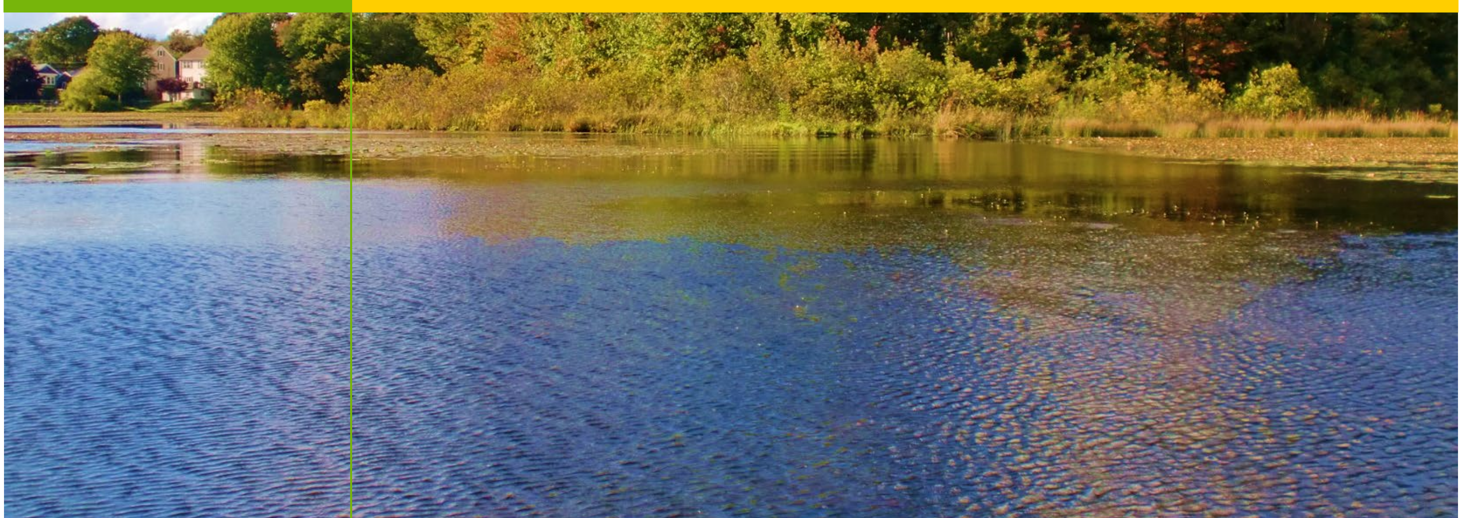
Draft for Client Review

Whitman's Pond Management Strategy

Weymouth, Massachusetts

This project was supported by Weymouth Community Preservation Act funds



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1.0 INTRODUCTION

ESS Group, Inc. (ESS) was contracted by the Town of Weymouth (Town) to prepare this Whitman's Pond Vegetation Management Strategy (Management Strategy) document. The purpose of the Management Strategy is to refresh and refocus the *Whitman's Pond Vegetation Management Action Plan* that was originally developed by ESS on behalf of the Town in 2013.

Additionally, the Management Strategy seeks to provide a streamlined set of recommendations that will take into account the progress made to date and focus on laying out a clear path for moving forward with the highest remaining management priorities for the pond. To do this efficiently, the Management Strategy makes use of existing information available from prior studies, publicly available documents or data, and direct input from Town officials.

As such, the Management Strategy report includes the following key elements:

- Summary review of studies and activities implemented since completion of the 2013 Vegetation Management Action Plan.
- Description of project approach.
- Statement of prioritized management issues and goals.
- Presentation of recommended management actions based on data collected to date and changes in technology, regulations, or standards.
- Five-year plan for implementation of next steps, including recommended timing and estimated costs for each element.

This project was supported by Weymouth Community Preservation Act funds. Additionally, several Town offices were involved in supplying information critical to developing the Management Strategy, including officials from the Mayor's Office, Department of Public Works (including Engineering Division and Water & Sewer Division), Conservation Commission, and Geographic Information System Office.

2.0 REVIEW OF ACTIONS COMPLETED SINCE 2013

The *Whitman's Pond Vegetation Management Plan* (ESS 2013) identified the primary management targets as invasive aquatic weed growth, excessive accumulation of fine sediments, and water quality. Among these, the most critical management issue at the time was considered to be invasive aquatic weed growth, specifically fanwort (*Cabomba caroliniana*), variable-leaf milfoil (*Myriophyllum heterophyllum*), and to a lesser extent curly-leaf pondweed (*Potamogeton crispus*). Fanwort beds were present in all three basins and estimated to cover nearly 76 acres. Variable-leaf milfoil was found in the Main Basin and South Cove, where it covered approximately 32 acres. Most variable-leaf milfoil was found in mixed beds with fanwort. Curly-leaf pondweed was only observed in the West Cove.

The primary recommendations management recommendations of the *Whitman's Pond Vegetation Management Plan* were as follows:

- Herbicide treatments (specifically fluridone and flumioxazin) for rapid control of exotic fanwort and variable-leaf milfoil beds.
- Hydroraking for small-scale control of other nuisance species, including water lilies.
- Resident waterfowl control to reduce public health, safety, and nutrient loading issues.

- Installation of benthic barriers for small-scale control of excessive vegetation near high traffic areas (e.g., docks and public access).
- Biological control of purple loosestrife using loosestrife beetles.
- Design and implementation of a winter drawdown program to control rooted nuisance vegetation in shallow areas.
- Dredging to improve the South Cove for water supply and aquatic habitat.
- Community education and outreach to raise awareness of management issues and generate interest in public involvement.
- Implementation of a comprehensive and sustained monitoring program.

At the time of the *Whitman's Pond Vegetation Management Action Plan* Whitman's Pond was listed as a Category 5 water body (i.e., needing a TMDL) with impairments listed as DDT and non-native aquatic plants (MassDEP 2013). This listing has changed only minimally in the intervening years, primarily to clarify that the DDT impairment is limited to fish tissue (MassDEP 2019). Although both major tributaries, including the Mill River and Old Swamp River, are listed as impaired by *E. coli* and fecal coliform, this impairment does not currently appear to extend into Whitman's Pond.

Since the completion of the *Whitman's Pond Vegetation Management Plan*, the Town has implemented several management actions, starting with the initiation of mechanical weed harvesting in 2016 (Table A).

Since then, the Town has operated the mechanical harvester primarily to clear biomass from the western portion of the Main Basin. In 2017, the western portion of the Main Basin was treated by SOLitude Lake Management with fluridone herbicide (trade name Sonar). The following year, SOLitude Lake Management returned to implement the same treatment in the West Cove.

In addition to the management actions above, the Town also commissioned two additional studies of Whitman's Pond (Table A).

The first was the 2016-2017 drawdown feasibility study conducted by Princeton Hydro, LLC. A review of the project file by Town officials yielded interim work products or draft deliverables for multiple tasks, including identification of flow profiles in and below the Whitman's Pond watershed, identification of nearby wells, mapping of the aquatic plant community, and an assessment of hydrologic and climatic conditions affecting drawdown effectiveness and refill rates. Although no final project report was issued, the preliminary conclusions of this assessment were that a) drawdown-sensitive nuisance plants like fanwort and variable-leaf milfoil were still present or had even expanded in Whitman's Pond and b) that a winter drawdown of up to five feet would be feasible in the Main Basin without the need for modification of control structures at the dam.

The second study was a vegetation evaluation of the western portion of the Main Basin completed by SOLitude Lake Management in 2018. This was completed following an herbicide treatment the prior year. Although map figures were not included as part of the report provided for this study, an inventory of aquatic plants was presented and compared to a prior survey of the area completed by Aquatic Control Technology, Inc (2010). Among the non-native species, the comparison indicated similar frequency of occurrence for curly-leaf pondweed between the two years, with a decline observed for variable-leaf milfoil in 2018, and a more substantial decline for fanwort in 2018. This suggests that the 2017 herbicide treatment may have had a positive impact on two of the three target non-native species in the treated area, although it is difficult to be certain without pre- and post-treatment surveys from the same or consecutive year. However, white water lily (*Nymphaea odorata*), coontail (*Ceratophyllum demersum*), and bladderworts (*Utricularia* spp.) all appeared to increase from 2010 to 2018. While these are native plant species they can generate substantial biomass and reach nuisance levels of growth when conditions are favorable.

Table A. Summary of Whitman's Pod Management Actions and Reports, 2013 to Present

Action/ Document	Timing	Author/ Implementor	Brief Description
Sonar Herbicide Treatment	Summer 2018	SOLitude Lake Management	Treatment of West Cove with Sonar (fluridone).
Whitman's Pond Vegetation Evaluation	June 2018	SOLitude Lake Management	Inventory of aquatic plants in western portion of Main Basin (called northwestern cove in report) and comparison to 2010 survey.
Sonar Herbicide Treatment	Summer 2017	SOLitude Lake Management	Treatment of western portion of the Main Basin with Sonar (fluridone).
Whitman's Pond Drawdown Project Status (letter)	2017	Princeton Hydro	Project status update letter. It indicates intent to recommend a maximum drawdown of five feet for the Main Basin. However, it also indicates uncertainty about feasibility and impact of drawdowns in the West Cove and South Cove.
Whitman's Pond Winter Drawdown Vegetation Analysis Report	2017	Princeton Hydro	Combined results of updated aquatic plant survey with those from 2013 Vegetation Management Action Plan. Assessed range of options for drawdown timing, duration, and extent.
Hydroraking	November 2016	SOLitude Lake Management	Removed water lilies from western portion of Main Basin. Work focused on approximately eight acres.
Whitman's Pond Drawdown Project Status (letter)	2016	Princeton Hydro	Project status update letter. It indicates that a five-foot drawdown would be possible in the Main Basin.
Whitman's Pond Feasibility of Drawdown Summary	Document undated but figures dated 2016	Princeton Hydro	Summary memorandum describing preliminary drawdown feasibility analysis. Includes drawdown scenario figures.
Whitman's Pond Hydraulic Profiles	2016	Princeton Hydro	Longitudinal profiles of hydraulic controls from Weymouth Great Pond to Herring Run Brook at Water Street. Elevations relative to Town of Weymouth datum.

Whitman's Pond Watershed Flow Structures	2016	Princeton Hydro	Group of figures and a spreadsheet, which includes the following elements: 1. Watershed map showing flow structures, gages, and wetlands. 2. Three figures at larger scale to show additional detail in pond. 3. Spreadsheet identifying flow structures and sizes.
Weymouth Private Well Information	2016	Author uncertain	List of private wells within 100- and 500-ft buffer of Whitman's Pond shoreline. Well depth and purpose information provided for many, but not all, wells. Indicates at least two wells may be used for domestic water, both of which are deep.
Mechanical Harvester Purchase	July 2016	Town of Weymouth	Has been used intermittently since 2016 purchase to harvest aquatic plants from western portion of Main Basin, near Middle Street public access during the growing season. Operation of the harvester has not been consistent from year to year.
Whitman's Pond Vegetation Management Action Plan	2013	ESS Group, Inc.	Comprehensive study of Whitman's Pond, including bathymetry, sediment, and aquatic plant mapping, water quality sampling, fish and wildlife observations, and water supply/hydrologic assessments. Results of the study were used to assess a range of in-pond and watershed management options and select recommended short- and long-term actions.

3.0 MANAGEMENT STRATEGY APPROACH

3.1 Pond Management Issues and Goals

This Management Strategy is centered around and driven by the primary management issues and goals for Whitman's Pond.

The primary management issues impacting Whitman's Pond include the following:

- Excessive growth of nuisance aquatic vegetation
    - Impact to aesthetic value
    - Impact to recreational value
    - Impact to native plant habitat
    - Impact to water quality/eutrophication

- Sedimentation
    - Impact to aesthetic value
    - Impact to recreational value
    - Impact to fish habitat
    - Impact to water quality/eutrophication
- Swimmer's itch (cercarial dermatitis) / water quality
    - Impact to recreational value

For the purposes of this assessment, management goals have been broken out by major basin (West Cove, Main Basin, and South Cove). Goals are shown in Table B.

Table B. Management Goals by Basin

Management Goal	Basin		
	West Cove	Main Basin	South Cove
Aesthetics	Primary	Primary	Secondary
Fish and Wildlife Habitat	Primary	Primary	Secondary
Recreation	Primary	Primary	N/A
Water Quality	Secondary	Primary	Primary

3.2 Anticipated Management Intensity

Once the management issues and goals for each basin in Whitman's Pond were defined, areas within each basin were grouped by anticipated management intensity. Management intensity describes both the anticipated frequency and extent of management actions to address the key challenges. In Whitman's Pond, three management intensity classes were defined (Table C).

Table C. Management Intensity Classification Scheme

Management Intensity	Description
High	Significant management challenges but high resource usage. Therefore, need for and extent of management action is likely to be greatest in these priority areas.
Moderate	Management challenges may be significant but resource usage is lower. Although one or more management actions are likely to be implemented, the frequency and/or extent are anticipated to be more limited.
Low	Management challenges are minimal. Resource usage is either lower or more focused (e.g., water supply). Management actions may be implemented in these areas but are likely to be of low frequency and/or extent.

Because these areas also share certain physical, biological, and human use characteristics, they serve as logical units for grouping recommended management actions, hereafter called Functional Management Areas. Seven Functional Management Areas were assigned to Whitman's Pond (Figure 1 and Table C).

Table C. Anticipated Functional Management Areas in Whitman's Pond

Area	Description	Management Challenges	Resource Usage
1	West Cove	Significant management challenges due to extensive sedimentation and growth of nuisance vegetation.	Moderate resource usage due to: Limited parking and opportunity for recreation from municipal public access at Greenvale Avenue. Middle Street culvert is a seasonal barrier, which may limit usage by fish and other aquatic wildlife. Abutter aesthetics and recreational opportunity.
2	Western portion of the Main Basin	Significant management challenges due to extensive growth of nuisance vegetation and some sedimentation. Resident waterfowl also present in larger numbers along Middle Street shoreline.	High resource usage due to: OFBA public boat launch. Extensive shoreline fishing and passive recreation opportunities along Middle Street. Good habitat connectivity for aquatic life. Abutter aesthetics and recreational opportunity.
3	Majority of the Main Basin, including deepwater areas Mill River inlet and pond spillway.	Management challenges present but typically limited in extent.	Low to moderate resource usage due to: Most of area only accessible by boat. Good habitat connectivity for aquatic life and variety of habitats present. Abutter aesthetics and recreational opportunity.

Area	Description	Management Challenges	Resource Usage
4	Lake Street access	Moderate management challenges present due to encroachment of nuisance aquatic vegetation and congregation of resident waterfowl.	Moderate resource usage due to: Canoe/kayak launch possible but limited parking for municipal public access at Lake Street. Good habitat connectivity for aquatic life. Abutter aesthetics and recreational opportunity.
5	Southern shoreline of Main Basin	Moderate management challenges present due to encroachment of nuisance aquatic vegetation.	Moderate resource usage due to: Canoe/kayak launch and access to Woodbine Island possible but limited parking for conservation access at Woodbine Road. Shoreline and Washington Street Bridge fishing opportunities. Good habitat connectivity for aquatic life. Abutter aesthetics and recreational opportunity.
6	Lambert Avenue access	Moderate management challenges present due to encroachment of nuisance aquatic vegetation and congregation of resident waterfowl.	Moderate resource usage due to: Canoe/kayak launch possible but limited parking for municipal public access at Lake Street. Good habitat connectivity for aquatic life. Abutter aesthetics and recreational opportunity.
7	South Cove	Moderate management challenges due to sedimentation and growth of nuisance vegetation.	Moderate resource usage due to: No public recreational access. Used only as backup water supply. Some habitat connectivity for aquatic life, although this may be altered during pumping. Abutter aesthetics only.

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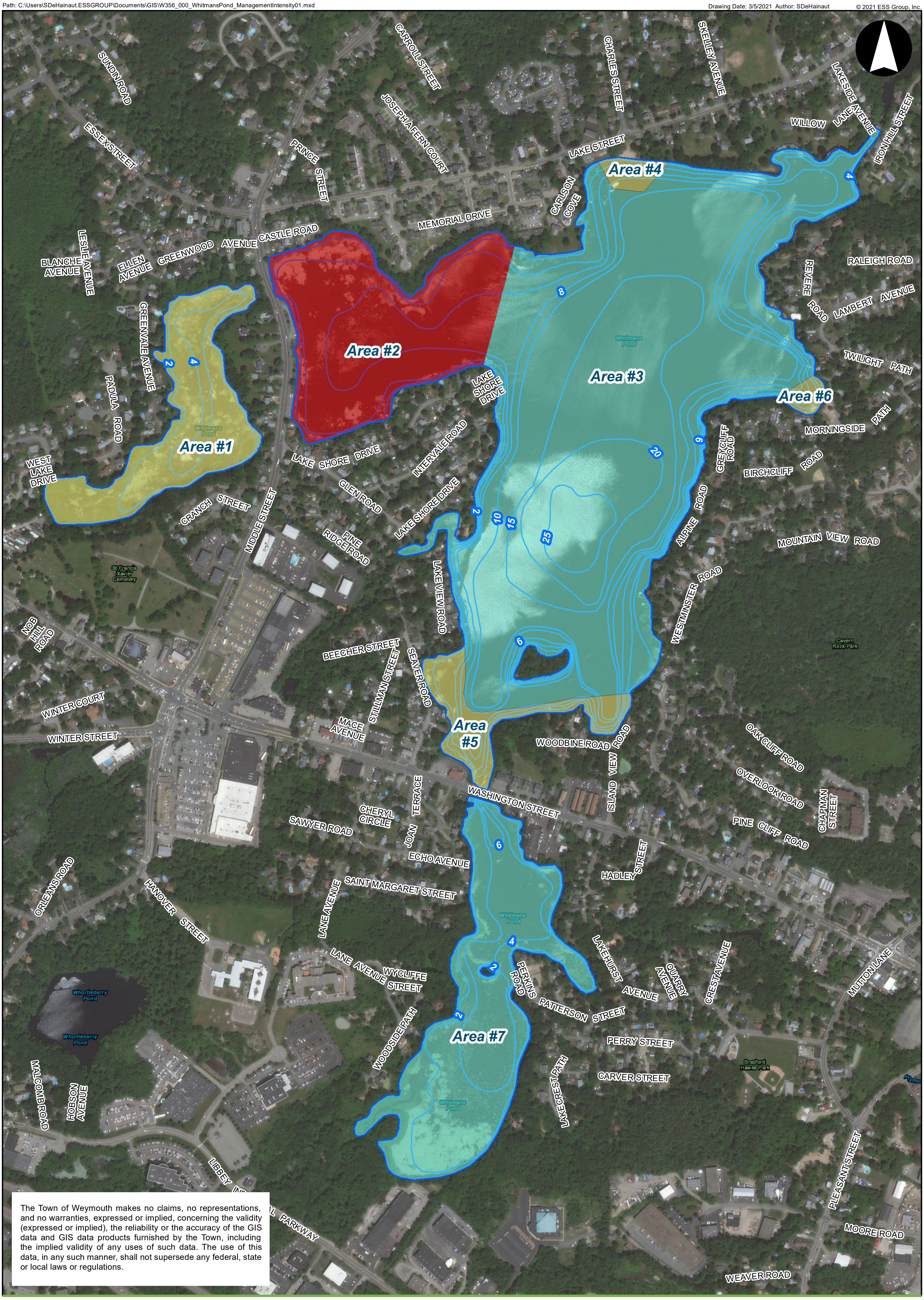

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Anticipated Management Intensity

- Low Intensity Zone
- Medium Intensity Zone
- High Intensity Zone
- Bathymetry Depth Contours (2-Ft Interval)

Source: 1) ESRI, World Imagery, 2019
2) ESS, Bathymetry, 2012

0 280 560 Feet

Figure 1

3.3 Special Management Zones

Although a variety of management options were considered as part of the Management Strategy, two were recognized as being likely to result in extensive or long-lasting improvement in aquatic nuisance plant control and/or sedimentation in discrete areas. These include herbicides and dredging, which were both also identified in the 2013 *Whitman's Pond Vegetation Management Action Plan*. Special management zones were developed to assist in conceptualizing these specific activities.

Herbicide Management Zones

Herbicide use is anticipated to be an important part of the management program for control of nuisance aquatic plant growth in some portions of Whitman's Pond, at least initially. To be protective of potentially sensitive resources, including the herring run and Washington Street pump station water intake, four Herbicide Management Zones were designated at Whitman's Pond (Figure 2). These Herbicide Management Zones establish key considerations for potential chemical use in Whitman's Pond (Table D). In turn, these guidelines can be used to select specific herbicides for potential use.

Table D. Herbicide Management Zones

Zone	Location	Key Considerations
A	West Cove	Favorable toxicity profile and minimal impact to non-target species. Avoid depletion of dissolved oxygen from rapid plant die-off over large area. Prevent development of plant resistance by avoiding frequent repeat use of herbicides with same mode of action.
B	Main Basin – Away from Washington Street	Seasonal avoidance of herbicide applications during herring spawning (April to June). Favorable toxicity profile and minimal impact to non-target species. Avoid depletion of dissolved oxygen from rapid plant die-off over large area. Prevent development of plant resistance by avoiding frequent repeat use of herbicides with same mode of action.
C	Main Basin – Near Washington Street	Coordinate herbicide applications with Water & Sewer Division. Seasonal avoidance of herbicide applications during herring spawning (April to June). Favorable toxicity profile and minimal impact to non-target species. Avoid depletion of dissolved oxygen from rapid plant die-off over large area. Prevent development of plant resistance by avoiding frequent repeat use of herbicides with same mode of action.
X	South Cove	No herbicide applications allowed in South Cove.

Potential Dredge Areas

Dredging may be useful for addressing excessive nuisance plant growth and sedimentation at Whitman's Pond. Management of these issues can be achieved by increasing water depth, removing nutrient-rich sediments, and reducing nuisance aquatic plant growth through light limitation. Two potential areas for dredging were identified as part of the Management Strategy workshop process with Town officials (Figure 3 and Table E.

Table E. Potential Dredge Areas

Location	Key Considerations	Areas Identified for Potential Project
West Cove	Basin is currently so shallow that it provides minimal aesthetic value, low volume of fish habitat, and limited recreational value. However, it does provide good wildlife habitat. Dredging could help to remediate impact of sedimentation from stormwater sources. Dredging may be useful for extending the area of open water in this basin. This would have more value if other management methods can be used to maintain existing open waters and prolong the length of a dredging project.	Yes
Main Basin	Potential use conflicts between motorized vessels and other recreational activities could arise near Middle Street if large area is deepened. If other management options can achieve desired control of nuisance plant growth, then dredging would not be preferred for this area.	No
South Cove	Large scale project not considered necessary for water quality and quantity purposes. No recreation is allowed in the South Cove. Elevation of water intake screens is currently sufficient to prevent clogging by sediments or biomass. However, there may be some value in creating a deeper sump around the water intake screen.	Yes

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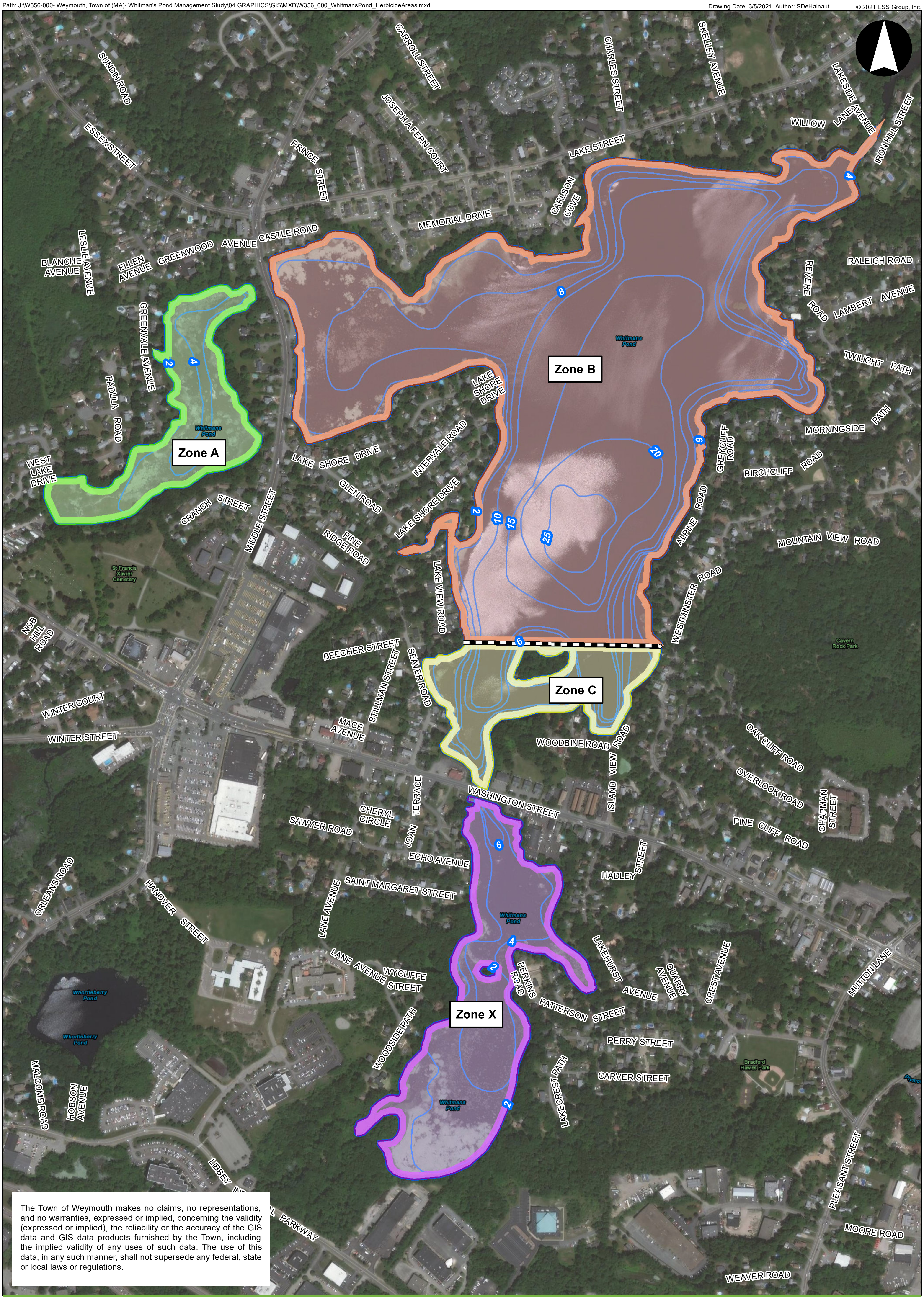

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Source: 1) ESRI, World Imagery, 2019
2) ESS, Bathymetry, 2012

0 280 560 Feet

Transition Zone

Bathymetry Depth Contours (2-Ft Interval)

Herbicide Zones

Zone A

Zone B

Zone C

Zone X

Herbicide Management Zones

Figure 2

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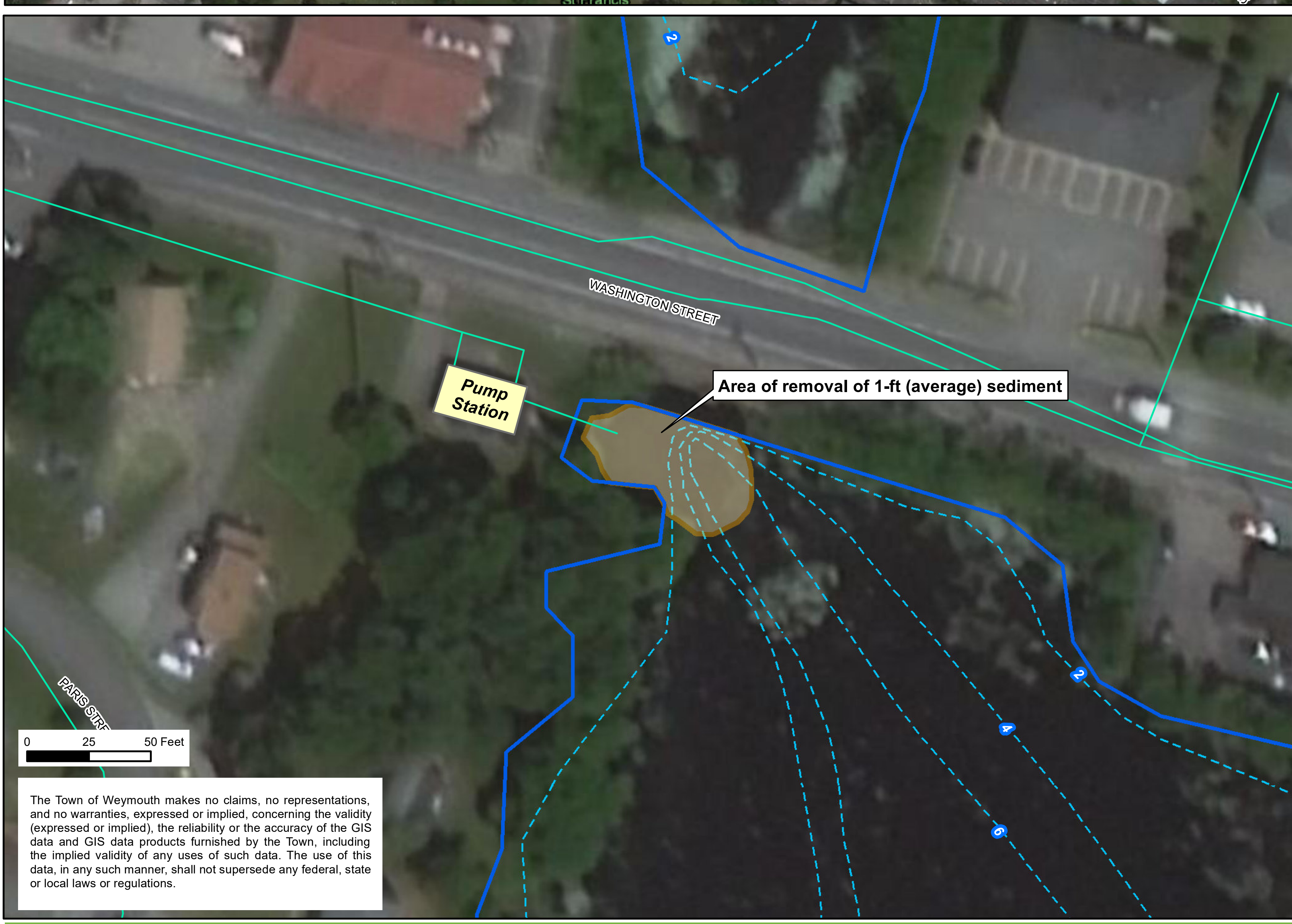

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Possible Dredge Areas

- Bathymetry Conceptual Dredge Contour Depth (2-Ft Interval)
- Bathymetry Original Contour Depth (2-Ft Interval)
- Shoreline
- Dredge Area
- Water Intake Line

Figure 3

Source: 1) ESRI, World Imagery, 2019
2) ESS, Bathymetry, 2012

4.0 RECOMMENDED MANAGEMENT ACTIONS OVER THE NEXT FIVE YEARS

As documented in the 2013 *Whitman's Pond Vegetation Management Action Plan* and also identified by both the community and other sources (e.g., MassDEP 2019), Whitman's Pond faces a myriad of management challenges. However, the primary purpose of this Management Strategy is to focus on the prioritized management issues and address those with a streamlined set of management recommendations that can be implemented at Whitman's Pond over a five-year period. The intent of this approach is to make the management plan more actionable so that progress in addressing management issues can be accelerated. However, the Town should anticipate the need to revisit the Management Strategy for Whitman's Pond every four to five years so that the management program can remain proactive and responsive to issues and challenges as they evolve.

This section provides a description of recommended management options for implementation over the next five years, some of which the Town may be able to implement without the need for further study or permitting. Other options require further study or design to evaluate feasibility or permit; in those cases, the next steps are presented with a timeline and estimated cost for either a) advancing those options to the implementation phase or b) dismissing those options from further consideration based on critical flaws or lack of cost-effectiveness.

In considering the best path forward for Whitman's 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 F and these will be used to inform the management actions that follow in this section.

Table F. Environmental Resource Designations or Jurisdictions in Vicinity of Whitman's Pond

Designation/Jurisdiction	Present	Location(s)	Impact on Management Activities
Anadromous Fish Run	Y	All of Whitman's Pond	Coordination with Town Herring Warden/ Division of Marine Fisheries to avoid impact on anadromous fish passage.
Area of Critical Environmental Concern	N*	Weymouth Back River (downstream of Whitman's Pond)	None anticipated
Coastal Zone	N	Boundary is well downstream of Whitman's Pond	None anticipated
Coldwater Fisheries Habitat	Y	Old Swamp River (extends into South Cove)	Division of Fisheries and Wildlife may comment on NOI submitted under Wetlands Protection Act and implementing regulations.
Estimated Habitat of Rare Wildlife	N	N/A	None anticipated
Great Pond	Y	Whitman's Pond	Chapter 91 may apply for projects involving fill, dredging, or water level manipulation. Public access to a Great Pond shall be preserved.

Designation/Jurisdiction	Present	Location(s)	Impact on Management Activities
Outstanding Resource Water	Y	Whitman's Pond	Some activities may be restricted or trigger additional review under state's 401 Water Quality Certification program.
Priority Habitat of Rare Species	N	N/A	None anticipated
Surface Water Protection Area	Y	South Cove and southernmost portion of Main Basin are designated as Zone A. South Cove is a backup water supply basin.	See Outstanding Resource Water.
Wellhead Protection Area	N*	Old Swamp River (Zone I WPA) is nearest.	None anticipated
Wetland Resource Area	Y	Resource areas present in and near Whitman's Pond. Examples include Land Under Water, Bordering Vegetated Wetland, Riverfront Area, and Inland Bank.	Order of Conditions from the Weymouth Conservation Commission required to undertake most management actions. Some actions may potentially be implemented under existing Amended Order of Conditions (issued June 26, 2009 and extended through present) or through further amendment.

*Not located within footprint of Whitman's Pond

The Management Strategy for Whitman's Pond includes the following recommended actions, which together provide a multi-pronged approach for addressing the three priority management issues at the pond (Table G):

- Benthic Barriers
- Chemical Controls
- Drawdown
- Dredging
- Hand Harvesting (Includes Diver Assisted Suction Harvesting [DASH])
- Hydroraking
- Mechanical Harvesting
- Resident Waterfowl Control

Each of these actions is described in more detail in the following section.

Table G. Management Tools by Issue Addressed

Management Tool	Issue Addressed		
	Nuisance Vegetation	Sedimentation	Swimmer's Itch / Water Quality
Benthic Barriers	D		I
Chemical Controls	D		I*
Drawdown	D		I
Dredging	D	D	I
Hand Harvesting/DASH	D		I
Hydroraking	D	I	I
Mechanical Harvesting	D		I
Resident Waterfowl Control			D

D = Directly Controlled; I = Indirectly Controlled; *Direct control may be possible through other chemical means but these are not currently recommended.

It should be noted that some of these actions may play a very limited role at Whitman's Pond and others may never need to be implemented. However, each of these is currently recommended for inclusion in the management toolbox to address issues in each Functional Management Area of Whitman's Pond (Table H).

Table H. Management Tools by Functional Management Area

Management Tool	West Cove	Main Basin					South Cove
	1	2	3	4	5	6	7
Benthic Barriers	X	X		X		X	
Chemical Controls	X	X	X	X	X	X	
Drawdown	X	X	X	X	X	X	
Dredging	X						X
Hand Harvesting/DASH	X	X	X	X	X	X	X
Hydroraking	X	X		X		X	
Mechanical Harvesting	X	X					
Resident Waterfowl Control		X		X			

4.1 Descriptions of Recommended Management Actions

4.1.1 Benthic Barriers

Benthic barriers are negatively buoyant materials, usually in sheet form, which can be applied on top of plant beds to limit light, physically smother, and allow unfavorable natural chemical reactions to interfere with further development of plants. Benthic barriers are best used for providing control of nuisance aquatic plant growth on a localized basis. They are most likely to be of use near shore and in the vicinity of shoreline structures where they can most easily be installed and maintained.

Plant topgrowth under the barrier will usually die back after about a month of deployment, although it may take longer for root crowns of perennial species to succumb. Barriers of sufficient tensile strength can be moved to a new location once control has been achieved, if desired. However, the continued presence of barriers will restrict recolonization of the area, especially if the barrier is maintained on a regular basis to prevent accumulation of sediments and billowing by trapped gases.

Benthic barriers are likely to generate both direct and indirect impacts to non-target species where they are deployed. This is due to the fact that benthic barriers are non-selective, which means all plants in the treatment area are killed, including desirable native plants. By smothering bottom sediments, barriers can also impact the invertebrate community within the treatment area, which may locally reduce food sources for fish. Another drawback of benthic barriers is that recolonization from adjacent plant beds can occur quickly, once the barrier has been removed. However, with experience, the barrier deployment and removal timing can be optimized to encourage recolonization by annual native species while keeping nuisance perennial species at bay.

Benthic barriers may be most effective near public access locations (e.g., Middle Street) to smother exotic plant beds and maintain a clear boating channel to deeper waters. This can help reduce the opportunity for fragmentation from outboard propellers. Barriers should not be placed in the shallowest areas directly below the boat launch where they could potentially be snagged and dragged by boaters or billow up to cause an obstruction. Placement to either side of the launch and in deeper waters well beyond the boat launch may have greater chance of success.

This management option would require an Order of Conditions from the Weymouth Conservation Commission to implement. Although the decision lies with the Commission, it may be possible to amend the existing Order of Conditions to include benthic barriers, rather than needing to file a new Notice of Intent.

4.1.2 Chemical Controls

The primary advantage of chemical controls is that they can be used to efficiently address management issues 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.

Any aquatic herbicide treatment program at Whitman's Pond will require an Order of Conditions from the Weymouth Conservation Commission. The current Order of Conditions possessed by the Weymouth DPW allows for the limited use of Sonar herbicide. Although the decision lies with the

Commission, it may be possible to amend the current Order of Conditions to include additional herbicides.

Additionally, each year's herbicide application program will require a License to Apply Chemicals from the MassDEP Bureau of Resource Protection –Watershed Management. The herbicide contractor is typically able to obtain the License to Apply Chemicals in two weeks or less at a nominal cost. Only applicators certified to apply herbicides in the Commonwealth of Massachusetts may apply aquatic herbicides to Whitman's Pond.

Table I. Potential Chemical Use by Herbicide Management Zone

Herbicide for Potential Use	Type	Mode of Action	Targets	West Cove	Main Basin		South Cove
				A	B*	C**	X
Florpyrauxifen-benzyl (e.g., ProcellaCOR)	Systemic	Auxin mimic	Variable-leaf milfoil	X	X	X	
Flumioxazin (e.g., Clipper)	Contact	PPO inhibitor	Submerged nuisance dicots	X	X	X	
Fluridone (e.g., Sonar)	Systemic	Carotenoid biosynthesis inhibitor	Fanwort Variable-leaf milfoil Curly-leaf pondweed	X			
Imazamox (e.g., Clearcast)	Systemic	ALS inhibitor	Water lilies or other floating-leaf nuisance species	X	X	X	

*Application may be subject to time-of-year restriction from April to June to be protective of Whitman's Pond herring run.
**Subject to same time-of-year restrictions as Herbicide Zone B. Treatment should also be coordinated with Water & Sewer Division.

The chemical controls recommended for potential use at Whitman's Pond are florpyrauxifen-benzyl, flumioxazin, fluridone, and Imazamox (Table I). Each of these is discussed in more detail below.

Florpyrauxifen-benzyl – Systemic Herbicide Targeting Exotic Milfoil: 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 selective for control of exotic milfoils without impacting most native aquatic plant species. Although not currently needed at Whitman's Pond, florpyrauxifen-benzyl can also be used as a foliar spray to control difficult and extremely invasive aquatic plants like yellow floating-heart (*Nymphoides peltata*).

Florpyrauxifen-benzyl is effective on exotic milfoils at low concentrations and requires much less contact time than most systemic 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.

In Whitman's Pond, florpyrauxifen-benzyl could be of use for controlling milfoil growth in Herbicide Zones A, B, and C. However, its use should be relegated to areas where fanwort has either already been controlled or is not co-dominant. Otherwise, fanwort would be likely to simply expand its growth into these areas as a monoculture.

Flumioxazin – Contact Herbicide Targeting Submerged Nuisance Dicots: 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's primary advantage is that it is effective on fanwort. Additionally, it 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 it cannot be used in more than 25% of a waterbody in any given year per state herbicide restrictions. Additionally, once flumioxazin has been used in a particular location of a lake, it cannot be used in that area again for four years. As a contact herbicide, flumioxazin 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.

In Whitman's Pond, flumioxazin could be of use for controlling fanwort and variable-leaf milfoil growth in Herbicide Zones A, B, and C. It could also be effective on other submerged dicot species that may grow at nuisance levels, such as coontail. However, it is unlikely to be of use in controlling curly-leaf pondweed where time-of-year restrictions apply because this plant's life cycle is typically complete by June.

Fluridone – Systemic Herbicide Targeting Fanwort, Variable-leaf Milfoil, and Curly-leaf Pondweed: 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 a narrow-spectrum herbicide that is highly effective on fanwort and also provides good control of variable-leaf milfoil and curly-leaf pondweed, 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. 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 remains one of the more expensive herbicides on the market, primarily due to the need for booster treatments to maintain the required concentration of the herbicide over time.

In Whitman's Pond, fluridone could be applied in either liquid or pellet form (typically a combination of the two) as a whole basin treatment in Herbicide Zone A. 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 is currently relegated to Herbicide Zone A.

Currently, fluridone use is not anticipated for Herbicide Zones B or C due to time-of-year concerns with the herring run. However, if the Town were willing to consider a pilot study in a fanwort or mixed bed within the Main Basin, the impact of the treatment could be minimized by using a slow-release pelletized formula to treat discrete beds.

Imazamox – Systemic Herbicide Targeting Nuisance Floating-leaf Plants: Imazamox (trade name Clearcast) is a systemic herbicide that acts as an acetolactate synthase inhibitor. Imazamox is readily translocated from the leaves to the rest of the plant and, as such, can be highly effective at low concentrations. However, they must be applied when the plants are in active growth mode to have the desired systemic impact. This herbicide is effective on many floating-leaved plants when applied as a foliar spray. When it is applied to water, it acts more as a growth regulator, slowing but not necessarily killing targeted species. In practice, imazamox is used more often as a foliar spray in Massachusetts.

The primary advantage of Imazamox is that it can serve as a cost-effective alternative to hydroraking for control of bulky floating-leaved aquatic plants. Because of the way it is applied, it can be used to clear lanes or patches of floating-leaf vegetation while leaving adjacent beds intact for fish and invertebrate habitat. This could potentially be useful at Whitman's Pond for quickly opening up channels in shallow water for access by small boats, canoes, and kayaks or for creating local fishing holes where near shoreline access points.

To be effective, imazamox must be applied when the leaves are dry. The passage of the treatment vessel through a plant bed results in enough wetting that the application will not be effective in those areas on the same day. Therefore, imazamox is typically applied as a series of two treatments: one when the leaves first emerge at the surface (early summer) and another about a month later to touch up areas that were crossed by the treatment vessel and any other targeted beds that show insufficient response.

Based on the Clearcast SDS, imazamox appears to be of low toxicity to terrestrial and aquatic organisms. It is effective on target plants at very low doses and, since application is to exposed leaves, its contact with water and aquatic life would be anticipated to be more incidental than with most other herbicides.

In Whitman's Pond, imazamox could be of use in Herbicide Zones A, B, and C. Due to the need for leaves to be fully out of the water, time-of-year restrictions are unlikely to conflict with the ideal treatment time for this herbicide.

Copper-based Molluscides (Not Recommended) – One proprietary copper-based formulation (EarthTec® QZ) has recently been tested as a nuisance snail control pesticide (Cormosini et al. 2018). Snails are the intermediate host for the schistosomal parasites that cause swimmer's itch (also known as cercarial dermatitis) and therefore necessary for these parasites to complete their life cycle (waterfowl are the primary hosts). Therefore, controlling snail populations could potentially help address the swimmer's itch issues at Whitman's Pond.

The EarthTec® QZ treatments in the Cormosini et al. (2018) study targeted the egg stage because eggs are more susceptible than adult snails. Therefore, the product can be used at a lower dosage to minimize impacts to non-target species. Overall, preliminary results suggest that there may be some potential for this approach to be used for selective snail control in the future. However, as an in-pond management approach, this technology is still experimental. Therefore, ESS does not currently recommend using this technique to address swimmer's itch issues. However, because swimmer's itch also requires the presence of waterfowl to serve as the primary host, waterfowl controls may provide some benefit (see Section 4.1.8). Additionally, since aquatic plants offer refuge from pond currents and increase the habitat area for aquatic snails, all measures that reduce aquatic plant biomass could indirectly help to minimize the population of the parasite that causes swimmer's itch.

4.1.3 Drawdown

Drawdown involves lowering the water level of a pond to expose shallow bottom sediments and associated plants to drying and/or freezing. Although drawdown can be conducted at any time, the interaction of drying and freezing that occurs with winter drawdown is usually most effective. Winter drawdown achieves the best results during cold, dry winters and where sediments dewater quickly. However, given the difficulty in predicting the exact duration of these conditions during a particular winter, most drawdown programs involve a periodic or as-needed winter drawdown.

ESS would anticipate winter drawdown to be most effective on submerged perennial nuisance species, such as fanwort and variable-leaf milfoil with fewer impacts on most other species. Some annual species, including both desirable native plants and non-native curly-leaf pondweed could potentially increase due to the implementation of a drawdown program.

As presented earlier in this document, the feasibility of winter drawdown in the Main Basin of Whitman's Pond was previously investigated (Princeton Hydro 2017). A five-foot drawdown was determined to be feasible at the time. Although our review found no specific reason to dispute this assessment from a technical standpoint, it currently seems unlikely that a drawdown in excess of three feet would receive consent from the Massachusetts Division of Fisheries and Wildlife. Even a standard three-foot drawdown program is likely to receive significantly more scrutiny now than it would have in prior years. This is due to new peer-reviewed research that suggests the potential for greater impact of drawdown on non-target species than previously identified. (e.g., Carmignani et al. 2019). Therefore, it is possible that additional study and/or development of a rigorous monitoring program would be required prior to approval of a winter drawdown program at Whitman's Pond.

Although planning for, permitting, and implementing winter drawdown in the Main Basin is unlikely to be a simple prospect, ESS recommends serious consideration of this as part of the Town's management program. The extent of potential benefit in controlling non-native aquatic plants is substantial. It could play a significant role in reducing herbicide use and also address nuisance plant growth in areas that are currently out of reach for the Town's mechanical harvester. Additionally, the implementation of drawdown would provide the side benefit of allowing for inspection and maintenance of shoreline structures during the drawdown period.

Winter drawdown would require an Order of Conditions from the Weymouth Conservation Commission. Due to the nature of drawdown and its potential widespread impact, ESS anticipates that a new Notice of Intent would need to be filed, specific to the drawdown program. The NOI would be subject to comment by the Massachusetts Division of Fisheries and Wildlife.

Additionally, given Whitman's Pond's status as a Great Pond, winter drawdown would require Chapter 91 authorization to alter water levels.

4.1.4 Dredging

Two potential areas for dredging were identified as part of the Management Strategy workshop process with Town officials. The first, higher-priority dredge area is located in the West Cove (Figure 3). This is an approximately 3.4-acre area extending from the vicinity of the Greenvale Avenue public access toward the southwestern end of the West Cove. The West Cove dredge area would extend the narrow open water area that represents deepest portion of the cove. This takes advantage of an existing area of open water to provide a more substantial central corridor for fish habitat and recreational opportunity. Dredging in the West Cove would also allow for the creation of a small area of deeper water, potentially as deep as 9 feet, near the Greenvale Avenue public access. In addition to providing aesthetic improvements, this would enhance recreational opportunities, including operation of small watercraft and fishing. The deeper water itself would be anticipated to provide some control of nuisance aquatic plant growth through light limitation. Additionally, this deepened section of the pond would enhance the pond's ability to provide suitable fish habitat by providing a deeper overwintering refuge and increased habitat volume.

The second, lower-priority dredge area is located in the South Cove near the existing pump station (Figure 3). The Weymouth Water and Sewer Division does not currently consider this to be an essential dredging project for the continued operation of the South Cove water intake (which transfers water to Great Pond). Due to the elevation of the current water intake and the fact that the Washington Street sluice gate must be sealed before pumping can occur, there is little to no water supply quantity benefit in enhancing the storage volume of the South Cove. Therefore, a large dredging project is unlikely to provide substantial benefit with regard to the Town's primary management goal for the South Cove. However, smaller project may be able to provide some value by enhancing the sump function of the area immediately adjacent to the intake. This would allow more volume to serve as a sump for trapping debris and sediment, which could in turn help prevent or delay obstruction of the water intake. By designing a sufficiently small dredge area, the project could also avoid some of the regulatory hurdles that would typically be associated with a dredging project, thereby potentially reducing cost and time to permit. Therefore, the South Cove dredge area currently envisioned would occupy less than 0.1 acre and would only entail the removal of less than 100 cubic yards of material.

Table J. Potential Dredge Areas and Project Size

Location	Max Water Depth – Existing (ft)	Max Water Depth – Dredged (ft)	Sediment Removal Extent (sq. y)	Average Sediment Removal Depth (y)	Sediment Removal Volume (cy)
West Cove- Greenvale Ave west	5	9	17,000	0.76	13,000
South Cove- Near pump station	7	8	250	0.33	83
Main Basin- Western portion	7	N/A	N/A	N/A	N/A

As described in the 2013 *Whitman's Pond Vegetation Management Action Plan*, dredging can be accomplished using a conventional "dry" dredge approach or through hydraulic dredging. Dry dredging requires drawing down the pond to allow dredging within the drained basin to occur using conventional excavation equipment. This approach could potentially allow for sediment to be dewatered within the basin itself by pulling the sediment up to the margins of the pond to allow water to drain back into the main portion of the basin.

Whether this can be effectively accomplished in the West Cove would require additional investigation under a full dredge feasibility study. However, depending on the relative water levels in the West Cove and Main Basin, it may be possible to pump or siphon water from the West Cove under Middle Street, although this would require further investigation to confirm. If possible, this may provide a pathway for dry dredging, although water management techniques such as temporary cofferdams or the creation of temporary channels to route the flow of water around the work area may be necessary.

Conventional dry dredging allows for direct loading of excavated sediments from dewatering locations or stockpiles into a hauler.

Typically, conventional dry dredging is best completed during the winter months when cold temperatures enhance access for dredging equipment and make for improved handling of excavated sediments. This is particularly true in cases where fine sediments account for a large portion of total material. Additionally, the reduced metabolic activity of wetland and aquatic organisms at this time of the year reduces stress from dredging disturbance.

If conventional dry dredging is not feasible due to drawdown restrictions or other limitations, hydraulic dredging may be considered. Hydraulic dredging is generally more expensive than dry dredging for limited projects but becomes increasingly cost-effective as the scale of a project increases. Hydraulic dredging requires significant planning for the dewatering of the sediment since the approach typically produces a sediment slurry that is 80 percent water or more. Removing this volume of water from the sediment requires either a more sophisticated containment area or advanced dewatering techniques such as the use of Geotubes (geotextile fabric for dewatering) or a belt-filter press machine. Each of these approaches may add costs over traditional dewatering. Regardless of the sediment dewatering option selected, land adjacent to or near the pond is required for the dewatering process. A minimum size of at least one acre is typically required, even for belt filter presses or Geotubes, unless the dredging project is very small. Although the equipment itself may fit into a smaller area, project progress would be substantially delayed without sufficient room for hauling trucks to efficiently stand by and then maneuver as needed to accept each load of dewatered sediment.

If a standard dewatering basin is used, an area of at least two acres would likely be required (possibly more). However, dewatering sediment within standard dewatering basins could cut costs by as much as half compared to use of a belt filter press or Geotubes.

Dredging impacts depend on whether the project would be completed in the dry or using hydraulic dredging. However, some level of direct impacts to non-target organisms should be anticipated due to the direct removal of sediments from the pond. Indirect impacts from increased turbidity or sediment transport may also result and will likely need to be mitigated and/or monitored as a condition of the project permits. Pond drawdown to accommodate dry dredging would carry its own impacts and likely be subject to time-of-year restrictions to minimize impacts to fish and wildlife. Additionally, impacts outside the pond will depend on the area needed for sediment dewatering and whether dredge spoils can be used locally or need to be hauled away for disposal.

As part of the Management Strategy, the 2012 bulk chemical sediment analyses collected from Whitman's Pond were reevaluated against the current MCP S-1/GW-1 standards, which were updated in 2014. Under the original standards that were applicable in 2012, a majority of the cores contained metals concentrations that would be in exceedance of the standard if the material were placed as soil at an upland location. However, under the current standards, only one core (collected from the Mill River) contains a metal (lead) that may exceed the standards (Appendix A). The composite core sample from the West Cove still would exceed the acetone standard. However, this result was considered suspect during the original study, due to the fact that acetone is a contaminant that could have been introduced through disinfection protocols. If the Town were to pursue a dredging project, new sediment cores would need to be collected first, as the validity of the old cores has expired for permitting purposes. However, this reanalysis of the sediment sampling results demonstrates that Whitman's Pond sediments may be less likely to be contaminated than previously thought. This could have a substantial impact on project cost. If sediments were resampled and found to be acceptable for reuse, hauling and disposal costs could be much less. Additionally, clean sediments could potentially have value to a local quarry or landscape wholesaler (or even directly to the Town), for use as soil amendment.

Actual dredging costs vary greatly depending on the quantity and quality of material to be removed, the disposal site, and what type of dredging would be most appropriate. Therefore, the first step to any pond dredging project is to complete a dredging feasibility study. As part of the dredge feasibility study, sediment cores would also be extracted and analyzed to assess the physical and chemical properties of the sediment in the proposed area(s) for dredging. Based on the initial volume estimates presented here, the Town should anticipate the need to collect at least two cores for the South Cove and thirteen in the West Cove, although additional samples may be warranted depending on whether distinct sediment stratification is observed in the cores. Options for ingress and egress of equipment, set up of any special equipment (e.g., belt filter press), dewatering and stockpiling of material, potential disposal sites, and other logistical issues would also be evaluated.

If determined to be feasible, the project would then proceed to the engineering design and permitting phase. Environmental permitting for dredging projects is moderately complex and typically requires a year or more before the project receives all required approvals. Federal, state, and local permits or approvals are all required, and would necessitate considerable advance information and review time. Permits and approvals required for the project are described below.

MEPA Certificate

The Massachusetts Environmental Policy Act (MEPA) and its implementing regulations establish procedures for the evaluation of environmental impacts associated with actions taken by state agencies, including issuance of permits and granting of financial assistance. Projects that exceed one or more MEPA review thresholds are required to undergo review by the MEPA Office. If a dredging project pursued by the Town requires a state action *and* exceeds MEPA review thresholds (i.e., alteration of one half or more acres of wetlands and dredging and disposal of 10,000 cubic yards), MEPA review will be required. Typically, this consists of the submittal of an Environmental Notification Form (ENF), which the MEPA Office uses to identify required permits or approvals and issue a Certificate from the Secretary of Energy and Environmental Affairs. However, larger or more impactful projects may require submittal of an Environmental Impact Report (EIR) which is a more substantial filing.

Of note, the MEPA Office is currently in the process of revising its regulations to more fully address climate change and environmental justice concerns per Governor Baker's Executive Order 569. Therefore, the Town should anticipate the need to review any new policies, guidance, or protocols issued before proceeding with future MEPA filings.

Notice of Intent

Whitman's Pond falls under the jurisdiction of the Wetlands Protection Act (WPA) and the Town of Weymouth Wetlands Protection Ordinance. Dredging may impact Land Under Water, Bordering Vegetated Wetlands, and/or other resource areas. Therefore, any dredging project in Whitman's Pond would require filing a Notice of Intent application with the Weymouth Conservation Commission and presenting the project at a public hearing. Approval by the Weymouth Conservation Commission would be issued as an Order of Conditions, which is typically valid for a three year period (although this may be extended).

401 Water Quality Certificate

A 401 Water Quality Certification is required for projects that involve the fill or excavation of 100 cubic yards of sediment or more from a pond or disturbance of 5,000 square feet or more of Land Under Water. This is also required for dredging projects of any size in Outstanding Resource Waters. An application for a 401 Water Quality Certification must be prepared and submitted to the MassDEP Division of Wetlands and Waterways. As part of the process, representative sediment samples must be collected within the proposed sediment removal limits to evaluate the bulk physical and chemical characteristics. The MassDEP standard for this assessment is one core per 1,000 cubic yards to be dredged, with a minimum of two required samples. Up to three cores can usually be combined into a single composite sample for laboratory analysis, although some analytes of concern (e.g., VOCs) would need to be collected from undisturbed cores.

Chapter 91

The Massachusetts Public Waterfront Act (Chapter 91) and its implementing regulations seek to protect and promote the public use of tidelands, Great Ponds, and non-tidal rivers and streams in accordance with the public trust doctrine. Whitman's Pond is a Great Pond; therefore, dredging would require a Chapter 91 permit issued by MassDEP. The Chapter 91 application can be submitted jointly with the 401 Water Quality Certificate application.

Section 404 of the Clean Water Act

Section 404 regulates the discharge of dredged, excavated, or fill material in wetlands, streams, rivers, and other waters of the U.S. Removal of 100 cubic yards of sediment or an impact area greater than one acre would require an individual permit from the USACE New England District under Section 404 of the Clean Water Act (CWA).

National Pollutant Discharge Elimination System

National Pollutant Discharge Elimination System (NPDES) permits regulate the discharge of point source pollutants through the CWA. NPDES permits include discharge limits and requirements for monitoring and reporting. Dredging projects exceeding one acre of disturbance (including upland areas) may require filing for coverage under the NPDES Construction General Permit for stormwater and dewatering discharge.

4.1.5 Hand Harvesting and DASH

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., fanwort and milfoils) aims to remove entire plants, including the roots, thereby preventing re-growth in subsequent seasons.

Hand harvesting is ideal for control of small patches of water chestnut, which can be harvested from the surface. At Whitman's Pond, divers would be required to hand harvest most of the nuisance species.

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 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.

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

In practice, it is difficult to achieve effective management of nuisance species through hand harvesting once they have become established in the pond. However, established infestations may be managed using diver assisted suction harvesting (DASH), which uses 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 diver hand harvesting operations.

Despite the increased efficiency, DASH is still a labor-intensive process that is likely to require more than one harvesting event per year over several years to successfully manage an established infestation. Even then, eradication may not feasible. However, containment may be, especially if the infestation has retreated to a cove or inlet where fragment barriers can be placed to minimize redispersal and recolonization by plant fragments.

Based on ESS's experience with large-scale DASH operations in other water bodies, this is likely to require several months of work during the growing season each year. In many cases, more than one dive team (including appropriately outfitted vessel) is needed to complete the work before freezing weather arrives. The number of qualified DASH contractors who have sufficient staffing and equipment to complete these kinds of programs is growing but still fairly limited, which can complicate the contracting process.

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.

Hand harvesting is likely to play a very important role as the preferred rapid response method in the Management Strategy. However, its use for large scale or regular seasonal management of areas with nuisance plant growth is likely to be limited.

DASH could play an important role as the preferred submerged nuisance plant control method in the most sensitive areas. This may include the South Cove, where there are currently few other desirable management options. However, to be successful, the Town would need to commit to multiple years of DASH operations, probably for several weeks at a time.

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.

This management option would require an Order of Conditions from the Weymouth Conservation Commission to implement. Although the decision lies with the Commission, these operations are similar in nature to other physical control methods like hydroraking and mechanical harvesting, which are permitted under the existing Order of Conditions for management of the pond. Therefore, it may not be necessary to file a new Notice of Intent to implement these actions.

4.1.6 Hydroraking

Hydroraking uses a backhoe-like machine mounted on a barge to remove plants directly from pond sediments. Typically, the targeted plants are water lilies or other coarse aquatic plants that are difficult to control through other physical management methods. Hydroraking is not considered dredging but it often results in incidental removal of sediments and accumulated debris. This provides a minor side benefit in addressing sedimentation.

Hydroraking would only be recommended in areas where water lilies or other coarse plants are considered to be problematic and other options for treatment are not preferred. It is not recommended as a primary control method for most submerged or vegetatively reproducing species, such as variable-leaf milfoil and fanwort.

Hydroraking is somewhat selective, in that non-target areas can be avoided. However, some impacts to non-target species (including bycatch of invertebrates and removal of some non-target plants) should be anticipated in the areas that are actively raked.

The Town DPW currently possesses a valid Order of Conditions from the Weymouth Conservation Commission to conduct hydroraking operations in Whitman's Pond. If the Order of Conditions expires, filing a new Notice of Intent would be required to allow continuation of hydroraking programs.

4.1.7 Mechanical Harvesting

Mechanical harvesting, which involves cutting and pulling aquatic plants from a specially equipped watercraft, is an effective short-term approach to control plant biomass. This method can be useful for scenarios where reduction in biomass is acceptable even if it does not result in long-term control of the targeted beds.

Mechanical harvesting can be a relatively expensive method. However, the Town currently owns and operates its own harvester, which may help to keep costs more manageable. The Town's harvester is most efficient when used in submerged plant beds but can be operated near and even in water lily beds by an experienced operator, although progress is slower in these areas. Most of the Town's prior harvesting operation has been focused on the area along and north of a line between the Middle Street boat launch at the west end and the Lake Street public access at the north.

When operating smoothly, the mechanical harvester is able to remove approximately 18 to 24 cubic yards (wet) of aquatic plant material per day. The harvester has been operated as much as five days a week (including volunteer operation), which would yield approximately 90 to 120 cubic yards of plants a week at peak efficiency.

Due to access requirements and physical limitations of the harvester as well as its propensity to malfunction or require repairs when operated in marginal conditions, mechanical harvesting appears to be feasible only in the Main Basin for now. The Town's harvester ideally requires a minimum of three feet of water to avoid becoming stranded and prevent damage to the conveyor belt.

Mechanical harvesting is one of the least selective management methods because the machine will tear or pull up any plants that are in its area of operation. Therefore, some impacts to non-target species (including bycatch of fish and invertebrates and removal of many non-target plants) should be anticipated in the areas that are actively harvested. Fragmentation is often a concern with mechanical harvesting programs, as it can release and spread viable fragments of non-native perennial species like fanwort and variable-leaf milfoil. However, the amount of fragmentation generated may be greatly reduced by an experienced operator.

The Town DPW currently possesses a valid Order of Conditions from the Weymouth Conservation Commission to conduct mechanical harvesting operations in Whitman's Pond. If the Order of Conditions expires, filing a new Notice of Intent would be required to allow continuation of harvesting programs.

4.1.8 Resident Waterfowl Control

Waterfowl serve as the primary host for the parasitic organisms that cause swimmer's itch (also known as cercarial dermatitis). Migratory species of waterfowl may carry the parasite but they tend to spend fewer days in a given water body and, in eastern Massachusetts, tend to be present outside of the summer season. However, resident waterfowl (primarily Canada Goose) are present year-round and tend to spend the most time in or near the water during the late spring and summer, when they are actively nesting and molting. Therefore, reducing the resident waterfowl population at Whitman's Pond may, in turn, help to reduce the source of the schistosomes that cause swimmer's itch. Resident waterfowl control would also reduce undesirable inputs of nutrients and bacteria to Whitman's Pond.

Management of the resident Canada Goose population is most likely to be accomplished if multiple active and passive control options are implemented as part of a comprehensive effort. Therefore, ESS recommends implementing a combination of various techniques to achieve the desired outcome. A few examples of active and passive control options are described in this section. However, this list is not exhaustive.

Egg addling or oiling is an active measure that seeks to reduce the viability of goose eggs without destroying the nest. When successful, geese will continue to incubate the non-viable eggs long enough that that they do not attempt to nest again that year. Over time, this reduces the locally grown population of geese. This activity can be implemented by trained volunteers but requires effort to locate nests each year.

Goose harassment is another active measure that involves the generation of loud noises or canine patrolling of favored areas to disturb geese and discourage them from persisting in these areas. Over time, the frequency of harassment may be decreased as geese learn to avoid these areas.

Raising the cutting height on lawnmowers and/or reducing mowing frequency is the simplest passive measure to discourage goose grazing. Geese find taller grass to be less palatable and gravitate to closely cropped lawn areas instead. This method would also have the added benefit of reducing the time and money spent on landscape maintenance by the Town and shoreline residents. It would also help to attenuate direct runoff and pollutant loading from adjacent properties into the pond.

Chemical repellents are another passive measure that makes grass less palatable to geese. However, these need to be reapplied frequently over a long period of time to be effective.

Decoys, often in the form of owls, coyotes, or other shapes/patterns that simulate predators are a popular passive measure that typically achieves little success in managing resident waterfowl populations. Although geese may initially avoid areas near decoys, they quickly learn that the simulated predators are not a real threat. Moving or switching decoys every few days may improve effectiveness.

The most effective passive measure involves creating a barrier to goose movement during the vulnerable summer molting season. This can be accomplished through installation of fencing or re-landscaping the immediate shoreline to incorporate a buffer of shrubs and larger herbaceous plants. When geese molt, they are unable to fly over barriers and avoid passing between obstacles that obscure their vision of potential predators.

If fencing is used, it must extend the entire perimeter of the open shoreline transition area (and extend up along property boundaries, if the neighboring property is unfenced). Fencing must be at least 30 inches tall with the first rail no more than 12 inches above the ground to be effective. Benches, stones, or other objects that form a similar barrier may also be added to break up the fenceline and provide greater visual interest or enhance passive recreational opportunities, although these must be flush with fenceposts and meet the required height specifications to avoid creating potential points of entry for geese to cross through the barrier. Gates may also be installed to allow human access while preventing goose passage. If vegetation is used to form the barrier, it must also be at least 30 inches tall and form a strip at least 6 feet wide, although narrow footpaths between vegetated areas may be maintained to allow people to access the pond. Vegetation may be selected to enhance both aesthetic interest and wildlife value. Vegetative barriers are a particularly attractive option because the also provide nutrient uptake and attenuate direct runoff from adjacent parcels into the pond.

Goose fencing is not always successful on its own, especially if geese are able to reach desirable foraging grounds through adjacent properties, as demonstrated here. However, when used appropriately and/or combined with other nuisance waterfowl control measures, such as vegetative buffers and reduced mowing, it can be very effective.

At Whitman's Pond, the Middle Street public access and adjacent park would be a logical target for implementation of multiple goose management approaches. This location hosts the largest contiguous strip of lawn on the pond shoreline. Several residences beyond the park also serve as an extension of goose grazing habitat. Where retaining walls or tall vegetation are already in place, no additional barriers are needed. However, in locations where geese could emerge from the pond and walk up a slope to graze, barriers would be recommended. Installation of a barrier at the boat launch itself may also be possible if designed as a gate that can be opened to allow watercraft to launch.

Other Town-owned parcels at Lambert Avenue and even Lake Street could potentially also benefit from goose fencing, even though they provide less ideal grazing habitat. However, these areas would be considered lower priority.

Resident waterfowl control may require filing a Request for Determination of Applicability or obtaining an Order of Conditions from the Weymouth Conservation Commission, depending on the proposed action(s). Some actions, such as reduced mowing, require no permits.

4.1.9 Implement a Long-term Monitoring Program

Implementation of a long-term monitoring program is critical for understanding and tracking trends in the condition of Whitman's Pond, as well as preventing or containing new issues as they arise.

At a minimum, the water quality parameters assessed as part of the 2013 *Whitman's Pond Vegetation Management Action Plan* study should be part of future monitoring. Water quality data are of limited value if not collected relatively frequently. Therefore, the Town may wish to consider a monthly or even weekly monitoring program, especially during the growing season. Phosphorus, nitrogen, dissolved oxygen, temperature, and transparency [Secchi depth] would all be key parameters to target. Additionally, chlorophyll a, pH, specific conductance, and turbidity would be beneficial if they can be accommodated. A number of reliable water quality monitoring sensors and data loggers are now on the market and could provide continuous data collection with minimal labor required. Some more advanced data systems, including data buoys, even have telemetry options that allow data to be transmitted to a secure website without needing to physically visit the logger and download the data.

Additionally, vegetation mapping efforts should be completed during the peak of aquatic plant growth, at least once a year. This mapping should include aquatic plant species distribution, cover, and biovolume. Vegetation mapping twice a year (i.e., pre- and post-implementation) is recommended when management actions are implemented.

These monitoring elements are critical to evaluating the success of any management actions that are implemented and optimizing the management program in future years. Furthermore, mapping of vegetation provides an excellent tool for identifying pioneer infestations of new invasive species so that they can be eradicated at minimal cost and effort before they spread.

A large portion of the data could potentially be collected by trained volunteers for cost-effectiveness. However, to make the most of the data collected by the monitoring program and provide interpretation of the trends, professional review and evaluation is recommended.

4.2 Five-year Management Schedule

The primary tasks and annual costs associated with the recommended management actions are presented in Table K.

Table K. Five-year Management Schedule

Management Action	Estimated Costs by Year					Five-Year Projected Costs				Notes
	1	2	3	4	5	Design/ Permitting	Implementation	Monitoring/ Reporting	Total	
Benthic Barriers										
Task 1. Amend Order of Conditions	$0	$0	$0	$0	$0	$0	$0	$0	$0	Assumes Town will amend permit without additional outside assistance. If outside assistance needed, recommend budget of $2,500. If a new NOI filing is required, recommend budget of $7,500.
Task 2. Material Purchase and Initial Installation	$10,000	$0	$0	$10,500	$0	$0	$20,500	$0	$20,500	Assumes 4,500 square feet of installed barrier near public access areas only. Annual O&M completed by Town. Replace after three seasons.
Benthic Barriers - Subtotal	**$10,000**	**$0**	**$0**	**$10,500**	**$0**	**$0**	**$20,500**	**$0**	**$20,500**	
Chemical Controls										
Task 1. Amend Order of Conditions to Be Consistent with Management Strategy Herbicide Zones	$0	$0	$0	$0	$0	$0	$0	$0	$0	Assumes Town will amend permit without additional outside assistance. If outside assistance needed, recommend budget of $2,500. If a new NOI filing is required, recommend budget of $7,500.
Task 2. Imazamox and Flumioxazin Spot Treatments	$15,000	$15,000	$16,000	$16,000	$17,000	$0	$79,000	$0	$79,000	Alternate spot treatments with other method to comply with label restrictions and/or avoid developing herbicide resistance
Task 3. Sonar Treatment	$25,000	$0	$0	$0	$27,500	$0	$52,500	$0	$52,500	Assumes West Cove (Zone A) only with retreatment after four years. Add $1,000/acre for small-scale treatments in Zones B or C.

Management Action	Estimated Costs by Year					Five-Year Projected Costs				Notes
	1	2	3	4	5	Design/ Permitting	Implementation	Monitoring/ Reporting	Total	
Task 4. ProcellaCOR Treatment	$0	$10,000	$10,500	$10,500	$11,000	$0	$42,000	$0	$42,000	Recommended annual budget for as-needed use only. To be used only if/where fanwort brought under control but milfoil remains.
Chemical Controls - Subtotal	**$40,000**	**$25,000**	**$26,500**	**$26,500**	**$55,500**	**$0**	**$173,500**	**$0**	**$173,500**	
Drawdown										
Task 1. Design and Permitting	$25,000	$25,000	$0	$0	$0	$50,000	$0	$0	$50,000	Assumes Town will pursue a three-foot drawdown of the Main Basin using existing structures and controls. Includes completion of final drawdown H&H analysis/report, O&M plan, and permitting (NOI, and Ch. 91).
Task 2. Implementation and Monitoring	$0	$10,000	$10,500	$10,500	$11,000	$0	$0	$0	$0	Assumes implementation completed by Town on annual or as-needed basis. Monitoring anticipates specialty surveys (e.g., mussels) not already included in the overall management program monitoring budget.
Drawdown - Subtotal	**$25,000**	**$35,000**	**$10,500**	**$10,500**	**$11,000**	**$50,000**	**$0**	**$0**	**$50,000**	
Dredging										
Task 1. Dredge Feasibility Study	$50,000	$0	$0	$0	$0	$50,000	$0	$0	$50,000	Assumes Town will combine West Cove and South Cove in the feasibility study. Includes sediment sampling, concept engineering plans, assessment of disposal options, and detailed opinion of cost. Sediment sampling data will be necessary to proceed to permitting stage.

Management Action	Estimated Costs by Year					Five-Year Projected Costs				Notes
	1	2	3	4	5	Design/ Permitting	Implementation	Monitoring/ Reporting	Total	
Task 2. Design and Permitting - West Cove	$0	$35,000	$35,000	$0	$0	$70,000	$0	$0	$70,000	Includes development of permitting level engineering plans, submittal of MEPA ENF, 401 Water Quality Cert, 404 Army Corps, Ch. 91, and NOI permit applications, and development of construction final plans and bid specs.
Task 3. Implementation - West Cove	$0	$0	$0	$1,275,000	$20,000	$0	$1,275,000	$20,000	$1,295,000	Midpoint estimate based on 13,000 cy. Cost contingent on findings of feasibility study and final extent/design of the project.
Task 4. Design and Permitting - South Cove	$0	$0	$0	$25,000	$0	$25,000	$0	$0	$25,000	Includes development of permitting level engineering plans, submittal of MEPA ENF, 401 Water Quality Cert, Ch. 91, and NOI permit applications, and development of construction final plans and bid specs.
Task 5. Implementation - South Cove	$0	$0	$0	$0	$75,000	$0	$75,000	$0	$75,000	Assumes sediments are clean enough for reuse or disposal in Massachusetts. Cost contingent on findings of feasibility study.
Dredging - Subtotal	**$50,000**	**$35,000**	**$35,000**	**$1,300,000**	**$95,000**	**$145,000**	**$1,350,000**	**$20,000**	**$1,515,000**	
Hand Harvesting and DASH										
Task 1. Permitting	$0	$0	$0	$0	$0	$0	$0	$0	$0	Assumes Town will amend permit without additional outside assistance. If outside assistance needed, recommend budget of $2,500. If a new NOI filing is required, recommend budget of $7,500 (may be combined with other approaches to save cost).
Task 2. Implementation - DASH	$100,000	$100,000	$85,000	$75,000	$55,000	$0	$415,000	$0	$415,000	Assumes aggressive DASH program focused on South Cove

Management Action	Estimated Costs by Year					Five-Year Projected Costs				Notes
	1	2	3	4	5	Design/ Permitting	Implementation	Monitoring/ Reporting	Total	
Task 3. On-call Implementation - Diver Hand Harvesting	$7,500	$7,500	$8,000	$8,000	$8,500	$0	$39,500	$0	$39,500	Annual budget estimate for emergency hand harvesting needs.
Hand Harvesting and DASH - Subtotal	**$107,500**	**$107,500**	**$93,000**	**$83,000**	**$63,500**	**$0**	**$454,500**	**$0**	**$454,500**	
Hydroraking										
Task 1. Permitting	$0	$0	$0	$0	$0	$0	$0	$0	$0	Assumes work can continue under existing OOC.
Task 2. Implementation	$36,000	$36,000	$38,000	$38,000	$40,000	$0	$188,000	$0	$188,000	Assumes multiple days of hydroraking per year.
Hydroraking - Subtotal	**$36,000**	**$36,000**	**$38,000**	**$38,000**	**$40,000**	**$0**	**$188,000**	**$0**	**$188,000**	
Mechanical Harvesting										
Task 1. Permitting	$0	$0	$0	$0	$0	$0	$0	$0	$0	Assumes work can continue under existing OOC.
Task 2. Implementation	$0	$0	$0	$0	$0	$0	$0	$0	$0	Assumes Town will continue implementing program internally and there are no outside O&M costs.
Mechanical Harvesting - Subtotal	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	
Resident Waterfowl										
Task 1. Design and Permitting	$15,000	$0	$0	$0	$0	$15,000	$0	$0	$15,000	Assumes retrofitting of existing facilities with fencing. Additional actions may not require permitting.
Task 2. Implementation	$0	$60,000	$10,000	$10,000	$11,000	$0	$91,000	$0	$91,000	Construction of passive barriers (fencing) and implementation of supplemental active measures.
Resident Waterfowl Control – Subtotal	**$15,000**	**$60,000**	**$10,000**	**$10,000**	**$11,000**	**$15,000**	**$91,000**	**$0**	**$106,000**	

Management Action	Estimated Costs by Year					Five-Year Projected Costs				Notes
	1	2	3	4	5	Design/ Permitting	Implementation	Monitoring/ Reporting	Total	
Monitoring										
Task 1. Routine Water Quality Monitoring	$18,000	$18,000	$19,000	$19,000	$20,000	$0	$0	$94,000	$94,000	Assumes implementation of monthly monitoring program during growing season by consultant and annual report.
Task 2. Biannual Vegetation Mapping	$10,000	$10,000	$10,500	$10,500	$11,000	$0	$0	$52,000	$52,000	Includes pre- and post-management vegetation mapping.
Monitoring - Subtotal	**$18,000**	**$18,000**	**$19,000**	**$19,000**	**$20,000**	**$0**	**$0**	**$94,000**	**$94,000**	
Total	**$301,500**	**$316,500**	**$232,000**	**$1,497,500**	**$296,000**	**$210,000**	**$2,277,500**	**$114,000**	**$2,601,500**	

5.0 POTENTIAL FUNDING OPTIONS

Although a number of funding opportunities exist to address watershed water quality and stream continuity issues, few funding opportunities are targeted specifically to in-pond management work. Often, these kinds of projects are funded through locally generated funding sources, such as the Community Preservation Act (CPA), which can also leverage state monies. The Weymouth Community Preservation Committee is responsible for funding these projects in the Town of Weymouth. 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. However, ESS is aware of other organizations that have received project funds for lake and pond projects. 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. Given Whitman's Pond status as a backup water supply and its identification as a potentially impacted environmental resource in Weymouth's MVP Summary of Findings Report (Stantec 2018), this program could potentially be a source of funding.

Another newer program is the Massachusetts Water Quality Monitoring grant, administered through MassDEP. This grant can be used to purchase water quality monitoring equipment and supplies or otherwise expand community capacity for water quality monitoring. Although the grant is targeted to non-governmental organizations, municipalities can also benefit from the monitoring data generated under the grant.

Other state and federal funding opportunities (including loan programs) that may be relevant to Whitman's Pond frequently arise through US EPA and/or the MassBays program, the New England Interstate Water Pollution Control Commission (NEIWPCC), and various state grant programs (including the Massachusetts Environmental Trust and Coastal Pollution Remediation). 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.

Although watershed improvements are outside the scope of this Management Strategy, the state-managed Section 604(b) and Section 319 grant programs are funded annually and target watershed water quality. Both of these grant programs are highly competitive and cannot be used to fund activities that are required for compliance with the Town's small municipal separate storm sewer system (MS4) permit.

The Section 604(b) grant program has no match requirement and may be used for watershed assessment programs, conceptual design of stormwater BMPs, or other types of projects associated with identification of and initial response to pollutant sources. Section 604(b) grant awards typically range from $30,000 to $50,000 but can be somewhat higher or lower.

The Section 319 grant program typically requires a 40% non-federal match but can be used to fund permitting, final design, construction, or other implementation of previously identified strategies or BMPs. However, project eligibility may be restricted to locations that are not currently covered through an MS4 permit. Typical award values range from $100,000 to $300,000 but awards outside of this range are occasionally made, particularly on the higher end.

6.0 REFERENCES

Aquatic Control Technology, Inc. 2010. Whitman's Pond Pre-treatment Survey Results and Management Plan.

Carmignani, J.R., A.H. Roy, P.D. Hazelton, and H. Giard. 2019. Annual winter water level drawdowns limit shallow-water mussel densities in small lakes. *Freshwater Biology*, 64:1519-1533.

Carmosini, N., R. Gillis, A. Ismail, and G. Sandland. 2018. A Pilot Evaluation of the Toxicity of EarthTec® QZ on Invasive (Bithynia tentaculata) and Native (Physa gyrina) Snail Species from the Upper Mississippi River. *Bulletin of Environmental Contamination and Toxicology*, 101:428-433.

ESS Group, Inc. [ESS]. 2013. Whitman's Pond Vegetation Management Action Plan. Prepared for Town of Weymouth and Whitman's Pond Working Group.

Massachusetts Department of Environmental Protection [MassDEP]. 2013. Massachusetts Year 2012 Integrated List of Waters. Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act. Worcester: Massachusetts Division of Watershed Management, Watershed Planning Program.

Massachusetts Department of Environmental Protection [MassDEP]. 2019. Massachusetts Year 2016 Integrated List of Waters. Final Listing of the Condition of Massachusetts' Waters Pursuant to Sections 305(b), 314 and 303(d) of the Clean Water Act. Worcester: Massachusetts Division of Watershed Management, Watershed Planning Program.

Princeton Hydro, LLC. 2017. Whitman's Pond Winter Drawdown Vegetation Analysis Report. Prepared for Weymouth Department of Public Works.

SOLitude Lake Management. 2018. 2018 Vegetation Evaluation, Whitman's Pond. Prepared for Weymouth Conservation Commission.

Stantec. 2018. Town of Weymouth, Municipal Vulnerability Preparedness Program, Summary of Findings Report. Revised June 28, 2018. Prepared for the Town of Weymouth.

Appendix A

2012 Sediment Analysis Results for Whitman's Pond with Updated Criteria

Sediment Analysis Results from Whitman's Pond, Weymouth, MA

Analyte	SC1-Comp	SC2-Comp	SC3-Comp	MR-Comp	MB-Comp	WC-Comp	MCP[1]	Lined Landfill[2]
Moisture Content (%)	88	78	87	77	91	89	NR	NR
Total Organic Carbon (mg/kg)	186,000	96,900	16,700	59,000	226,000	280,000	NR	NR
Mercury by SW-846 7471 (mg/kg):								
Mercury	*0.17*	*0.089*	*0.15*	1.2	*0.23*	*0.18*	20	10
Trace Metals by 6010B (mg/kg):								
Arsenic	*4.2*	*2.2*	*3.8*	20	*5.8*	4.9	20	40
Cadmium	*0.85*	0.55	1.7	8.1	1.3	0.99	70	80
Chromium	11	17	38	38	10	5.4	100	1000
Copper	12	9.7	20	59	24	20	NR	NR
Lead	14	20	58	400	39	7.9	200	2000
Nickel	7.2	5.2	45	22	9.1	4.2	600	NR
Zinc	63	28	93	610	92	19	1000	NR
Volatiles by 8260B (µg/kg):								
Acetone	*14000*	*9500*	1600	1000	*10000*	8000	6000	NR
Acrylonitrile	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
Benzene	*36*	*24*	*33*	24	*100*	*24*	2000	NR
Bromobenzene	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
Bromochloromethane	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
Bromodichloromethane	*36*	*24*	*33*	*18*	*100*	*24*	100	NR
Bromoform	*36*	*24*	*33*	*18*	*100*	*24*	100	NR
Bromomethane	*36*	*24*	*33*	*18*	*100*	*24*	500	NR
2-Butanone (MEK)	*3600*	*2400*	270	240	1500	410	4000	NR
n-Butylbenzene	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
sec-Butylbenzene	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
tert-Butylbenzene	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
Carbon disulfide	43	*24*	*33*	*18*	160	*24*	NR	NR
Carbon tetrachloride	*36*	*24*	*33*	*18*	*100*	*24*	10000	NR
Chlorobenzene	*36*	*24*	*33*	*18*	*100*	*24*	1000	NR
Chloroethane	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
Chloroform	*36*	*24*	*33*	*18*	*100*	*24*	400	NR
Chloromethane	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
2-Chlorotoluene	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
4-Chlorotoluene	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
1,2-Dibromo-3-chloropropane (DBCP)	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
Dibromochloromethane	*36*	*24*	*33*	*18*	*100*	*24*	5	NR
1,2-Dibromoethane (EDB)	*36*	*24*	*33*	*18*	*100*	*24*	100	NR
Dibromomethane	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
1,2-Dichlorobenzene	*36*	*24*	*33*	*18*	*100*	*24*	9000	NR
1,3-Dichlorobenzene	*36*	*24*	*33*	*18*	*100*	*24*	3000	NR
1,4-Dichlorobenzene	*36*	*24*	*33*	*18*	*100*	*24*	700	NR
Dichlorodifluoromethane	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
1,1-Dichloroethane	*36*	*24*	*33*	*18*	*100*	*24*	400	NR
1,2-Dichloroethane	*36*	*24*	*33*	*18*	*100*	*24*	100	NR
1,1-Dichloroethene	*36*	*24*	*33*	*18*	*100*	*24*	3000	NR
cis-1,2-Dichloroethene	*36*	*24*	*33*	*18*	*100*	*24*	300	NR
trans-1,2-Dichloroethene	*36*	*24*	*33*	*18*	*100*	*24*	1000	NR
1,2-Dichloropropane	*36*	*24*	*33*	*18*	*100*	*24*	100	NR
1,3-Dichloropropane	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
2,2-Dichloropropane	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
1,1-Dichloropropene	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
cis-1,3-Dichloropropene	*36*	*24*	*33*	*18*	*100*	*24*	10	NR
trans-1,3-Dichloropropene	*36*	*24*	*33*	*18*	*100*	*24*	10	NR
Diethyl ether	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
1,4-Dioxane	*140*	*95*	*130*	*71*	*420*	*96*	200	NR
Ethylbenzene	*36*	*24*	*33*	*18*	*100*	*24*	40000	NR
Hexachlorobutadiene	*36*	*24*	*33*	*18*	*100*	*24*	30000	NR
2-Hexanone	*73*	*47*	*67*	*36*	*210*	*48*	NR	NR
Isopropylbenzene	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
4-Isopropyltoluene	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
Methyl tert-butyl ether (MTBE)	*36*	*24*	*33*	*18*	*100*	*24*	100	NR
4-Methyl-2-pentanone (MIBK)	*73*	*47*	*67*	*36*	*210*	*48*	400	NR
Methylene chloride	*36*	*24*	*33*	*18*	*100*	*24*	100	NR
Naphthalene	*36*	*24*	*33*	*18*	*100*	*24*	4000	NR
n-Propylbenzene	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
Styrene	*36*	*24*	*33*	*18*	*100*	*24*	3000	NR
Tetrahydrofuran	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
trans-1,4-Dichloro-2-butene	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
1,1,2-Trichloro-1,2,2-trifluoroethane	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
1,2,3-Trichloropropane	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
1,1,1,2-Tetrachloroethane	*36*	*24*	*33*	*18*	*100*	*24*	100	NR
1,1,2,2-Tetrachloroethane	*36*	*24*	*33*	*18*	*100*	*24*	5	NR
Tetrachloroethene (PCE)	*36*	*24*	*33*	*18*	*100*	*24*	1000	NR
Toluene	*36*	*24*	*33*	*85*	*100*	*24*	30000	NR
1,2,3-Trichlorobenzene	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
1,2,4-Trichlorobenzene	*36*	*24*	*33*	*18*	*100*	*24*	2000	NR

1,1,1-Trichloroethane	*36*	*24*	*33*	*18*	*100*	*24*	30000	NR
1,1,2-Trichloroethane	*36*	*24*	*33*	*18*	*100*	*24*	100	NR
Trichloroethene (TCE)	*36*	*24*	*33*	*18*	*100*	*24*	300	NR
Trichlorofluoromethane	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
1,2,4-Trimethylbenzene	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
1,3,5-Trimethylbenzene	*36*	*24*	*33*	*18*	*100*	*24*	NR	NR
Vinyl chloride	*36*	*24*	*33*	*18*	*100*	*24*	900	NR
o-Xylene	*36*	*24*	*33*	*18*	*100*	*24*	400000	NR
m,p-Xylenes	*73*	*47*	*67*	*36*	*210*	*48*	400000	NR
PCBs by 8082 (µg/kg):								
Aroclor 1016	*110*	*59*	*100*	*57*	*150*	*120*	1000*	<2000*
Aroclor 1221	*110*	*59*	*100*	*57*	*150*	*120*	1000*	<2000*
Aroclor 1232	*110*	*59*	*100*	*57*	*150*	*120*	1000*	<2000*
Aroclor 1242	*110*	*59*	*100*	*57*	*150*	*120*	1000*	<2000*
Aroclor 1248	*110*	*59*	*100*	*57*	*150*	*120*	1000*	<2000*
Aroclor 1254	*110*	*59*	*100*	480	*150*	*120*	1000*	<2000*
Aroclor 1260	*110*	*59*	*100*	*57*	*150*	*120*	1000*	<2000*
Pesticides by 8081A (µg/kg):								
Aldrin	*22*	*12*	*20*	*23*	*31*	*30*	80	NR
alpha-BHC	*22*	*12*	*20*	*23*	*31*	*30*	NR	NR
beta-BHC	*22*	*12*	*20*	*23*	*31*	*30*	NR	NR
delta-BHC	*22*	*12*	*20*	*23*	*31*	*30*	NR	NR
gamma-BHC (Lindane)	*22*	*12*	*20*	*23*	*31*	*30*	3	NR
alpha-Chlordane	*22*	*12*	*20*	*23*	*31*	*30*	500	NR
gamma-Chlordane	*22*	*12*	*20*	*23*	*31*	*30*	500	NR
4,4'-DDD	*22*	*12*	*20*	*23*	*31*	*30*	8000	NR
4,4'-DDE	*22*	*12*	*20*	*23*	*31*	*30*	6000	NR
4,4'-DDT	*22*	*12*	*20*	*23*	*31*	*30*	6000	NR
Dieldrin	*22*	*12*	*20*	*23*	*31*	*30*	80	NR
Endosulfan II	*22*	*12*	*20*	*23*	*31*	*30*	500	NR
Endrin aldehyde	*22*	*12*	*20*	*23*	*31*	*30*	NR	NR
Endosulfan I	*22*	*12*	*20*	*23*	*31*	*30*	500	NR
Endosulfan sulfate	*22*	*12*	*20*	*23*	*31*	*30*	NR	NR
Endrin	*22*	*12*	*20*	*23*	*31*	*30*	10000	NR
Endrin ketone	*22*	*12*	*20*	*23*	*31*	*30*	NR	NR
Heptachlor	*22*	*12*	*20*	*23*	*31*	*30*	300	NR
Heptachlor epoxide	*22*	*12*	*20*	*23*	*31*	*30*	100	NR
Methoxychlor	*22*	*12*	*20*	*23*	*31*	*30*	200000	NR
Toxaphene	*1100*	*590*	*1000*	*1100*	*1500*	*1500*	NR	NR
Chlordane	*110*	*59*	*100*	*110*	*150*	NR	500	NR
Polynuclear Aromatic HC (mg/kg):								
2-Methylnaphthalene	*1.67*	*1.12*	*1.94*	*0.97*	*2.57*	*1.89*	700	NR
Acenaphthene	*1.67*	*1.12*	*1.94*	*0.97*	*2.57*	*1.89*	4000	NR
Acenaphthylene	*1.67*	*1.12*	*1.94*	*0.97*	*2.57*	*1.89*	1000	NR
Anthracene	*1.67*	*1.12*	*1.94*	*0.97*	*2.57*	*1.89*	1000000	NR
Benz(a)anthracene	*1.67*	*1.12*	*1.94*	*0.97*	*2.57*	*1.89*	7000	NR
Benzo(a)pyrene	*1.67*	*1.12*	*1.94*	*0.97*	*2.57*	*1.89*	2000	NR
Benzo(b)fluoranthene	*1.67*	*1.12*	*1.94*	1.11	*2.57*	*1.89*	7000	NR
Benzo(ghi)perylene	*1.67*	*1.12*	*1.94*	*0.97*	*2.57*	*1.89*	1000000	NR
Benzo(k)fluoranthene	*1.67*	*1.12*	*1.94*	*0.97*	*2.57*	*1.89*	70000	NR
Chrysene	*1.67*	*1.12*	*1.94*	1.23	*2.57*	*1.89*	70000	NR
Dibenz(a,h)anthracene	*1.67*	*1.12*	*1.94*	*0.97*	*2.57*	*1.89*	700	NR
Fluoranthene	*1.67*	*1.12*	*1.94*	1.89	*2.57*	*1.89*	1000000	NR
Fluorene	*1.67*	*1.12*	*1.94*	*0.97*	*2.57*	*1.89*	1000000	NR
Indeno(1,2,3-cd)pyrene	*1.67*	*1.12*	*1.94*	*0.97*	*2.57*	*1.89*	7000	NR
Naphthalene	*1.67*	*1.12*	*1.94*	0.97	*2.57*	*1.89*	4000	NR
Phenanthrene	*1.67*	*1.12*	*1.94*	*0.97*	*2.57*	*1.89*	10000	NR
Pyrene	*1.67*	*1.12*	*1.94*	1.82	*2.57*	*1.89*	1000000	NR
MA EPH Ranges (mg/kg)								
C11-C22 Aromatics	*66.6*	*44.8*	*77.5*	64	*103*	112	1000	NR
C09-C18 Aliphatics	*66.6*	*44.8*	*77.5*	*38.8*	*103*	*75.6*	1000	NR
C19-C36 Aliphatics	*66.6*	*44.8*	*77.5*	46.9	*103*	*75.6*	3000	NR
Total TPH							1000	5000

Italicized values aligned right = analyte not detected; value reported is laboratory detection limit
NR: Not Reported
*Standard applies to total PCBs
Laboratory Reporting Limit Exceeds MCP S-1/GW-1 Standard
Analyte Exceeds MCP S-1/GW-1 Standard

1: MADEP, 2014. Massachusetts Contingency Plan 310 CMR 40

2: MADEP, 1997. Reuse and Disposal of Contaminated Soil at Massachusetts Landfills Department of Environmental Protection Policy # COMM-97-001