanwort and milfoil growth is brought down to a level of one to possibly two acres in area or when the regrowth of the plants is relatively sparse.

Costs of hand harvesting are low, typically consisting of the costs of disposal of the harvested vegetation. Often, the city or town highway department will truck and dispose of the material for free, but occasionally the rental of an appropriately sized dumpster may be required. Additional costs may also include training and organization of the volunteers by a professional to ensure that the work is clearly planned and executed the first year.

If hand harvesting is done professionally, costs typically range between $1,500 and $2,500 per day for a pair of divers.

4.2.14 *Water Level Control – Drawdown (Not Recommended)*

Drawdown involves lowering the water level to expose shallow bottom sediments and associated plants to drying and/or freezing. It has the distinct advantage of being relatively inexpensive to implement but must be conducted carefully and sometimes needs to be repeated over multiple years to be effective. Drawdown is also a useful technique for addressing aquatic invasive plants in submerged riprap or otherwise inaccessible areas that would not otherwise be susceptible to harvesting.

As a management tool, drawdown is most effective against species that reproduce mainly by vegetative means, including Eurasian and variable-leaf milfoils and fanwort. Drawdown is less effective on species that reproduce primarily by seed (e.g., pondweeds) and/or turion (e.g., curly-leaf pondweed) and may actually expand beds of these species.

Timing of drawdown is also important. Although it can be conducted at any time, the interaction of drying and freezing that occurs with winter drawdown is usually most effective. In southern New England, winters are often variable in their intensity and the ideal condition of at least two weeks of very cold weather with limited snow cover (which would otherwise insulate the plants) may not be achieved every year. In addition to the need for exposure of sediments to freezing, refill of the lake should be completed as early as possible after a prolonged thaw period has begun. Otherwise, shallow water conditions in the littoral zone could actually enhance germination and growth of problem species by allowing more light to penetrate to the lake bottom.

In addition to these potential drawbacks, drawdowns may also impact non-target species, including fish, reptiles, amphibians, invertebrates, and native plants. Drawdown typically reduces fish habitat volume, access to spawning areas, and availability of dissolved oxygen, among other parameters, each of which should be considered prior to drawdown implementation. Native plants in exposed sediments are likely to be killed or set back by winter drawdown. However, many desirable native species reproduce through seeds, turions or other means that allow them to quickly repopulate areas exposed by drawdown. Typically, this would be expected to favor native species over the target invasives and improve aquatic habitat.

In most cases, undesired impacts can be mitigated through careful planning, operation, and monitoring. If possible, drawdown should be initiated in early November and completed by December 1, although this may be difficult to achieve in practice during wet years. Ideally, the drawdown rate should not exceed 0.25 feet per day or result in flows exceeding 4 cubic feet per second per square mile (cfsm). Refill of the water body should be complete by April 1.

Drawdown requires an outlet control structure and/or a significant drop in elevation at the pond outlet, which is not the case for Hundred Acre Pond. Even if an outlet structure existed at Hundred Acre Pond, the fanwort and variable-leaf milfoil is distributed throughout the pond, including deep areas which could not be dewatered, therefore drawdown alone will not be able to maintain the desired level of fanwort and milfoil control. Drawdown is not a viable method to control plant species for Hundred Acre Pond.

4.2.15 Dredging (Not Recommended)

Dredging works as a plant control technique when either a light limitation is imposed through increased water depth or when enough soft sediment is removed to reveal a less hospitable substrate for plant growth (e.g. hard bottom or other nutrient-poor substrate). Light limitation through increased depth is possible in Hundred Acre Pond, but at considerable cost as enough sediment would need to be removed to create depths greater than 8 feet in areas where plants currently grow. Because dredging involves removing pond sediments, it is considered a non-selective management technique that will affect non-target plant species and some animals (primarily invertebrates) living in the immediate dredged area.

Conventional "dry" dredging requires pond drawdown

The amount of material to be removed and the type of disposal or reuse has a significant impact on the cost of dredging. For a complete pond dredging at Hundred Acre Pond, the amount of sediment to be removed would be expected to exceed 170,000 cubic yards to achieve a depth that would preclude light penetration to the bottom (assumes 3 feet of removal over a 35 acre area). Environmental permitting for dredging projects is moderately complex and requires at least a year before the project could receive all required approvals. Federal (U.S. Army Corps of

Engineers 404), state (401 Water Quality Certificate, Wetlands Permit), and possibly local permits are all required, and would necessitate considerable review time. Costs for design and permitting of a dredge project at the pond would be on the order of $150,000 with construction costs for dredging using hydraulic suction dredging expected on the order of $8.5 million to $10 million.

For a more focused and localized dredging project with an estimated sediment removal volume of approximately 25,000 cubic yards, the cost of a hydraulic dredging project the costs would likely run between $1.5 million and $2 million (including permitting and design as well as off-site disposal at a facility equipped to receive contaminated sediment).

If localized dredging is considered to be a viable long-term option, the next steps would be:

1. Assessment of specific scope and extent of dredge program including possible funding options.
2. Chemical and physical analysis of the sediments in areas targeted for dredging.
3. Development of an engineering design for submission to permitting authorities.
4. Initiation of the permitting process including outreach to state and federal permitting authorities.

These four activities might be expected to cost up to $50,000 for Hundred Acre Pond but are essential if dredging is to be pursued as a management option. Additional design costs would include final engineering design following the permitting process (incorporating any accepted changes resulting from these reviews) along with the development of a bid specification package for the project.

5.0 Summary of Management Recommendations

Hundred Acre Pond continues to provide shoreline residents with immense recreational and aesthetic value; however, conditions within the waterbody have deteriorated due to the infestation of invasive fanwort and variable-leaf milfoil.

Management goals include controlling nuisance non-native vegetation, protecting or improving water quality and preventing future algal blooms. Recommended management actions for 2023 through 2027, and associated costs, are summarized and presented in Table 5.

Table 5. Recommended Management Actions and Associated Costs* for Hundred Acre Pond, 2023 - 2027

Management Action	Frequency	Approximate Timeframe	Estimated Annual Cost* 2023	2024	2025	2026	2027	Total Cost 2023-2027
Hundred Acre Pond								
Water quality monitoring by contractor	Annually	June and August	$1,500	$1,500	$1,500	$1,500	$1,500	$7,500
Aquatic plant mapping	Annually	June and August	$3,500	$3,500	$3,500	$3,500	$3,500	$17,500
Phosphorus Binding (alum) ~30 acres low dose	Pilot in 2024	June/July	$0	$15,000	$0	$0	$0	$15,000 (optional)
Algaecide ~15 acres/yr if needed	Annually if needed	July - September	$3,000	$3,000	$3,000	$3,000	$3,000	$15,000 (if needed)

Table 5. Recommended Management Actions and Associated Costs* for Hundred Acre Pond, 2023 - 2027

Management Action	Frequency	Approximate Timeframe	Estimated Annual Cost*					Total Cost
			2023	2024	2025	2026	2027	2023-2027
Fluridone (Sonar)	Once	June through September	$60,000	$0	$0	$0	$0	$60,000
Spot treatment of up of high-density nuisance plants with diquat and Flumioxazin	Annually beginning as soon as 2025	July	$0	$0	$3,000 minimum for 5 acres with additional acres at $600/ac.	$3,000 minimum for 5 acres with additional acres at $600/ac.	$0 with additional acres at $600/ac.	$6,000
Diver Hand harvesting of fanwort and milfoil regrowth	Annually beginning as soon as 2025	July - September	$0	$0	$0 with volunteers	$0 with volunteers	$0 with volunteers	$0 with volunteers/ highly variable $ with contractor

Table 5. Recommended Management Actions and Associated Costs* for Hundred Acre Pond, 2023 - 2027

Management Action	Frequency	Approximate Timeframe	Estimated Annual Cost*					Total Cost
			2023	2024	2025	2026	2027	2023-2027
DASH	Annually as soon as 2025 but unlikely until 2027	Anytime	$0	$0	$0	$0	$6,000 minimum for 2 days at $3,000/day	$6,000
Total Cost			**$68,000**	**$23,000**	**$11,000**	**$11,000**	**$14,000**	**$127,000**

* Estimated costs assume that work would be performed separately, however there may be savings if multiple tasks are combined. (e.g., herbicide treatments are performed by a single contractor on the same dates or water quality monitoring is performed in combination with plant mapping by same consultant). Additionally, annual plant control effort, and thus cost, will likely vary considerably based on the amount of undesirable plants that are mapped each year, the success of the prior year's effort, and the desire by HAPA to continue to control those plants each year.

The cost for managing Hundred Acre Pond is not insignificant, however, the cost will decrease significantly following the initial re-set of the pond using fluridone. Based on the anticipated cost to implement the recommended 5-year Management program, the average annual cost is expected to be about $25,000 per year over the initial 5-year period. Average cost per year thereafter should be expected on the order of $10,000 to $15,000 depending upon the management technique implemented and the amount of spot-control required.

Although this is significantly more than HAPA has been spending on an annual basis to date to manage the pond, this amount is not unusual for most well managed lakes of this size in the region, particularly for those that have had to battle with non-native plants. Furthermore, the results that will be achieved under this program should provide pond residents with a far superior recreation experience and a much healthier and sustainable ecological resource for fish and wildlife than what has been achieved over the past.

Attachment A: Plant Maps

PLANT COVER

SHORELINE

NONE (38.2 ACRES)

1% - 25% (11.2 ACRES)

26% - 50% (20.9 ACRES)

51% - 75% (13.0 ACRES)

76% - 100% (12.3 ACRES)

PROJECT:	**LAKE CONSULTING SERVICES** **HUNDRED ACRE POND** **WEST KINGSTOWN, RI**
TITLE:	**VEGETATION COVERAGE** **JUNE 21, 2022**
DRAWN BY:	T. LATHAM
CHECKED BY:	S. DEHAINAUT
APPROVED BY:	M. PROKO
DATE:	JUNE 2022
PROJ. NO.:	496374.0000.0000

FIGURE 1

BASE MAP: ESRI, WORLD IMAGERY, 2021
DATA SOURCES: TRC, GPS LOCATIONS, JUNE 21 2022

0 200 400 FEET
1:6,000

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

FILE: 496374_HUNDREDACREPOND_INVASIVES_20220621

COORDINATE SYSTEM: NAD 1983 2011 STATEPLANE RHODE ISLAND FIPS 3800 FT US; MAP ROTATION: 0

FANWORT COVERAGE

SHORELINE

NOT OBSERVED (58.0 ACRES)

1% - 25% (16.4 ACRES)

26% - 50% (9.9 ACRES)

51% - 75% (8.9 ACRES)

76% - 100% (1.3 ACRES)

BASE MAP: ESRI, WORLD IMAGERY, 2021
DATA SOURCES: TRC, GPS LOCATIONS, JUNE 21 2022

0 200 400 FEET

1:6,000

PROJECT: **LAKE CONSULTING SERVICES**

HUNDRED ACRE POND
WEST KINGSTOWN, RI

TITLE: **FANWORT COVERAGE**
JUNE 21, 2022

DRAWN BY:	T. LATHAM	PROJ. NO.:	496374.0000.0000
CHECKED BY:	S. DEHAINAUT	**FIGURE 2**	
APPROVED BY:	M. PROKO		
DATE:	JUNE 2022		

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

FILE: 496374_HUNDREDACREPOND_INVASIVES_20220621

VARIABLE-LEAF MILFOIL COVERAGE — SHORELINE

- NOT OBSERVED (81.7 ACRES)
- 1% - 25% (4.4 ACRES)
- 26% - 50% (4.5 ACRES)
- 51% - 75% (3.9 ACRES)
- 76% - 100% (0.0 ACRES)

BASE MAP: ESRI, WORLD IMAGERY, 2021
DATA SOURCES: TRC, GPS LOCATIONS, JUNE 21 2022

0 200 400 FEET
1:6,000

PROJECT: **LAKE CONSULTING SERVICES**
HUNDRED ACRE POND
WEST KINGSTOWN, RI

TITLE: **VARIABLE-LEAF MILFOIL COVERAGE**
JUNE 21, 2022

DRAWN BY:	T. LATHAM	PROJ. NO.:	496374.0000.0000
CHECKED BY:	S. DEHAINAUT	**FIGURE 3**	
APPROVED BY:	M. PROKO		
DATE:	JUNE 2022		

TRC

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

FILE: 496374_HUNDREDACREPOND_INVASIVES_20220621

PLANT COVER

SHORELINE

NONE (65.2 ACRES)

1% - 25% (10.6 ACRES)

26% - 50% (7.7 ACRES)

51% - 75% (7.3 ACRES)

76% - 100% (5.3 ACRES)

BASE MAP: ESRI, WORLD IMAGERY, 2021
DATA SOURCES: TRC, GPS LOCATIONS, 09/07/2022

0 275 550 FEET

1:6,600 1" = 550'

PROJECT:	LAKE CONSULTING SERVICES HUNDRED ACRE POND WEST KINGSTOWN, RI
TITLE:	VEGETATION COVERAGE SEPTEMBER 7, 2022

DRAWN BY:	T. LATHAM	PROJ. NO.:	496374.0000.0000
CHECKED BY:	S. DEHAINAUT	FIGURE 4	
APPROVED BY:	M. PROKO		
DATE:	SEPTEMBER 2022		

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

FILE: 496374_HUNDREDACREPOND_INVASIVES_20220621

COORDINATE SYSTEM: NAD 1983 2011 STATEPLANE RHODE ISLAND FIPS 3800 FT US. MAP ROTATION: 0
SAVED BY: TLATHAM ON 9/10/2022 08:44:20 AM.

COORDINATE SYSTEM: NAD 1983 2011 STATEPLANE RHODE ISLAND FIPS 3800 FT US; MAP ROTATION: 0
SAVED BY: TLATHAM ON 9/13/2022, 08:44:29 AM; FILE PATH: T:\1-PROJECTS\HUNDREDACREPONDASSOCIATION\496374_PLANTMAPPING\2-APRX\496374_HUNDREDACREPOND_INVASIVES_20220821\496374_HUNDREDACREPOND_INVASIVES_20220621.APRX; LAYOUT NAME: 06-22 FANWORT

FANWORT COVERAGE

- NOT OBSERVED (73.3 ACRES)
- 1% - 25% (9.3 ACRES)
- 26% - 50% (8.9 ACRES)
- 51% - 75% (4.0 ACRES)
- 76% - 100% (1.1 ACRES)
- SHORELINE

BASE MAP: ESRI, WORLD IMAGERY, 2021
DATA SOURCES: TRC, GPS LOCATIONS, 09/07/2022

0 275 550 FEET
1:6,600 1" = 550'

PROJECT:	LAKE CONSULTING SERVICES HUNDRED ACRE POND WEST KINGSTOWN, RI		
TITLE:	FANWORT COVERAGE SEPTEMBER 7, 2022		
DRAWN BY:	T. LATHAM	PROJ. NO.:	496374.0000.0000
CHECKED BY:	S. DEHAINAUT	FIGURE 5	
APPROVED BY:	M. PROKO		
DATE:	SEPTEMBER 2022		
FILE:	496374_HUNDREDACREPOND_INVASIVES_20220621		

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

VARIABLE-LEAF MILFOIL COVERAGE ▭ SHORELINE

	NOT OBSERVED (86.3 ACRES)
▒	1% - 25% (2.4 ACRES)
▒	26% - 50% (4.9 ACRES)
▒	51% - 75% (3.0 ACRES)
▒	76% - 100% (0.0 ACRES)

BASE MAP: ESRI, WORLD IMAGERY, 2021
DATA SOURCES: TRC, GPS LOCATIONS, 09/07/2022

N

0 275 550 FEET

1:6,600 1" = 550'

PROJECT: **LAKE CONSULTING SERVICES**
HUNDRED ACRE POND
WEST KINGSTOWN, RI

TITLE: **VARIABLE-LEAF MILFOIL COVERAGE**
SEPTEMBER 7, 2022

DRAWN BY:	T. LATHAM	PROJ. NO.:	496374.0000.0000
CHECKED BY:	S. DEHAINAUT	**FIGURE 6**	
APPROVED BY:	M. PROKO		
DATE:	SEPTEMBER 2022		

TRC

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

FILE: 496374_HUNDREDACREPOND_INVASIVES_20220621