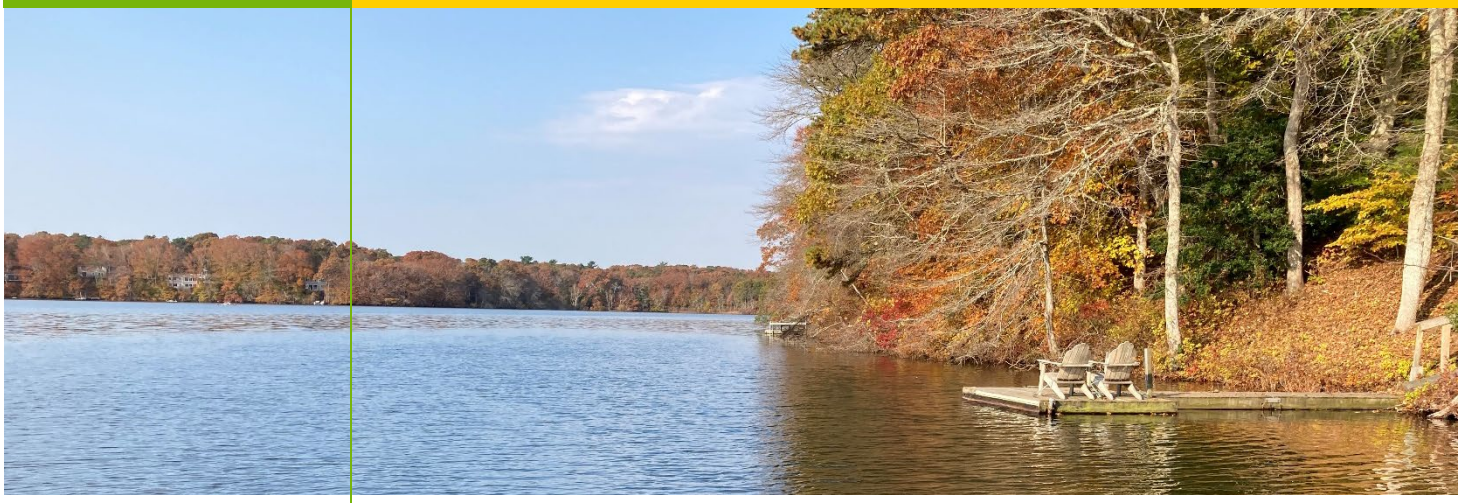
Santuit Pond Focused Feasibility Study

Interim Recommendations for Water Quality Improvement

Mashpee, Massachusetts



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1.0 INTRODUCTION

ESS Group, LLC (ESS) was contracted by the University of Maine System to prepare this focused feasibility study of potential management actions to improve water quality in Santuit Pond. The purpose of this study is to evaluate and recommend the most appropriate measures for in-pond implementation over the short-term.

To do this efficiently, the focused feasibility study makes use of existing information available from prior studies, publicly available documents or data, and direct input from project stakeholders.

This focused feasibility study report includes the following key elements:

- Description of the pond's geographic setting.
- Summary review of existing conditions and recent studies.
- Statement of management issues and goals.
- Evaluation in-pond management options and prioritized recommendations.
- Identification of potential funding sources.

This project was supported by federal funding administered through the University of Maine System Environmental Finance Center on behalf of the Southeast New England Program (SNEP) Network. Project partners include the Town of Mashpee and the Mashpee Wampanoag Tribe.

2.0 SETTING

Santuit Pond is an approximately 176-acre Great Pond located entirely in the town of Mashpee, Massachusetts. The pond serves as the headwaters of the Santuit River, which originates as the outlet at the pond's southernmost end and flows south into Shoestring Bay.

(Left) View toward Briant's Neck from eastern shoreline of Santuit Pond.
(Right) View of the abandoned Chop Chaque cranberry bog from the Santuit Pond shoreline.

Santuit Pond is located within an approximately 1,400-acre watershed that extends from the pond outlet northwest to Mashpee Wakeby Pond and north into the Town of Sandwich (Howes et al. 2004). The primary watershed land use is forest with residential contributing the bulk of the remainder. Shoreline development is present along much of the western edge of the pond with some residential areas also present along the

east-central shoreline. The northern and southern ends of the pond remain undeveloped, although a few abandoned cranberry bogs are present.

(Left) Historical USGS topographic map showing Santuit Pond in 1941. Note diversion to Lovell's Pond at Southeastern end of Santuit Pond.
(Right) Santuit Pond watershed as depicted in MassDEP's Watershed-Based Planning tool (2021)

As with most of Cape Cod, Santuit Pond is located in an area of thick glacial outwash deposits. As a result, the pond is primarily groundwater-fed and has no permanent surface tributaries, although surface flows may reach the pond in the form of stormwater runoff. The Santuit Pond dam was built in the mid-1800s but was rehabilitated and outfitted with an improved fish ladder to aid passage of anadromous river herring in 2013 (USACE 2021). Additionally, an historical diversion to Lovell's Pond in Barnstable was closed off following the cessation of active cranberry operations in the early 2000s (WRS 2014). Although some seepage from Santuit Pond may still flow toward Lovell's Pond, the Santuit River now effectively serves as the only surface outlet of the pond.

3.0 EXISTING CONDITIONS AND RECENT STUDIES

Santuit Pond is classified by MassDEP as a Class B freshwater body. Pursuant to 314 CMR 4.02, these waters are "designated as a habitat for fish, other aquatic life, and wildlife, including for their reproduction, migration, growth and other critical functions, and for primary and secondary contact recreation...Class B waters shall be suitable for irrigation and other agricultural uses and for compatible industrial cooling and process uses. These waters shall have consistently good aesthetic value."

Under the *Final Massachusetts Integrated List of Waters for the Clean Water Act 2018/2020 Reporting Cycle* (MassDEP 2021), Santuit Pond is listed as a Category 5 water body (i.e., needing a TMDL) and is impacted by the following impairments:

1. Fish passage barrier
2. Abnormal fish deformities, erosions, lesions, tumors
3. Chlorophyll-a
4. Harmful algal blooms
5. Nutrient/eutrophication biological indicators
6. High pH
7. Total phosphorus
8. Transparency/clarity

With the possible exception of the first two, these impairments are highly interrelated. For example, excessive total phosphorus is likely to result in eutrophication biological indicators, including harmful algal blooms, which likewise result in high concentrations of chlorophyll a. These impairments, in turn, reduce transparency and can lead to high pH levels. This suggests that the reduction of phosphorus concentrations in Santuit Pond could have cascading benefits.

The most recent comprehensive study of the pond and its watershed was the *Santuit Pond Diagnostic Study* (AECOM 2010). This diagnostic study included field sampling of surface water, stormwater, cranberry bog floodwater, and groundwater. It also involved limited sediment sampling and biological surveys of aquatic macrophytes and waterfowl. Additionally, this study reviewed and incorporated historical data as well as contemporaneous water quality data collected by others, including the Pond and Lake Stewardship (PALS) program, the Mashpee Wampanoag Tribe, the Town of Mashpee, MassDEP, and the Massachusetts Department of Public Health (MDPH).

The key diagnostic findings of this study were as follows:

- Santuit Pond is eutrophic (highly nutrient-enriched) and experiences high phosphorus concentrations, low water transparency, and high chlorophyll a concentrations.
- Despite shallow depths and frequent mixing, dissolved oxygen depletion still occurs in bottom waters. This allows release of phosphorus from sediments into the waters of Santuit Pond (internal loading).
- The total phosphorus load to Santuit Pond is approximately 380 kg/yr, which is equivalent to an annual in-lake phosphorus concentration of 80 µg/L. Most of this (78%) is from internal loading. Groundwater sources, including septic systems, contribute the next largest portion (8%) of the phosphorus load, followed by surface runoff (5%), direct precipitation (5%), cranberry bogs (3%), and waterfowl (1%).

To address these key findings, the study set a target phosphorus concentration of 15 µg/L and developed an evaluation of potential restoration options.

The primary in-pond restoration options examined by this report included the following:

- Dredging
- Artificial circulation using submerged diffusers and/or solar surface circulators
- Nutrient inactivation

Of these, dredging was considered to be poorly suited for Santuit Pond due to the high cost and feasibility concerns. The other two options were recommended for implementation due to their lower cost and better application to the control of internal phosphorus loading.

The report also concluded that, although control of internal phosphorus loading could probably achieve most of the required reductions, external phosphorus load reduction would also be critical to long-term success. Recommended external loading controls including the following:

- Watershed management (stormwater, fertilizer reduction, and vegetated buffers)
- Septic system maintenance and upgrades
- Cranberry bog best management practices
- Waterfowl control

Since the publishing of the AECOM 2010 diagnostic study, six SolarBee solar-powered surface circulators have been installed in Santuit Pond. ESS is unaware of any other in-pond management actions that have been implemented, although monitoring with a water quality sonde has continued. Recent unpublished data (from 2020) provided by project partners suggest that chlorophyll a and phycocyanin (a pigment used by cyanobacteria) levels remain elevated at Santuit Pond.

The New England District of the US Army Corps of Engineers (USACE) recently completed a sediment sampling program to reexamine the feasibility of dredging Santuit Pond and support the development of potential designs (USACE 2021). As part of this effort, 19 sediment cores were collected from Santuit Pond and tested for grain size, environmental chemistry, and nutrients.

The results of the sampling and testing indicated that fines (silt and soft organic sediments) were present over much of the pond bottom. These deposits were often more than eight feet thick and are underlain by sand and gravel deposits.

The bulk chemical analyses completed on the core samples documented contaminant concentrations (e.g., heavy metals) in exceedance of the Massachusetts Contingency Plan (MCP) S-1/GW-1 standard in some locations. In particular, the northernmost sample and some of the samples in the southeastern part of Santuit Pond demonstrated exceedances. Although not explicitly stated in the report, these exceedances may pose a challenge for off-site reuse or disposal.

Total phosphorus and total iron were also included in a subset of the analyses completed for the USACE study. However, phosphorus fractionation analysis was not conducted. Therefore, the data do not provide sufficient information to fully assess the availability of sediment phosphorus for internal loading in the pond. If significant deposition of fine sediments has occurred since the analyses completed in the AECOM (2010)

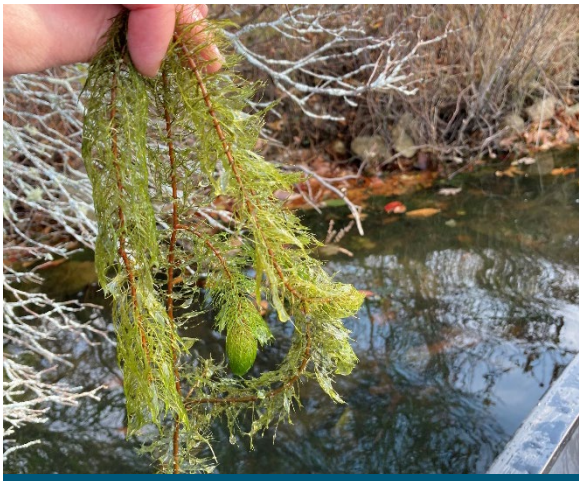
diagnostic study, it is possible that phosphorus release rates and composition of phosphorus fractions (iron-bound, organically bound, etc.) may also have changed substantially.

Results of this study and subsequent consultations with the project sponsor (Mashpee Wampanoag Tribe) and co-sponsor (Town of Mashpee) resulted in the identification of a preferred preliminary alternative, which includes the removal of approximately 100,000 cubic yards of fine sediments from a 25-acre area in the southeastern portion of Santuit Pond. Due to concerns about offsite disposal, the preliminary design of this alternative would also include the placement of the dredged sediments into a coir-log containment area to create new fringe emergent and shrub-scrub wetlands along the southwestern shoreline.

4.0 POND MANAGEMENT ISSUES AND GOALS

Watershed management actions to provide long-term improvement of water quality in Santuit Pond are currently in the planning or design stage. These include enhancements in wastewater collection and treatment as well as upgraded stormwater management. Although these actions are anticipated to result in the reduction of external pollutant loading to Santuit Pond over time, the gains will take years to realize. In the case of septic loading, the extended time of travel for groundwater movement means that full benefits may take five years or more, after implementation, to reach the pond.

Given these limitations, in-pond management actions could help to accelerate the improvement of water quality in Santuit Pond in the interim, thereby serving as a bridge until watershed source controls can be brought fully online. As such, this feasibility study is focused on developing a prioritized list of in-pond management actions for the improvement of water quality. The actions evaluated and ultimately recommended for implementation will be centered on and driven by the primary management issues and goals for Santuit Pond.



Variable-leaf milfoil fragment found along the shoreline of Santuit Pond in November 2021.

The primary management issues affecting Santuit Pond include the following:

¶ Excessive nutrients

¶ Excessive algal growth, resulting in persistent and recurring cyanobacteria blooms

¶ Additionally, growth of nuisance aquatic vegetation (variable-leaf milfoil [*Myriophyllum heterophyllum*]) was observed at Santuit Pond during the project kick-off site visit for this study. During a January 27, 2022 project meeting, a Town official confirmed that beds of this species are present north of the Town landing (Ashley Fisher, pers. comm.).

The suggested interim management goals for Santuit Pond are shown in Table A, along with the key uses that would be benefit from the implementation of effective management actions.

Table A. Suggested Management Goals

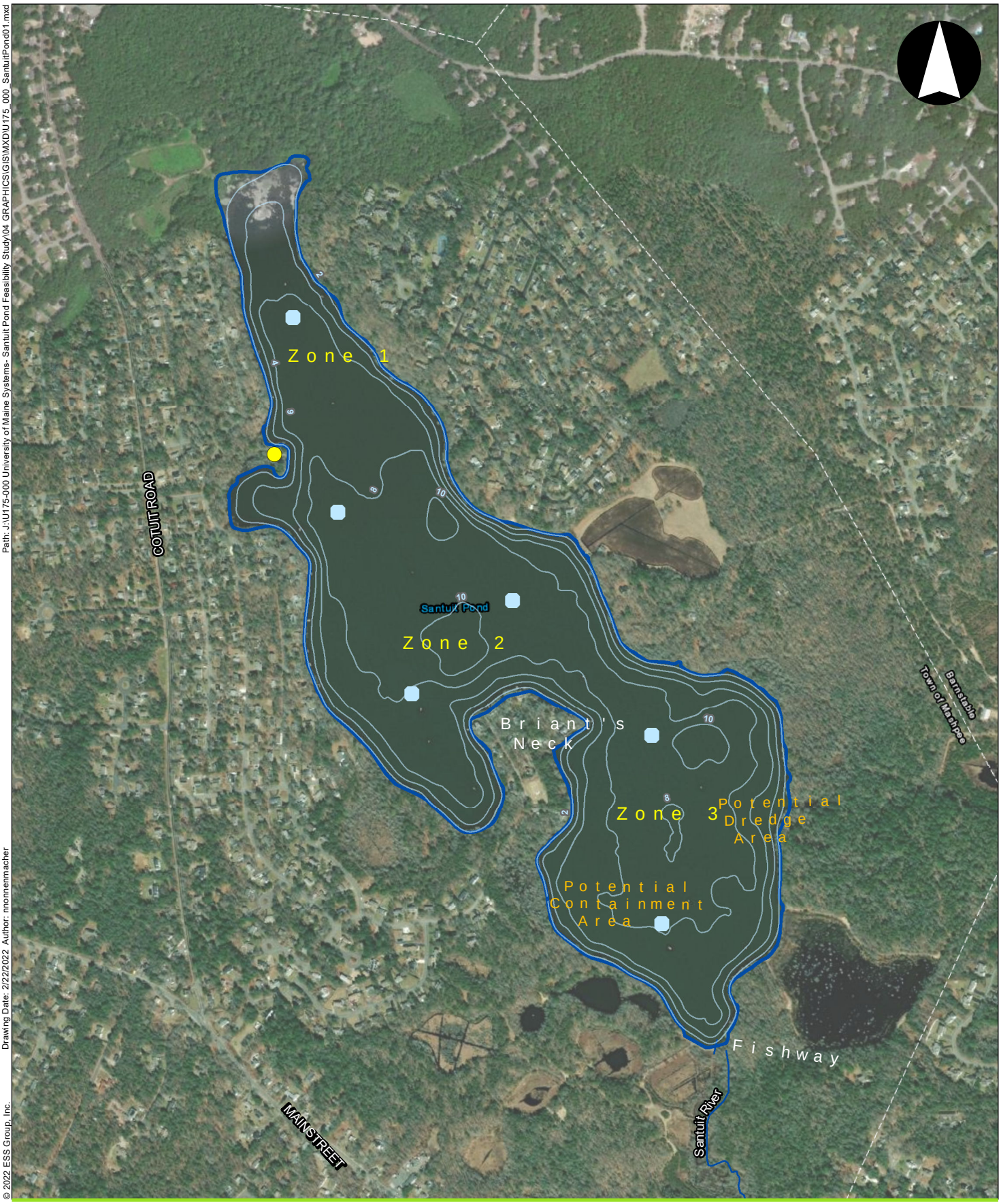
Management Goal	Uses Benefited by Action
Improve water quality by decreasing nutrient concentrations	Water Quality Fish and Wildlife Habitat
Reduce the duration and severity of cyanobacteria blooms	Aesthetics Fish and Wildlife Habitat Recreation Water Quality
Control non-native aquatic plant growth	Aesthetics Fish and Wildlife Habitat Recreation

The selection and practical implementation of measures to address management issues and achieve goals could be aided by the conceptual delineation of management zones with Santuit Pond. This approach recognizes that some issues affect the entire pond while others are either more localized or subject to certain constraints or opportunities.

Santuit Pond can be conceptually divided into three management zones to help facilitate a discussion of possible management activities (Table B, Figure 1). This conceptual identification of management zones is based on the types of management issues present, physical characteristics, visibility, and the presence of existing management or monitoring infrastructure.

Table B. Conceptual Management Zones in Santuit Pond

Zone	Description	Management Issues	Observations and Considerations
1	Town landing and areas to the north	Water quality Algae blooms Non-native aquatic plants	Shallowest water Highest public visibility (Town landing) One SolarBee circulator
2	Bordered by Town landing to the north and Briant's Neck to the south	Water quality Algae blooms	Deepest water Highest resident visibility (densely developed shoreline) Three SolarBee circulators Water quality monitoring sonde deployed in this area
3	South and east of Briant's Neck	Water quality Algae blooms	Identified by USACE as potential dredge and fringe wetland restoration area Intermediate public and resident visibility Two SolarBee circulators Near dam and fish ladder



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Santuit Pond Focused Feasibility Study

Mashpee, MA

- In-Pond Solar Bee Circulators (approx)
- Town Landing
- Bathymetry Contours (2ft Intervals)
- Streams

Source: 1) ESS Survey, 2021
2) ESRI, World Imagery, 2021
3) MassGIS, Bathymetry, 2019

0 400 800 Feet

Santuit Pond
Key Featur
Concept
Management

Figure 1

5.0 RECOMMENDED MANAGEMENT ACTIONS OVER THE NEXT FIVE YEARS

As documented in the 2010 *Santuit Pond Diagnostic Study* (AECOM) and also identified by both the community and other sources (e.g., MassDEP 2021), Santuit Pond faces a myriad of management challenges. However, the primary purpose of this study is to focus on the prioritized management issues and address those with a streamlined set of in-pond management recommendations that can be implemented at Santuit Pond in the near future, should key stakeholders desire. As such, this section provides a description of potential and recommended management options for implementation while watershed improvements are coming online.

In considering the best path forward for Santuit Pond, it is helpful to understand the environmental resource designations and jurisdictions that may affect the manner in which management actions are designed, permitted, and/or implemented. A summary of key designations is presented in Table C and these will be used to inform the management actions that follow in this section.

Table C. Environmental Resource Designations or Jurisdictions in Vicinity of Santuit Pond

Designation / Jurisdiction	Present	Location(s)	Impact on In-Pond Management Activities
Anadromous Fish Run	Y	All of Santuit Pond	Coordination with Town Herring Warden/ Division of Marine Fisheries to avoid impact on anadromous fish passage. An April to June time-of-year restriction is typical for many activities.
Area of Critical Environmental Concern	N	N/A	None anticipated.
Coastal Zone	Y	All of Santuit Pond	None anticipated.
Coldwater Fisheries Habitat	Y	Santuit Pond, extending downstream into Santuit River.	Division of Fisheries and Wildlife may provide comment on NOI submitted under Wetlands Protection Act and implementing regulations.
Estimated Habitat of Rare Wildlife	N*	Present adjacent to the southern shoreline	None anticipated.
Great Pond	Y	All of Santuit Pond	Chapter 91 permitting may apply for projects involving fill, dredging, or water level manipulation.
Groundwater Protection District (Municipal)	Y	All of Santuit Pond and adjacent areas	None anticipated.
Outstanding Resource Water	N	N/A	None anticipated.
Priority Habitat of Rare Species	N*	Present adjacent to the southern shoreline	None anticipated.
Surface Water Protection Area	N	N/A	None anticipated.

Designation / Jurisdiction	Present	Location(s)	Impact on In-Pond Management Activities
Wellhead Protection Area	N*	Zone II adjacent to portions of Santuit Pond.	None anticipated.
Wetland Resource Area	Y	Resource areas present in and near Santuit Pond. Examples include Land Under Water and Inland Bank.	Order of Conditions from the Mashpee Conservation Commission required to undertake most management actions.

*Located adjacent to but not within footprint of Santuit Pond.

Although the focus of this study is on water quality improvement, an effective control program for variable-leaf milfoil should be in place prior to or coincident with implementation of any in-pond water quality improvement actions. This is because improved water transparency is expected to enhance the habitat for this plant by allowing more light to penetrate through the water column. If variable-leaf milfoil were to become established over large portions of the pond, it could have its own impact on water quality (e.g., greater biological oxygen demand) and also reduce or degrade spawning habitat for anadromous river herring. Therefore, in addition to the in-pond water quality improvement options, ESS also considered nuisance vegetation measures targeted to variable-leaf milfoil.

In evaluating in-pond management options, ESS primarily considered those assessed in the General Environmental Impact Report (Mattson 2004). However, given recent developments in lake management that could have a material impact on the success of an in-pond management program at Santuit Pond, ESS also considered new products and methods. Dredging was not considered as an in-pond management option for the purposes of this study, given that evaluation of the viability of this approach is already being vetted by the USACE and project stakeholders.

The two priority recommended actions are as follows

1. Herbicides to control non-native nuisance vegetation (variable-leaf milfoil).
2. Nutrient inactivation to control excessive algal growth and improve water quality.

In addition to these priority actions, several other in-pond water quality management options are recommended as supplemental or optional actions, including aeration/circulation, algaecides, and hand harvesting. Five other management options were also considered but are not currently likely to be useful or feasible at a meaningful scale in Santuit Pond. (Table D).

Table D. Management Tools by Issue Addressed

Management Tool	Included In 2004 GEIR	Issue Addressed		
		Excessive Algal Growth	Nuisance Vegetation	Nutrients / Water Quality
Primary Recommendations				
Herbicides	Y**		D	
Nutrient Inactivation	Y	D		D
Secondary Recommendations				
Aeration/Circulation	Y	I		I
Algaecides	Y	D		
Hand Harvesting	Y		D	
Not Currently Recommended				
Barley Straw	Y	I		
Bioaugmentation (Bacterial Additives)	N*	I		I
Biochar and Proprietary Phosphorus Removal Devices	N	I		D
Biomanipulation	Y	I		I
Sonication	N*	D		

Y=Yes; N=No; D = Directly Controlled; I = Indirectly Controlled
*Mentioned briefly but not fully assessed.
**Broadly included but neither flumioxazin (Clipper) nor florpyrauxifen-benzyl (ProcellaCOR) were registered for use in Massachusetts at the time.

Each of the recommended management actions can be further refined by conceptual management zone (Table E).

Table E. Recommendations by Conceptual Management Zone

Management Tool	Conceptual Management Zone		
	1 - North	2 - Central	3 - South
Primary Recommendations			
Herbicides	Y	N	N
Nutrient Inactivation	Y	Y	C*
Secondary Recommendations			
Aeration/Circulation	Y	Y	Y
Algaecides	A	A	A
Hand Harvesting	A	A	A

Y=Yes; A=As-needed; C=Conditional; N=No
*Only in areas that would not be disturbed by dredging

Finally, the approximate costs associated with each recommended management action over a five-year period are summarized in Table F. The estimated costs for non-recommended management options are also presented for context. Each of these actions is described in more detail in the following section.

Table F. Approximate In-Pond Management Costs

Management Tool	Anticipated Management Quantity	Approximate Costs over Five-year Period			
		Permitting and Design*	Implementation	Operations & Maintenance	Total
Primary Recommendations					
Herbicides	<20 acres	$9,000	$50,000	$0	$59,000
Nutrient Inactivation	125 acres	$40,000	$400,000	$50,000	$480,000
Subtotal		*$49,000*	*$450,000*	*$50,000*	*$549,000*
Secondary Recommendations					
Aeration/Circulation	6 units	$N/A	$N/A	$50,000	$50,000
Algaecides	<75 acres	$9,000	$50,000	$0	$59,000
Hand Harvesting	<1 acre	$7,500	$25,000	$0	$32,500
Subtotal		*$16,500*	*$75,000*	*$50,000*	*$141,500*
Total Recommended		***$65,500***	***$525,000***	***$100,000***	***$690,500***
Not Currently Recommended					
Barley Straw	176 acres	$7,500	$350,000	$0	$357,500
Bioaugmentation (Bacterial Additives)	176 acres	$7,500	$400,000	$0	$407,500
Biochar and Proprietary Phosphorus Removal Devices	176 acres	$7,500	$200,000	$0	$207,500
Biomanipulation	176 acres	$20,000	$150,000	$0	$170,000
Sonication	4 units	$25,000	$200,000	$50,000	$275,000

*If completed as a standalone action. Substantial cost savings may be possible by combining the permitting for two or more actions.

5.1 Descriptions of Recommended Priority Management Actions

5.1.1 Herbicides

The primary advantage of herbicides is that they can be used to efficiently address aquatic nuisance plant growth over large areas within a relatively small timeframe and with little or no physical disturbance. Label restrictions are typically limited to irrigation with few or no restrictions on use for primary recreation, boating, fishing, or drinking. Therefore, direct impacts to non-target species or practical use of the pond are usually minimal. Rather, indirect impacts (e.g., changes in aquatic vegetative cover or temporary increase in oxygen demand as plant dieback occurs) are often the

primary concern. However, these impacts can be managed through appropriate selection and application of herbicides.

Although other herbicides are available (e.g., diquat dibromide), the three identified for potential use in the control of variable-leaf milfoil at Santuit Pond are florpyrauxifen-benzyl, flumioxazin, and fluridone (Table G). Of these, florpyrauxifen-benzyl would be the preferred option, should herbicide use be pursued for management of variable-leaf milfoil. Each of these herbicides is discussed in more detail below.

Table G. Summary of Herbicides Effective in Controlling Variable-leaf Milfoil

Herbicide	Type	Mode of Action	Selectivity	Recommendation
Florpyrauxifen-benzyl (e.g., ProcellaCOR)	Systemic	Auxin mimic	High – little to no action on non-target species at the recommended dosage.	Preferred herbicide for use at Santuit Pond due to selectivity, systemic control, and effectiveness outside the April to June time-of-year restriction.
Flumioxazin (e.g., Clipper)	Contact	PPO inhibitor	Low – action on a broad spectrum of non-target species. This can be mitigated by limiting area of application.	Not preferred due to potential to impact non-target species and short-term control.
Fluridone (e.g., Sonar)	Systemic	Carotenoid biosynthesis inhibitor	Moderate – some action on non-target species. This can be mitigated by using low dosage.	Not preferred due to need for extended contact time (45 days or more) and reduced effectiveness outside the April to June time-of-year restriction.

Florpyrauxifen-benzyl – Systemic Herbicide: Florpyrauxifen-benzyl (trade name ProcellaCOR) is a reduced risk systemic herbicide that acts as an auxin mimic. Auxin is a key plant hormone that regulates growth processes; herbicides that mimic auxin are able to control target species by disrupting these processes. In certain dicot plant species auxin mimics can be very effectively translocated throughout the plant, allowing the growth disruption to impact the overall plant and eventually resulting in death.

Florpyrauxifen-benzyl was fully approved for use in Massachusetts in 2019 and has since been used in multiple locations. It is effective on exotic milfoils at low concentrations and requires much less contact time than most other systemic aquatic herbicides. This means that it can be applied at very low doses and is unlikely to require costly booster treatments. These factors make florpyrauxifen-benzyl both cost-effective and protective of non-target plants when treating exotic milfoils.

Additionally, based on the ProcellaCOR EC SDS, florpyrauxifen-benzyl appears to be practically non-toxic to birds, other terrestrial organisms, and fish and only slightly toxic to freshwater invertebrates. Therefore, florpyrauxifen-benzyl appears to present minimal risk to non-target resources, particularly

when used at the very low doses required for effective control of exotic milfoils. This product was recently used to control exotic milfoil in another Mashpee pond with a herring run (Johns Pond).

Flumioxazin – Contact Herbicide: Flumioxazin (trade name Clipper) is a fast-acting contact herbicide and 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. As might be expected, plant cells not directly exposed to the agent or sunlight (e.g., roots) are not killed by flumioxazin. Therefore, plants with sufficient energy reserves may re-grow from the roots during the subsequent growing season.

Flumioxazin requires very little contact time to be effective and can be successfully applied in summer, outside of the time-of-year restrictions currently anticipated for river herring. One drawback of flumioxazin is that, as a contact herbicide, it is likely to only kill topgrowth. Although this may weaken the target plants, it is likely that at least some will return from the roots during the subsequent growing season.

Additionally, flumioxazin is effective on a relatively broad range of aquatic dicot species. Therefore, non-target species impacts would be likely. However, this issue could be mitigated by judicious application of the chemical only in the immediate vicinity of the target variable-leaf milfoil beds.

Fluridone – Systemic Herbicide: Fluridone (trade name Sonar) is a systemic herbicide that acts as a carotenoid biosynthesis inhibitor, effectively leading to the depletion of chlorophyll. This results in chlorosis (bleaching) and the eventual starvation of the entire plant.

Fluridone is provides good control of variable-leaf milfoil, even at low concentrations, with minimal impact to other plants. However, these target fluridone concentrations must be maintained for a relatively long period of time (up to 90 days) to achieve effective systemic treatment. This typically requires the use of pelleted formulations and booster treatments. It also means that most fluridone treatments are effectively whole-lake treatments, even if the target beds are limited to small areas. This makes fluridone treatments more expensive than most other herbicides.

One side benefit of this slow action is that it attenuates the plant tissue decay process, thereby avoiding spikes in dissolved oxygen demand that sometimes occur during rapid plant die-off.

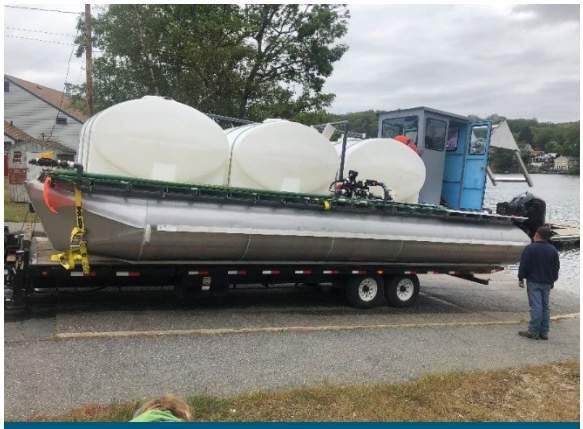
Fluridone is most effective when applied in spring or early summer so that target species can uptake and translocate the herbicide effectively from one part of the plant to another. Therefore, its use would be difficult if impacted by time-of-year restrictions associated with anadromous fish runs.

Estimated Costs

Treatment costs at Santuit Pond will depend on the herbicide used and the area treated. ESS is not aware of available maps showing the current extent and density of variable-leaf milfoil growth. However, if all beds are currently located north of the Town landing, it is likely that the extent is less than 20 acres. Assuming ProcellaCOR is used, treatment costs could be expected to be in the range of $10,000 to $20,000 for the initial treatment. Depending on the control achieved, additional treatment costs may be incurred in future years. However, if regrowth is limited, hand harvesting would potentially become a viable option for ongoing control (see Section 5.2.3).

5.1.2 Nutrient Inactivation

Nutrient inactivation in Massachusetts primarily involves the addition of alum (aluminum sulfate), which is typically injected just below the water surface. The alum precipitates out of solution and binds to available phosphorus in the water column and surficial sediments. Aluminum is highly effective at binding phosphorus under most naturally occurring conditions and is not sensitive to oxygen-poor (anoxic) conditions. Aluminum is also one of the most common metals on the plant and naturally found in soils and pond sediments. Other nutrient inactivation products are available (e.g., Phoslock, polyaluminum chloride) but tend to be more costly and offer few advantages over alum for in-pond treatments. Additionally, some of some of the proprietary nutrient inactivation products make use of rare earth materials. In addition to being more difficult to source, the potential impacts of those materials in the aquatic environment are less well-understood. Barring substantial shifts in cost, alum remains the favored nutrient inactivation approach for in-pond treatments.



Due to the large volumes required, sediment dose alum treatments are applied using a pontoon boat / barge and typically require the ability to launch from a trailer.

A crane can also be used to deploy the treatment vessel, where traditional access is determined to be insufficient.

Alum can be applied at a high dose if the goal is to treat the sediments and prevent continued release of phosphorus from the sediments. Alternatively, it can be applied at a low dose if the goal is only to strip phosphorus and algae from the water column for the short term.

Alum has the potential to addresses a substantial fraction of internal phosphorus loading and, given the low flushing rate of Santuit Pond, could possibly reduce internal loading rates for multiple years. Therefore, nutrient inactivation is anticipated to be highly cost-effective at reducing phosphorus, as compared to most other in-pond management options.

Due to the low alkalinity reported from Santuit Pond (and typical of coastal plain ponds in Massachusetts), sediment dose nutrient inactivation is usually accomplished with a buffered treatment. Sodium aluminate is the most commonly used buffer for this purpose and has the attractive property of also forming an aluminum oxide flocculent (i.e., additional phosphorus binding sites).

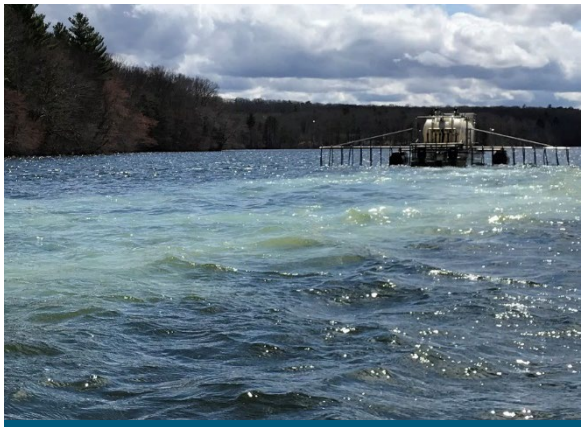
The goal of buffering is to prevent the formation of free aluminum by keeping the pH of the pond within a safe operating range (typically between 6.0 and 8.0). In practice, a 2:1 ratio of alum to sodium aluminate has worked well for most buffered treatments in eastern Massachusetts. Occasionally, a

higher ratio is used when ongoing algae blooms have resulted in elevated pH conditions. However, this is typically an adjustment that is made based on treatment monitoring.

Sediment dose nutrient inactivation is typically conducted with a specially outfitted vessel that has been designed for stability and efficiency in application of large volumes of product to open waters. The vessel usually features a boom that is directed into or toward the water. Application is through direct injection or, more commonly, via weighted hoses that are fitted with nozzles. In buffered applications, the liquid chemicals are kept entirely separate until injected into the water column, at which point where they are then able to mix freely.

A sediment dose nutrient inactivation project also requires an area for chemical storage that is reasonably accessible for tanker truck deliveries. Trucks must either be able to back into the area or have sufficient radius to turn around for site egress. Traffic detail may be required for busy roads, although that is unlikely to be an issue if the Town landing is used (access from Timberlane Drive).

A location adjacent to the pond is also required for chemical storage tanks and tanker deliveries..



A visible flocculent trail forms during the initial injection. This settles rapidly to the pond bottom when applied during appropriate weather conditions.

The appropriate dosage for a sediment dose alum treatment is selected based on the availability of phosphorus in sediments, as well as the targeted sediment depth and longevity of treatment. In eastern Massachusetts, sediment aluminum doses have ranged from as low as 20 g/m^2 to well over 100 g/m^2. To determine the appropriate dosage to maximize the longevity of the treatment while avoiding impacts to aquatic life, a sediment coring and dosing study is recommended prior to permitting and bidding the treatment work. Due to the potential for deep sediments to release phosphorus under anoxic conditions, sediment cores should be targeted for penetration to 25 cm (10 in), if possible. Additionally, undisturbed cores should be sectioned to provide a vertical profile of phosphorus availability in the sediments. This will provide critical information on the existing gradient in mobile phosphorus, which will inform the depth to which a sediment dose treatment would need to be targeted to provide long-term control. The dosing study also typically forms the foundation for required permit applications.

Low dose alum treatments are more logistically simple but would also be expected to provide only short-term benefits, unless applied repeatedly over several years. Formal dosing studies are not typically required for low dose treatments. Rather, an aluminum concentration of 2 mg/L to 5 mg/L (areal equivalent of approximately 4.5 g/m^2 to 10.5 g/m^2) is usually targeted depending on site conditions, budget, and concentration of phosphorus in the water column. A repeated annual regimen

of low dose alum application was recently implemented at West Monponsett Pond in Halifax and appears to have achieved some success in reducing phosphorus concentrations and cyanobacteria blooms over a multi-year period. However, the longevity of the project has not been established. Additionally, low dose treatments fill up a much higher percentage of phosphorus binding sites than sediment dose treatments. This means that a lower proportion of the alum goes toward reduction of internal loading from the sediments.

Estimated Costs

The costs to undertake an alum dosing study would be expected to range from $25,000 to $30,000 depending on the extent and density of sampling required. Permitting would be expected to cost another $8,000 to $10,000, inclusive of abutter notification and production costs.

The costs to implement a nutrient inactivation program varies with the dosage required, the total area targeted for treatment, and the price of the commodities used. For example, based on an informal market survey of local vendors, the price of sodium aluminate has risen substantially in the last year, which could impact the cost of a buffered treatment at Santuit Pond. Additionally, a certain base level of mobilization costs should be expected and may be more than $20,000 for a high dose treatment. The actual treatment costs range from $2,500 per acre to more than $4,000 per acre depending on dosage and treatment efficiency.

Treatment costs at Santuit Pond will depend on whether a sediment dose or low dose treatments is applied, as well as the total area treated. However, a 100-acre sediment dose treatment focused on the northern two-thirds of the pond (i.e., avoiding areas that might be within the footprint of a dredging project) is likely to range from $275,000 to $400,000 or more, depending on the final dosing. A low dose treatment would likely be $55,000 to $120,000 per application.

Detailed water quality and biological monitoring is likely to be required prior to, during, and following the treatment and is recommended to help avoid impacts to potentially sensitive non-target species, such as fish. Additionally, monitoring would be recommended to track the success of the nutrient inactivation program as an interim water quality improvement measure. Monitoring for alum treatments could be expected to range from $7,500 to $50,000. The lower end of this range would typically be associated with low dose treatments (per treatment) while the high end would be associated with a sediment dose treatment. Ultimately, the cost will depend on the number of days required to complete the treatment and whether deployment of additional sensors (e.g., data buoys) or collection of samples for laboratory analysis are required.

5.2 Descriptions of Recommended Secondary or Optional Management Actions

5.2.1 Aeration/Circulation

Aeration and circulation are related techniques used to treat problems with excessive algal growth and low dissolved oxygen concentrations. The primary difference is that aeration uses injection of air to raise dissolved oxygen concentration in the water column while circulation focuses on inducing currents to redistribute dissolved oxygen. Most, but not all, kinds of aeration systems also induce circulation. Air diffusers, aerating fountains, and water pumps are common types of equipment that may be installed to increase aeration or circulation in a lake or pond.

Aeration and circulation systems increase dissolved oxygen concentrations in the water. When properly designed and implemented, the increase in dissolved oxygen can benefit aquatic life while reducing the bioavailability of phosphorus by encouraging the formation of compounds with low solubility in water (e.g., ferric phosphates).

Additionally, the induced currents of many of these systems can potentially help control algae blooms by physically disturbing the vertical position of phytoplankton cells. To some degree this can prevent or lessen the severity of blooms by reducing photosynthetic efficiency or disrupting the buoyancy control that some cyanobacteria use to seek optimal water column positions for nutrient uptake.

Aeration and circulation systems are usually powered from shore, which requires operational expenses (sometimes substantial) to keep the unit(s) running. However, solar-powered units are also available.

The cost of purchasing, installing, and maintaining this equipment becomes substantial as water body size increases. Likewise, the effectiveness of the equipment tends to decline with pond size as it is difficult to achieve sufficient circulation in large bodies of water.

A SolarBee unit in Santuit Pond.

In the years since the AECOM (2010) study was completed, in-pond water quality management has been limited primarily to the installation and operation of solar surface circulators (SolarBees). A total of six solar surface circulators have been deployed at Santuit Pond. The approximate distribution of these units suggests that they were installed to enhance circulation in all portions of pond. However, it is not currently known whether the number and arrangement of the units deployed is aligned with the manufacturer's recommendations for Santuit Pond. Additionally, ESS is unaware of any studies that have been undertaken to specifically evaluate the effectiveness of these units in improving dissolved oxygen concentrations or reducing cyanobacteria. Although Santuit Pond continues to experience seasonal cyanobacteria blooms, it is difficult to surmise whether those blooms would have been better, worse, or the same without the solar surface circulators. The *Santuit Pond Diagnostic Study* (AECOM 2010) suggested that circulation could reduce internal phosphorus loading by 67 percent but also cautioned that circulation could potentially worsen algae blooms if improperly designed or executed.

Therefore, ESS recommends that the solar surface circulators continue to be used for now, especially if nutrient inactivation cannot be implemented in the near future. However, their use should be accompanied by a water quality study to document the lateral and vertical gradients in key parameters within the pond. According to the manufacturer, SolarBee units are designed to draw water in from below and release it near the top of the water column in a radial pattern of near laminar flow. Smaller secondary currents are also induced by this action, resulting in additional water column circulation between the surface and the depth of the bottom intake. This information can be used to design a site-specific study that examines both the extent of the circulation generated as well as the end result for key water quality parameters in the pond. This study could be conducted over a short period of time to

keep costs low but the measurements should be frequent and of a sufficient density to provide the answers needed to support operational decision-making.

Estimated Costs

If no additional aeration or circulation units are deployed, the primary costs would be associated with ongoing operations and maintenance of the six SolarBee units. Additional costs would be expected to study the effectiveness of the units. Together, the costs would be anticipated to run approximately $50,000 over the next five years.

The cost of alternative or additional units would likely be much more substantial. However, this is not currently recommended at Santuit Pond.

5.2.2 Algaecides

Algaecides are analogous to herbicides in many ways but primarily target algae and cyanobacteria. Application of algaecides results in almost immediate control of a broad spectrum of planktonic and filamentous algae. A variety of registered algaecide formulations are available for use, including copper sulfate and chelated copper-based formulations (e.g., Captain and K-Tea), which will generally control most nuisance green algae and cyanobacteria species. Peroxide-based formulations (e.g., PAK 27) are also available for control of nuisance algae.

Of these formulations, peroxide-based algaecides are typically the most expensive, although they can be useful where the use of copper-based algaecides is undesirable due to sensitive environmental receptors (e.g., rare aquatic life, surface water supplies). Chelated copper-based formulations remain active in the water column longer than copper sulfate and are therefore more effective at lower doses. These are typically intermediate in cost. Copper sulfate is the least expensive and most frequently used algaecide. However, copper sulfate tends to settle out of solution faster than chelated copper, which means more of the product ends up in the sediments, thereby reducing the longevity of the treatment.

Water use restrictions associated with most algaecides are minimal and temporary. Some labels do not carry any restrictions.

Algaecides may be useful for short-term control of excessive algal growth on an as-needed basis. Although effective, algaecides treat only the symptom (i.e., excessive algae) and do not address the cause of algae blooms (i.e., excessive nutrients). Therefore, long-term improvements should not be anticipated from the use of algaecides alone.

Estimated Costs

Treatment costs at Santuit Pond will depend on the algaecide used and the area treated. If alum treatment is implemented, then algaecide costs would be expected to be minimal in any given year. However, an annual budget of $10,000 to $15,000 is recommended to be kept in reserve, in case it is needed for response to nuisance blooms during the growing season.

5.2.3 Hand Harvesting

The simplest form of harvesting is hand pulling of selected plants. Depending on the depth of the water at the targeted site, hand harvesting may involve wading, snorkeling, or SCUBA diving. Pulled plants and fragments are placed in a mesh bag or container that allows for transport and disposal of the

vegetation. Hand harvesting of submerged perennial vegetation (e.g., variable-leaf milfoil) aims to remove entire plants, including the roots, thereby preventing re-growth in subsequent seasons.

Hand harvesting is an excellent approach for control of pioneer infestations when bed extent and density are limited. Although divers are typically required, most pioneer infestations can be effectively contained or even eradicated with a day or two of harvesting. Hand harvesting in these cases should proceed as soon as possible to prevent further spread of the plants. This should be followed by detailed surveys of the area to find and remove any plants that may have been missed or incompletely removed by the dive team. The establishment of pioneer infestations is hard to predict, especially where the presence of public access at the Town landing in Mashpee increases the risk of new plants being introduced to the pond. However, the opportunity to contain or eradicate a new infestation is of enormous potential benefit to the Town because it can save tens to hundreds of thousands of dollars in future management costs and much more when lost recreational, habitat, and property value are factored into the equation. For this reason, ESS strongly recommends that the Town maintain a standing budget for rapid response hand harvesting operations at Santuit Pond.

DASH operations are able to pump harvested weeds directly into mesh bags on deck, reducing the amount of fragmentation in the water.

For larger, more established infestations diver assisted suction harvesting (DASH) may be the most appropriate form of hand harvesting. DASH involves the uses of a hose lift system to transport pulled plants to a collection vessel at the surface. This significantly reduces the time it takes for the diver to handle and return plants to the surface and also helps to minimize the fragmentation that may occur over the course of typical harvesting operations.

Despite the increased efficiency, DASH is still a labor-intensive process that is likely to require repeat harvesting over several years to successfully manage an established infestation. Fragment barriers can be placed to minimize redispersal and recolonization by plant fragments while harvesting control efforts are being implemented.

Hand harvesting and DASH are both very selective methods because each plant must be pulled by hand. Although some incidental removal of non-target species is still likely to occur, most non-target vegetation would be expected to remain in place. Therefore, they tend to have only negligible to minor impacts on non-target species.

As with any physical plant removal program, implementation of hand harvesting or DASH operations should include identification of temporary stockpiling and permanent disposal areas as well as fragment release control methods prior to initiation of each project phase.

Due to the sustained, intensive effort required to control submerged invasive plants (like variable-leaf milfoil) over a period of years, hand harvesting is only recommended as a secondary or optional control measure at this time. The urgency of control suggests that a more efficient and effective measure be implemented first at Santuit Pond. Therefore, herbicides are likely to be the better initial choice for

control of variable-leaf milfoil and are recommended as the primary control measure (See Section 5.1.1).

Hand harvesting costs at Santuit Pond will depend on the extent and density of the beds to be managed. Costs for diver harvesting or DASH typically range from $1,500 to $3,000 per day. The rate of progress will be faster for DASH than traditional diver harvesting. However, clearance of more than 0.5 acre per day is unlikely, except where beds are very sparse.

Estimated Costs

Hand harvesting costs at Santuit Pond will be largely dependent on the effectiveness of any herbicide treatments, as well as the ability to successfully prevent new invasive species from entering the pond. However, an annual budget of $5,000 to $10,000 is recommended, in case hand harvesting or DASH becomes necessary to respond to small areas of variable-leaf milfoil regrowth or pioneer infestations of other species.

5.3 Descriptions of Other Management Options – Not Currently Recommended

5.3.1 Barley Straw

Barley straw has been promoted as a “natural” method to control algae blooms. Although the virtues of this method are extolled by a few pond supply warehouses and state agricultural cooperative extensions, the mode of action is not completely certain. It may be related to the release of chemicals as the barley straw decomposes in water but it is not clear exactly which chemicals are responsible for the control or whether they are exuded from the barley straw itself or a metabolic byproduct produced by decomposers. Regardless, the chemicals appear to act more as a preventative (algaestat) rather than killing existing algae (algaecide). Therefore, barley straw is not regulated by US EPA as a pesticide.

Based on limited laboratory studies and field trials, barley straw may be more effective on planktonic algae and cyanobacteria and less so on filamentous or benthic algal mats, although the reasons for this are not clear. Additionally, at least one published study (Molversmyr 2001) suggests that barley straw may stimulate the growth of certain planktonic cyanobacteria. Overall, the use of barley straw appears to have very unreliable results (Mattson et al. 2004). Therefore, as with many biological control methods, successful use of barley straw is likely to require an iterative approach.

Although there is little agreement in the literature on the appropriate dosage, one suggested application rate is 225 pounds of barley straw per surface acre of lake (Haberland and Mangiafico 2011). The straw is typically deployed by loosely packing it into a cage or netting, then securing it at or near the surface of the pond with a stake or tether. Depending on conditions, barley straw may need to be replaced every four to six months to continue being effective. Some recent studies suggest that barley straw extract may be effective, in lieu of deploying straw bales (e.g., Peczula 2013).

Estimated Costs

Barley straw addition is usually implemented in smaller water bodies or isolated coves. If scaled up to extend along more of the perimeter of Santuit Pond, costs of $50,000 to $75,000 per year would not be unexpected. Costs could be even higher if replacement of the straw was required more than once per year.

5.3.2 Bioaugmentation

Bioaugmentation includes a wide variety of approaches involving the addition of biological organisms or extracts to solve a lake management issue. This may include the addition of enzymes or microbial agents to stimulate biodegradation of bottom sediments, control pathogens, manage algae, improve water clarity, or reduce aquatic plant growth. A wide variety of proprietary bioaugmentation blends are available and range from generic pond "cleaners" to specific seasonal "boosters" and fortified "muck-eaters." Products are sold in many different forms, including blocks, bags, liquids, powders, pucks, and pellets.

The actual implementation of this approach requires a highly iterative process of testing, product application, retesting, and subsequent adjustment of product type or application rate repeated over the course of the year. Recommended reapplication rates may be as frequent as every week but depend on the product and environmental conditions. Some proprietary bioaugmentation systems also require the purchase of a special aeration or circulation system for the process to work as intended.

Unfortunately, the peer-reviewed research regarding this approach is primarily associated with its use in wastewater treatment processes, where automation reduces the logistical challenges and environmental conditions can be more easily manipulated. Evaluations concerning the effectiveness of this approach in lakes and ponds are primarily limited to studies conducted directly by the vendor or vendor partners and have not been published in the peer-reviewed literature.

Ultimately, bioaugmentation does not currently appear to be a reliable process for phosphorus reduction, algae control, or aquatic plant management, especially when scaled up from relatively controlled environments to natural lakes and ponds.

Estimated Costs

Bioaugmentation is usually implemented in smaller water bodies, where costs can be kept reasonably to scale while the approach is tested and tuned. Most bioaugmentation products require frequent reapplication over the course of the year. Therefore, full-scale application of this method in Santuit Pond could be expected to cost upwards of $75,000 per year.

5.3.3 Biochar and Proprietary Phosphorus Removal Devices

Biochar describes a wide range of products derived from biomass that has been processed (often pyrolyzed) to enhance its nutrient adsorption capacity. When used for lake management purposes, biochar is typically deployed in porous socks, which are then staked in a location where the material can come into contact with nutrient-rich sources (e.g., tributary flows), thereby acting as a filter before the water enters the lake or pond. They can also be deployed in-pond from floating islands or anchored in groups to remove ambient nutrients from the water column.

Biochar socks are typically left in place for a few weeks to a few months, depending on environmental conditions. At some point, the adsorption process becomes inefficient, as binding sites begin to fill up, and the spent biochar is removed, disposed of, and replaced with new material.

The use of biochar for lake and pond management is still under evaluation. Many of these products were originally designed for water and wastewater treatment processes, which are more controlled

environments than natural lakes and ponds. However, to date it appears that biochar's primary advantage in lake management is the ability to market it as a "natural" remedy for excess nutrients.

Biochar quality varies greatly with source, which makes it difficult to develop an effective dose to reduce nutrient concentrations to the desired level. In fact, unmodified biochars appear to be of limited utility due to the paucity of binding sites in most materials, as well as the potential for release of nutrients when submerged (Zhang et al. 2020). Therefore, the most effective biochars are likely to be those which have been modified through the addition of metal oxides (e.g., aluminum oxide) to provide more binding sites. This effectively transforms biochar into a disposable version of nutrient inactivation, whereby the metal cations that capture dissolved nutrients are embedded in a removable substrate.

EutroSORB is a proprietary (SePRO Corporation) phosphorus removal technology that can be used in a similar manner to biochar. The manufacturer claims that this technology removes more phosphorus than biochar, although the effectiveness of EutroSORB has not been demonstrated within the peer-reviewed literature and the "nutrient-binding media" it relies on appears to be a trade secret. Until this product develops more of a track record, it is difficult to recommend its use at anything more than a pilot scale.

Estimated Costs

Assuming biochar or EutroSORB socks were deployed primarily near known areas of focused stormwater runoff and near the locations of the existing SolarBees (where they could take advantage of the induced flow), annual costs would likely range from $25,000 to $50,000. This assumes a replacement interval of once every month or two during ice-free periods of the year.

5.3.4 Biomanipulation

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 Santuit 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 a sizeable water body like Santuit 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.

Estimated Costs

Costs to stock predatory fish depend on the supplier and the sizes stocked. However, a cost of $1,000/acre to $3,000/acre would be anticipated.

5.3.5 Sonication

Sonic disruption technologies utilize ultrasound for the control of phytoplankton (algae). These devices generate specific ultrasound frequencies (inaudible to the human ear), that are emitted from a transducer located under the water surface. The frequency is “tuned” to generate structural resonance in the specific targeted subset of phytoplankton. In cyanobacteria, sonication disrupts vacuoles, causing them to lose buoyancy control and sink to the pond bottom where they eventually starve. In other types of phytoplankton (e.g., green algae), sonication damages inner cell walls, thereby preventing nutrient transfer and the ability of the cell to successfully reproduce. These changes lead to a gradual loss of viability in the target phytoplankton over the course of several days to several weeks. Sonication does not directly cause lysis (splitting) of algal cells, which may reduce or prevent the direct release of toxins from toxigenic species.

Due to the nature of ultrasound waves, these devices are only effective on waters that are in “line-of-of sight” to the sonication buoy. Therefore, any islands, peninsulas, or other shoreline irregularities would minimize their effectiveness and require additional buoys to achieve full coverage of the pond..

Sonication offers less immediate results than most other algae control measures. Sonic disruption technology is best implemented in a natural pond system by suspending the sonic device in the water from a solar powered buoy anchored to the pond bottom.

Sonic disruption device anchored in a reservoir with a solar buoy.

However, sonication systems are still relatively unproven outside of controlled aquatic systems in Europe and little information is available in the peer-reviewed literature. Manufacturers indicate that sonication buoys can manage up to 50 acres per buoy, although this would apply to ideal and unobstructed conditions. Anecdotally, where these systems have been used in New England, they appear to have some effect on algal growth but not on a large enough scale to be a cost-effective management option.

Estimated Costs

Costs to purchase and install each buoy are approximately $50,000 to $70,000 with additional costs for annual maintenance ($15,000 to $20,000). The acreage and elongate morphology of Santuit Pond suggest that four to five sonication buoys would be the minimum for whole-pond control of algae blooms, which would imply a minimum capital expenditure of at least $200,0000. However, a pilot-scale deployment or a single buoy could be implemented at a reduced cost.

6.0 POTENTIAL FUNDING OPTIONS

Although a number of funding opportunities exist to address watershed water quality and stream continuity issues, fewer funding opportunities are targeted specifically to in-pond management work. However, a few potential funding sources are available, as described in this section.

In-pond management projects are often funded directly by communities or through locally generated funding sources, such as the Community Preservation Act (CPA), which can also leverage state funds. The Mashpee Community Preservation Committee is responsible for funding these projects in the Town of Mashpee. Maintenance projects are not eligible for funding through this program. However, costs associated with assessment, design, and permitting of projects in an acceptable category may be. Additionally, project implementation may also be eligible as long as the project is not considered to be a maintenance activity.

The state Municipal Vulnerability Preparedness program may also be a source of funding through an MVP Action Grant. This grant program is relatively new and is focused on adaptation to climate change impacts. To be eligible, a project must specifically address how it will prepare the community and its environmental resources for resiliency in the face of climate change impacts.

Other state and federal funding opportunities (including loan programs) that may be relevant to Santuit Pond frequently arise through the Southeast New England Program (SNEP), the New England Interstate Water Pollution Control Commission (NEIWPCC), and various state grant programs (e.g., Massachusetts Environmental Trust). However, the funding, focus, and requirements of these programs may vary from year-to-year. Therefore, it may be worthwhile to evaluate these programs for potential project funding on an annual basis.

Finally, the state-managed Section 319 grant program is funded annually and targets projects that implement nonpoint source reductions. The Section 319 grant program typically requires a 40% non-federal match and an EPA “nine key elements” watershed-based plan. However, the grants can be used to fund project permitting, final design, and implementation. MassDEP has also awarded Section 319 grants to fund in-pond nutrient loading controls, including alum treatment. Recent awards of this nature include West Monponsett Pond in Halifax and Lake Attitash in Amesbury. Typical award values range from $100,000 to $300,000 but awards outside of this range are occasionally made.

In most cases, grant proposals that specifically address the primary concerns of the funding program, document some form of match, and demonstrate broad support, collaboration, and commitment will be more likely to receive funding.

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