LAUREL LAKE

SUBMERGED AQUATIC VEGETATION SURVEY

October 2021

EVALUATION & RECOMMENDATIONS FOR
NUISANCE VEGETATION MANAGEMENT

Location: Laurel Street (Route 20)
Town: Lee & Lenox, MA
Owner: Laurel Lake Preservation Association
Consultants: Foresight Land Services, Inc. & Otter Environmental Services
Date of Survey: October 7, 2021

FLS Project # E2962

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TABLE OF CONTENTS

LAUREL LAKE SUBMERGED AQUATIC VEGETATION SURVEY
OCTOBER 2021
EVALUATION & RECOMMENDATIONS FOR NUISANCE VEGETATION MANAGEMENT

UNITED STATES GEOLOGICAL SURVEY MAP

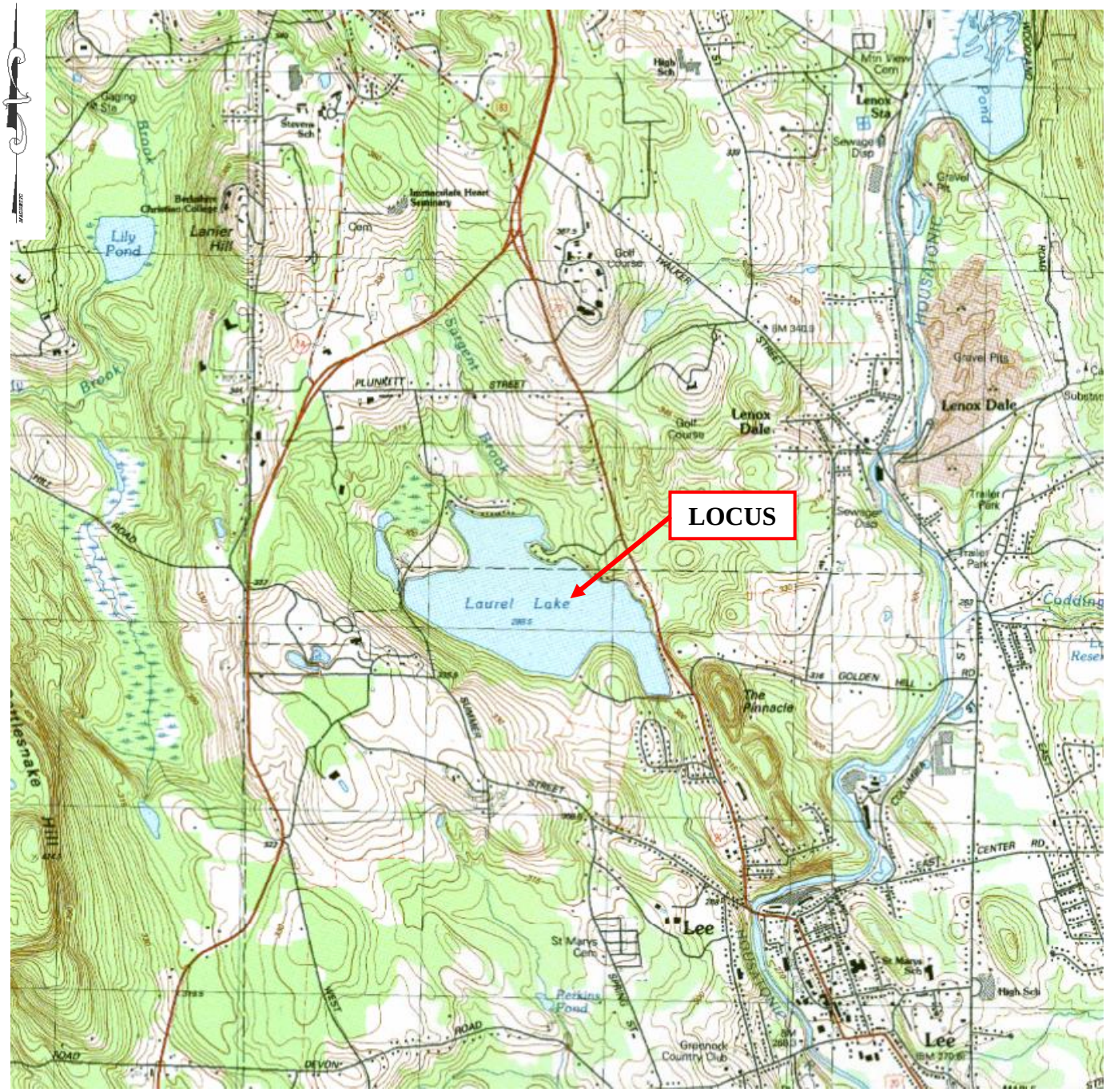

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Exhibit A-1
USGS Stockbridge QUAD, 1988 ed.
Source MASSGIS

Laurel Lake
Route 20
Lee & Lenox, MA

PRIORITY HABITATS AND ESTIMATED HABITATS Effective October 1, 2008
Priority Habitats for use with the MA Endangered Species Act Regulations (321 CMR 10)
Estimated Habitats for use with the MA Wetland Protection Act Regulations (310 CMR 10)
Produced by Natural Heritage & Endangered Species Program

MA Division of Fisheries and Wildlife

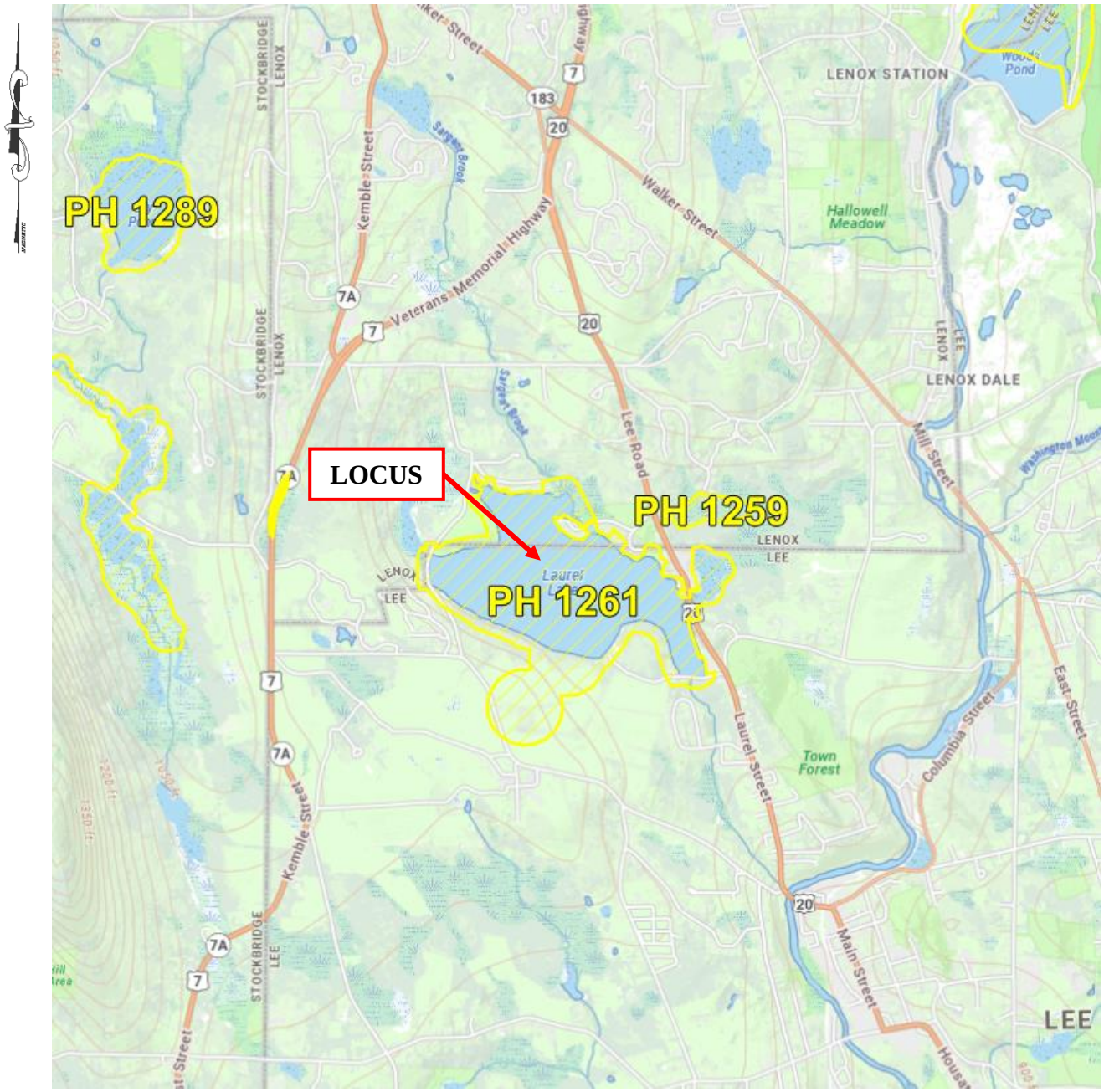

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Exhibit A-2
Priority Habitat Map
USGS Stockbridge QUAD, 1988 ed.
Source MASSGIS

Laurel Lake
Route 20
Lee & Lenox, MA

NATIONAL FLOOD INSURANCE PROGRAM

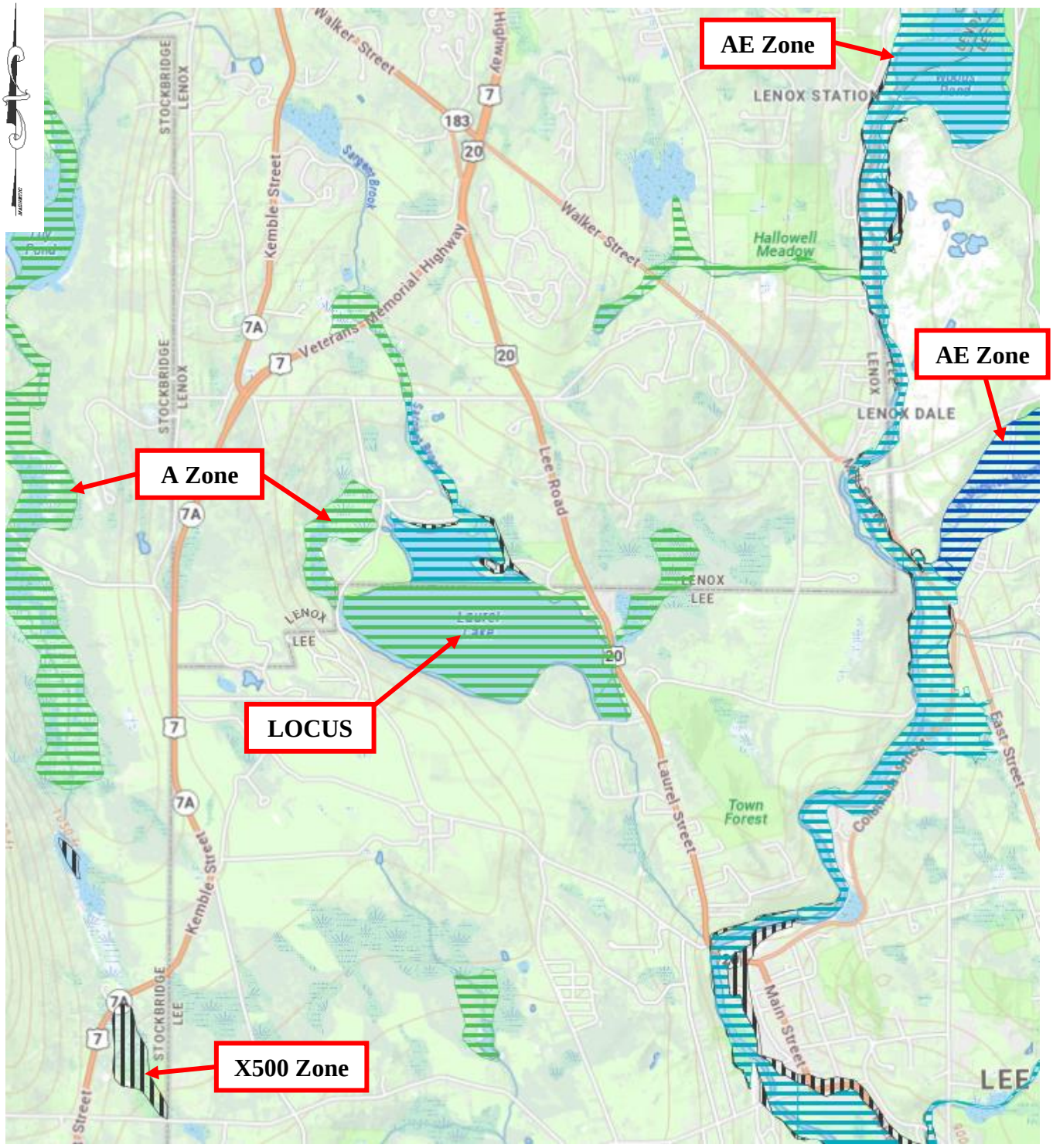

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Exhibit A-3
USGS Stockbridge QUAD, 1988 ed.
Source MassGIS

Laurel Lake
Route 20
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AERIAL PHOTOGRAPH

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Exhibit A-4
2021 Aerial Photograph
Source: MassGIS

Laurel Lake
Route 20
Lee & Lenox, MA

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*Steven A. Mack, P.E.**
Marc S. Volk
Marc A. LeVasseur

EXHIBIT B
SUBMERGED AQUATIC VEGETATION SURVEY REPORT

Evaluation & Recommendations for Nuisance Vegetation Management in Laurel Lake
Laurel Lake Preservation Association
Laurel Street (Route 20), Lee & Lenox, MA

GENERAL INFORMATION

According to information proved by the Massachusetts Department of Environmental Protection (MassDEP), Laurel Lake is an approximately 178-acre alkaline "great pond", located just to the west of Laurel Street (US Route 20), partially within both Lee and Lenox, Massachusetts. The Massachusetts Department of Environmental Protection (MassDEP) designates Laurel Lake as a "great pond", under Chapter 91, The Massachusetts Public Waterfront Act. The Laurel Lake Dam is privately owned and maintained. The Laurel Lake Preservation Association is a non-profit organization dedicated to the welfare and management of Laurel Lake.

The scope and purpose of this report and its associated Submerged Aquatic Vegetation GPS Survey Map is to evaluate the current (2021) distribution of both native and non-native species of submerged aquatic vegetation (macrophytes), within Laurel Lake. Then, using the information collected, analyze the various advantages and challenges of potential strategies for management of "nuisance" vegetation within the lake. This study and report have been commissioned by the Laurel Lake Preservation Association to address the ongoing concerns surrounding nuisance vegetation in the lake. This report reviews the various sections of the Massachusetts Wetlands Protection Act (WPA), Massachusetts Endangered Species Act (MESA), and other applicable regulations that would need to be addressed for each potential management strategy.

Important Notes: The information contained within this report and its associated "Submerged Aquatic Vegetation GPS Survey Map", dated May 23, 2022, is based upon information and data provided by the following; The Laurel Lake Preservation Association, Berkshire Environmental Laboratories Inc., the Massachusetts Division of Fisheries & Wildlife (Mass Fish & Wildlife), the Massachusetts Department of Environmental Protection (MassDEP), the Massachusetts Bureau of Geographic Information (MassGIS), the Massachusetts Office of Environmental Affairs, Municipal Assessor's information, and various other public sources.

The Submerged Aquatic Vegetation GPS Survey of Laurel Lake was performed on October 7, 2021, by Foresight Land Services, Inc. and Biologist Thomas Coote of Otter Environmental Services. Location information of macrophyte species, shown on the Submerged Aquatic Vegetation GPS Survey Map, dated May 23, 2022, was collected in field using a sub-meter accurate handheld GPS unit and interpolated onto the attached map using computer aided drafting software.

BACKGROUND & HISTORY OF LAUREL LAKE

Laurel Lake has a surface area of approximately 178-acres, with approximately 147-acres located within The Town of Lee and the remaining 31-acres in The Town of Lenox. Laurel Lake has a maximum depth of approximately 53 feet and an average depth of approximately 26 feet. Laurel Lake has two main inlets; Sargent Brook at the northern end and the unnamed tributary that enters the western end of the lake through the culvert beneath Laurel Lake Road. According to previous studies of Laurel Lake by Environmental Science Services, Inc., commissioned by The Town of Lee, the total watershed area of Laurel Lake is approximately 1,824 acres. Water transparency in the lake is considered by MassDEP to be generally good (±12' depth); however, significant algae blooms have often been observed within the lake in the late summer and fall months.

The bottom substrate of the lake consists primarily of stone, gravel, and rubble; however, considerable levels of clay and mud sediment exist in the shallow cove areas located in the northern, western, and southern ends of the lake. Wherever mud/sediment is present on the lake bottom, submerged aquatic macrophytes are extremely abundant and form dense patches extending throughout the lake's littoral zone, to depths of 15 feet and greater. The continued growth and decay of the dense beds of non-native macrophytes in these areas likely further contributes to the buildup of organic muck/mud in these areas, making them ideal locations for non-native macrophyte growth. The densest beds of non-native macrophytes have historically been observed in the northern and western coves near the inlets from Sargent Brook and the unnamed tributary that enters the lake through the culvert beneath Laurel Lake Road, as well as within the southern cove adjacent to the existing dam.

According to previous studies, provided by the Laurel Lake Preservation Association and the town of Lee, Laurel Lake has also historically faced minor issues of phosphorus and nitrogen eutrophication that potentially contribute to both submerged aquatic vegetation growth and algae blooms in the lake. A 2002 comprehensive diagnostic study of the lake, performed by Environmental Science Services, Inc., indicated that concentrations of phosphorous within the lake were high during storm events. While eutrophication was not considered to be a significant issue by the 2002 diagnostic study, it was noted that nutrient loading analysis suggested phosphorous and nitrogen levels were nearly equal to the typically acceptable level and eutrophic conditions may develop if nutrient loading increases. Eutrophic conditions can potentially contribute to the overall level of submerged aquatic nuisance vegetation present in the lake.

HISTORY OF SUBMERGED AQUATIC VEGETATION MANAGEMENT

Macrophytes (submerged aquatic vegetation) are important elements of the littoral zone habitat, providing structure and shelter for fish, amphibian and invertebrate communities; However, in areas subject to elevated nutrient and sediment loads (such as the inlets and outlets of Laurel Lake), aquatic plant growth of "nuisance macrophyte species" may reach excessive levels and result in significant degradation of native habitat. High densities of "nuisance" macrophyte species may choke out native macrophytes and other native wetland vegetation, displace wildlife dependent upon open water areas and specific native plant species, hamper recreational activities, and negatively impact the connectivity of the lake to its downstream waterways.

Various historic documentation and reports of the lake indicate that non-native/invasive nuisance vegetation has been an ongoing concern of the Laurel Lake watershed for decades. Multiple previous reports (1971, 1974 & 2002) specifically cite "extremely dense" patches and consistent

"heavy growth" of Eurasian watermilfoil (*Myriophyllum spicatum*) and Curly pondweed (*Potamogeton crispus*), which are both non-native nuisance vegetation species. The 2002 comprehensive diagnostic study of the lake, performed by Environmental Science Services, Inc., indicated that greater than 50% plant cover of invasive aquatic nuisance vegetation was observed throughout the northern, western, and southern coves of the lake. That study also states that dense beds of nuisance macrophytes dominated the majority of the littoral zone of the lake at historically high levels, during the 2002 submerged aquatic vegetations survey.

An annual lake drawdown of approximately 3' has been conducted in Laurel Lake, beginning in 2010. The main goal of the lake drawdown is the management of invasive Zebra Mussels and Eurasian watermilfoil (*Myriophyllum spicatum*). While the annual 3' drawdown has been effective at reducing nuisance vegetation levels in the 0'-3' depth range, the majority of nuisance vegetation observed in the 2021 survey was in areas between 3' - 15' of depth, where it is unaffected by the annual 3' drawdown.

Hydro-raking and hand pulling have also been utilized at several specific locations in the lake (town beaches, boat ramp, etc.) in past years; however, it appears to have had little effect on the spread of nuisance vegetation throughout the lake's littoral zone.

As stated above, aquatic nuisance vegetation has been a documented issue in Laurel Lake for at least 50 years. The Laurel Lake Preservation Association commissioned this study and report to evaluate the current distribution of both native and non-native species of submerged aquatic vegetation within Laurel Lake and analyze the various advantages and challenges of potential strategies for management of "nuisance" vegetation within the lake. In the sections below the results of the 2021 submerged aquatic vegetation survey and the potential options for management of nuisance vegetation are reviewed in further detail.

2021 SUBMERGED AQUATIC VEGETATION (MACROPHYTE) SURVEY

The 2021 submerged aquatic vegetation/macrophyte survey was conducted on October 7, 2021, by Foresight Land Services, Inc. and Biologist Thomas Coote of Otter Environmental Services. Location information of macrophyte species, shown on the Submerged Aquatic Vegetation GPS Survey Map, dated May 23, 2022, was collected in field using a sub-meter accurate handheld GPS unit and interpolated onto the attached map using computer aided drafting software.

A total of ten macrophyte species were identified and located during the October 7, 2021 survey. The native/indigenous macrophyte species identified include the following; Coontail (aka Hornwort) (*Ceratophyllum demersum*), Western waterweed (*Elodea nuttallii*), American eelgrass (*Vallisneria americana*), and Floating pondweed (*Potamogeton natans*). The non-native/invasive macrophyte species identified include the following; Muskgrass (*Chara*), Eurasian watermilfoil (*Myriophyllum spicatum*), Brittle waternymph (*Najas minor*), Curly pondweed (*Potamogeton crispus*), Waterthyme (aka Hydrilla) (*Hydrilla verticillata*), and Water chestnut (*Trapa natans*).

Both Eurasian watermilfoil (*Myriophyllum spicatum*) and Curly pondweed (*Potamogeton crispus*) were observed to be, by a large margin, the most abundant and densely growing macrophyte species present in the lake at the time of the 2021 survey. Consistent with previous macrophyte surveys of the lake; the northern, western, and southern shallow cove areas were dominated by dense and consistent beds of Eurasian watermilfoil (*Myriophyllum spicatum*) and Curly pondweed

(*Potamogeton crispus*). Also consistent with previous surveys, Eurasian watermilfoil (*Myriophyllum spicatum*) and Curly pondweed (*Potamogeton crispus*) are distributed in dense patches around the majority of the littoral zone of the lake.

An issue of particular significance is the density at which Eurasian watermilfoil (*Myriophyllum spicatum*) was growing directly in and adjacent to the mouths/inlet points of Sargent Brook and the unnamed tributary that flows into the lake at the western inlet. These patches of Eurasian watermilfoil (*Myriophyllum spicatum*) appeared to be growing at such a density they could potentially affect the flow of water into the lake.

Analysis of the 2021 collected information and previous records of macrophyte species in Laurel Lake indicates that the level of invasive/non-native "nuisance" vegetation in the lake, as well as the ratio of non-native to native macrophytes species, has risen considerable since the previous studies. This indicates that nuisance vegetation continues to displace and outcompete the native macrophytes in the lake. The continued dominance of nuisance vegetation throughout the littoral zone of the lake indicates that the nuisance vegetation issues documented by previous reports have continued to propagate and have now reached what appear to be historically high levels of non-native nuisance vegetation.

High densities of "nuisance" macrophyte species can have numerous negative impacts to a lake and its related interests. Dense growth of invasive nuisance macrophytes may choke out and displace native macrophytes and other native wetland vegetation. Dense patches of nuisance vegetation can also displace native wildlife that depend upon open and semi-open water habitats within the littoral and limnetic zones of a lake. As discussed above, extremely dense nuisance vegetation can also affect the connectivity of the water body to downstream waterways and wetland habitats that depend on the consistent flow of water from the lake. In addition to the negative ecological impacts, nuisance vegetation can hamper recreational activities on the lake.

NUISANCE VEGETATION MANAGEMENT STRATEGIES

To address the multiple negative ecological and public impacts discussed above that can result from high densities of nuisance vegetation within Laurel Lake, Foresight has reviewed several potential strategies for management of invasive nuisance vegetation in the lake. Those potential strategies include; lake drawdown, dredging, installation of benthic barriers, vegetation harvesting/hydro-raking, and chemical control (ie. herbicide/algicide). The benefits, drawbacks, and applicable regulations for each strategy are discussed below.

Aquatic vegetation management projects are subject to regulation under The Massachusetts Wetlands Protection Act (WPA) 310 CMR 10.00. Aquatic vegetation management projects must submit a WPA Notice of Intent to demonstrate that the proposed management strategy is in compliance with the general performance standards of each applicable Wetland Resource Area (Bank 310 CMR 10.54, Land Under Water Body 310 CMR 10.56, and Bordering Land Subject to Flooding 310 CMR 10.57). Certain aquatic vegetation management projects can qualify as "Limited Projects" under 310 CMR 10.53(4) *Ecological Restoration Limited Projects,* or 310 CMR 10.53(3)(l) *Water Dependent Uses.*

Aquatic vegetation management in Laurel Lake will also be subject to regulation under the Massachusetts Endangered Species Act (MESA), due to Laurel Lake being located within Natural

Heritage and Endangered Species Program (NHESP) designated Priority Habitat Area PH 1261. Aquatic vegetation management in Laurel Lake will need to be permitted through a MESA review, issued by the NHESP western regional office.

LAKE DRAWDOWN (Recommended to continue/increase drawdown depth)

The annual 3' drawdown of Laurel Lake has been effective in reducing the population of Zebra Mussels in the 0' - 3' depth range of the lake. It also appears, based on observations made in the 2021 survey, that the drawdown has reduced the amount of both Eurasian watermilfoil (*Myriophyllum spicatum*) and Curly pondweed (*Potamogeton crispus*) in the 0' - 3' depth range. The areas in deeper than 3' appear to be unaffected by the drawdown and dense beds of nuisance vegetation are present in the 3' - 15'+ depth range.

A typical lake drawdown, for the purpose of nuisance vegetation management, consists of lowering the level of the lake by a selected number of feet during the winter months. This exposes the bottom sediments and nuisance plants contained in the sediments to drying and/or freezing; effectively killing the plants and reducing the amount of nuisance vegetation that can grow in the following season. Drawdowns are particularly effective on macrophyte species that reproduce by vegetative means (root systems), such as Eurasian watermilfoil (*Myriophyllum spicatum*); however, it is not as effective on annual macrophyte species that depend on seed distribution to reproduce, such as curly and floating pondweeds. (ie. *Potamogeton crispus).*

Effectiveness – Drawdowns are typically effective in accomplishing reduction of nuisance vegetation in the areas that are exposed to drying and freezing; however, the obvious shortcoming of this approach is that it only affects the areas that are within the selected depth range of the drawdown. As stated above, the annual 3' drawdown of Laurel Lake has been effective in the 0'-3' range, but has seemingly had no affect at reducing the population of nuisance vegetation, particularly Eurasian watermilfoil (*Myriophyllum spicatum*) and Curly pondweed (*Potamogeton crispus*), in the 3' - 15'+ depth range, where it is most abundant.

Ongoing Requirements/Maintenance – The ongoing requirements of the drawdown method are minimal. An annual drawdown requires only a small amount of time and effort to successfully complete a drawdown once annually and can qualify as a Limited Project under 310 CMR 10.53(3)(m). Records of the lakes water level throughout the year should be kept.

Ecological Effect – The ecological effects of lake drawdowns are relatively minimal and non-invasive, when compared with other mechanical methods of nuisance vegetation management. Laurel Lake has sufficient depth and water volume to support a drawdown, while not adversely affecting the water dependent wildlife and surrounding Wetland Resource Areas. The annual 3' drawdown has had seemingly very little effect on the wildlife habitat of the lake, apart from the loss of nuisance vegetation and Zebra Mussels in the 0'-3' depth range. Another drawback of the drawdown method of vegetation management, is that it is indiscriminate in which species of vegetation it kills. All vegetation that depend upon their root systems for reproduction, native and non-native, in the drawdown depth range are likely to be killed off over winter. In Foresight's opinion, the potential effect of lake drawdowns on MESA protected flora and fauna species is relatively minimal when compared with other management strategies such as benthic barriers, hydro-raking, dredging, and mechanical harvesting.

Permitting & Regulations – As stated above, lake drawdown projects can be permitted under the Wetlands Protection Act, as a Limited Project per 310 CMR 10.53(3)(m). This WPA permitting process can be simpler and more likely to be approved than other methods that would be required to meet the WPA general performance standards for each applicable Wetland Resource Area. Orders of Conditions for drawdown projects can be extended by the local Conservation Commission. Utilizing the WPA Limited Project permitting pathway can simplify and speed up the environmental permitting process for aquatic vegetation management projects; however Limited Projects, as the name suggests, are very limited in their scope and do not allow deviation or additional vegetation management of any kind outside the project.

As mentioned above, Laurel Lake is also subject to regulation under the Massachusetts Endangered Species Act (MESA), because it is located within Natural Heritage and Endangered Species Program (NHESP) designated Priority Habitat Area PH 1261. Any proposed nuisance vegetation management strategy, including lake drawdowns, in Laurel Lake must be permitted through MESA review. MESA review entails an in-depth analysis of the proposed management strategy's potential effects on the native flora and fauna species MESA and NHESP recognize to inhabit the priority habitat area (PH 1261) Laurel Lake is located within. The MESA review process for lake nuisance vegetation management projects can be a lengthy and costly permitting process, depending upon the proposed management strategy. Lake drawdown projects are typically permittable under MESA review, but this process is something that must be considered for each potential management strategy.

Cost – Lake drawdowns can be a very cost-effective option for submerged aquatic vegetation management. After the investment in the initial permitting process, the cost to continue the drawdown program year after year is essentially zero. The drawdown can be performed and recorded by trained municipal employees and requires very little work beyond that.

Recommendation – Foresight recommends continuing the annual 3' drawdown of the lake to continue repressing Zebra Mussel and nuisance vegetation growth in that depth range. Foresight also recommends proposing and permitting an increase in the annual drawdown depth from 3' to 5' - 6', to increase the effective area of this management technique. As can be seen on the attached "Submerged Aquatic Vegetation GPS Survey Map", dated May 23, 2022, large dense beds of Eurasian watermilfoil (*Myriophyllum spicatum*) are present in the 3'-10' depth range in the northern, western and southern coves of the lake. An increase in the annual drawdown depth by just a few feet would vastly increase the effective area of this management technique and could potentially have a significant effect in reducing the growth of Eurasian watermilfoil (*Myriophyllum spicatum*) and Curly pondweed (*Potamogeton crispus*) in the shallow cove areas of the lake, as well as controlling the population of Zebra Mussels in that depth range.

Foresight also recommends the use of other management strategies, discussed below, in conjunction with an extended drawdown to manage those macrophyte species that are less affected by the drawdown.

DREDGING (Not recommended)

Dredging for the purpose of aquatic nuisance vegetation management typically involves the removal of nutrient rich sediments in shallow areas to deepen those areas, precluding light from penetrating to the bottom and preventing rooted macrophyte growth. Typically dredging projects target to achieve a depth of about 10' to prevent rooted macrophyte growth.

Effectiveness – Dredging is typically very effective in reducing the growth of rooted macrophytes when done properly; however, in areas exposed to incoming sediment loads, sediment is likely to build up over time and lessen the effectiveness of the dredging in those areas. Typically dredging projects target to achieve a depth of about 10' to prevent rooted macrophyte growth; however, the clear water of Laurel Lake and the presence of Eurasian watermilfoil (*Myriophyllum spicatum*) in the 10'-15' depth range, indicates that light penetrates to at least 15' depth. Therefore, in order to control rooted macrophyte growth in that range, dredging efforts would need to be increase to about 20' depth. This is problematic both from a logistical standpoint as well as financial. Not all dredging equipment is designed to dredge at such great depths, so specific dredging equipment would be needed. The need to dredge to about 20' depth also drastically increases the area that would need to be dredged, making this option extremity costly and essentially unfeasible. Transportation and containment of the dredged sediment would also be a significant obstacle for this management technique.

Ongoing Requirements/Maintenance – As stated above dredging would likely need to be a recurring practice in the areas of the lake that receive a sediment load from upstream and surrounding areas, particularly the two main inlet points of the lake, Sargent Brook and the unnamed tributary that flows into the west cove. This would be a significant ongoing expense for this management strategy.

Ecological Effect – The ecological effect of dredging is typically more significant than some other management strategies and as such, is regulated much more tightly by the Wetlands Protection Act and Massachusetts Environmental Policy Act (MEPA). Removal of nutrient rich sediment to deepen areas of a lake causes significant alteration and modification to Wetland Resource Areas. This management technique is also indiscriminate in which species of macrophytes (native and non-native) that it removes from the lake and prevents future growth. This can have a negative impact upon the native flora and fauna of the lake. This method can also cause harm to wildlife that depend upon the bottom sediment in shallow areas for shelter and food. Dredging, if not done properly, also has the potential to release/distribute significant sediment loads into the water column of the lake as it disrupts the bottom sediment. This can have a negative impact upon water quality and turbidity. It is Foresight's opinion that the potential effect of large-scale dredging on MESA protected flora and fauna species is significant when compared with other less invasive management strategies. Dredging on an effective scale would undoubtedly have a negative impact upon any protected aquatic species.

Permitting & Regulations – A large scale dredging project, like that would be necessary to control nuisance vegetation in Laurel Lake, will require the submission of a Wetlands Protection Act Notice of Intent (NOI), as well as a Massachusetts Environmental Policy Act Environmental Notification Form (ENF). There are no WPA Limited Project categories that permit large scale dredging for the control of submerged aquatic vegetation; therefore any proposed dredging would be required to meet the general performance standards for all of the applicable Wetland Resource

Areas under the Wetlands Protection Act. The quantities of Wetland Resource Areas alteration that would be required to effectively manage nuisance vegetation with dredging would be significant, making this strategy a challenge to permit. As mentioned above, the negative impacts of a dredging project of effective scale on MESA protected species would likely be significant. For this reason, it is Foresight's opinion that a dredging project of effective scale is not likely to be permitted by NHESP under the required MESA review.

Cost – A large scale dredging project, like that would be necessary to control nuisance vegetation in Laurel Lake, would be extremely costly when compared to other management strategies. Dredging to the necessary 20' depth means that a significant portion of the lake would need to be dredged to make this strategy effective at reducing rooted macrophyte growth; therefore, dredging is not a cost-effective management strategy for Laurel Lake.

Recommendation – While dredging of specific areas could potentially be effective at reducing rooted macrophyte growth in those areas, it would not be effective as an overall management strategy. Dredging of all the areas necessary to combat rooted macrophyte growth would be unduly expensive and difficult to permit. Foresight does not recommend the use of dredging for management of submerged aquatic vegetation in Laurel Lake.

BENTHIC BARRIERS (Not recommended)

Benthic barriers are negatively buoyant sheets that rest upon the lake bottom, killing the plants beneath them and preventing further growth under the barriers. Benthic barriers typically kill the plants they are placed over very quickly; however, once the barrier is moved it does not prevent regrowth in that area. Barriers are made from a variety of materials and come in different forms. Some benthic barriers are constructed out of semi-porous material to prevent gas build up under the barrier that can cause billowing and to allow some exchange of oxygen between the water and the sediment beneath the barrier. Other benthic barriers are constructed of solid non-porous material. Benthic barriers are typically very effective at killing and prevent plant growth when they function properly; however, they are often less effective in practice due to variable conditions.

Effectiveness – As stated above, benthic barriers can be very effective when applied and maintained properly. In practice they are often not 100% effective due to variable conditions of each situation. Porous material benthic barriers are not recommended for prevention of Eurasian watermilfoil (*Myriophyllum spicatum*), as watermilfoil has been documented to recolonize on porous benthic barriers and those sheets would need to be removed, cleaned and replaced regularly to be effective. Solid non-porous barriers often experience issues with gas build up, which causes billowing of the barrier, unless they are heavily anchored and properly vented. Anchoring and venting materials for benthic barriers make them difficult to maintain or move. While benthic barriers can be effective in small scale area management, the limiting factor is the cost of materials, labor, and maintenance required to cover a significant area of the lake.

Ongoing Requirements/Maintenance – Benthic barriers require consistent maintenance to be an effective method of nuisance vegetation management. Cleaning, replacement, adjustment, and moving of benthic barriers are all typically required to maintain them in effective condition. The consistent maintenance required for the use of benthic barriers contributes to the high cost of this management strategy.

Ecological Effect – Benthic barriers can have a significant ecological effect on the areas that they cover. Particularly solid/non-porous benthic barriers can have a negative impact upon the organisms that live within the benthic zone of the lake in the areas they cover. Benthic barriers can prevent the exchange of oxygen from the water trapped beneath to the surrounding water, impacting the organisms beneath the barrier. It is Foresight's opinion that the potential effect of large-scale benthic barrier use on MESA protected flora and fauna species is significant when compared with other less invasive management strategies. The use of benthic barriers on the scale necessary to control nuisance vegetation throughout Laurel Lake would undoubtedly have a negative impact upon any protected aquatic species.

Permitting & Regulations – Installation of benthic barriers typically requires the submission of a WPA Notice of Intent for the area of Land Under Water Body (310 CMR 10.56) to be covered by the barriers. There are no WPA Limited Projects for the installation of benthic barriers; therefore, installation of benthic barriers would need to comply with the general performance standards for the applicable Wetland Resource Areas. This can be a limiting factor in the use of benthic barriers to control nuisance vegetation across large areas. As mentioned above, the negative impacts of large-scale use of benthic barriers on MESA protected species would likely be significant. For this reason, it is Foresight's opinion that the use of benthic barriers to control nuisance vegetation through Laurel Lake is not likely to be permitted by NHESP under the required MESA review.

Cost – The cost and labor of the installation and continued necessary maintenance of benthic barriers is the most significant limiting factor for use as a nuisance vegetation management strategy. Use of benthic barriers over large areas (>1 acre) can be extremely costly to purchase, install and maintain. Benthic barriers can be a cost-effective solution for nuisance plant management in small specific areas, but its use to control nuisance vegetation across an approximately 178-acre lake would be unreasonable expensive. Volunteer labor and bulk purchase of materials can defray the cost per acre of this method but would still be unduly expensive when compared with other management strategies.

Recommendation – Foresight does not recommend the use of benthic barriers as an overall nuisance vegetation management strategy, due to its high cost of installation and maintenance. As stated above, benthic barriers can be a cost-effective solution for nuisance plant management in small specific areas, but its use to control nuisance vegetation across an approximately 178-acre lake would be unreasonably expensive. Foresight only recommends the use of benthic barriers for very specific small areas (such as town beaches) where they can be easily applied and maintained.

VEGETATION HARVESTING/HYDRO-RAKING (Not recommended)

Aquatic vegetation harvesting can consist of multiple plant removal techniques, such as hand pulling, manual/by hand cutting and collection, mechanical cutting and collection, suction dredging, and hydro-raking. Typically, these techniques are needed on an regular and ongoing basis to be effective at managing nuisance vegetation in the long-term. Hydro-raking has been utilized at several specific locations in the lake (town beaches, boat ramp, etc.) in past years; however, it appears to have had little effect on the spread of nuisance vegetation throughout the littoral zone of the lake.

Effectiveness – Aquatic vegetation harvesting can be an effective long-term solution to manage macrophyte species that reproduce by seed (such as Curly pondweed), when harvesting is timed

properly to eliminate the annual seed production over the course of several seasons. Harvesting is typically less effective on macrophyte species that reproduce vegetatively (such as Eurasian watermilfoil). Harvesting can also be an effective short-term strategy to mitigate nuisance vegetation for limited areas of consistent harvesting, comparable to mowing the lawn. Typical harvesting methods are not recommended for long term control of species that reproduce vegetatively (such as Eurasian watermilfoil), and can actually contribute to the spread, rather than control, of those macrophyte species. Harvesting can allow fragments of those plants, such as Eurasian watermilfoil, to be left in the water, where they float elsewhere and colonize.

Ongoing Requirements/Maintenance – As stated above, vegetation harvesting can be effective when timed properly and applied to the appropriate macrophyte species; however, harvesting does require significant ongoing labor and maintenance throughout the year and large efforts during portions of the year when it is most advantageous to harvest. Harvesting can be an effective long-term strategy for management of certain species of macrophytes, but it requires repeated and consistent harvesting efforts to be effective.

Ecological Effect – The ecological effects of aquatic vegetation harvesting are relatively minimal, as any native macrophyte species that is not the target of the harvest will be able to regrow after harvesting. Harvesting is typically only effective in long term reduction of macrophyte species that rely on seeds to reproduce. Native macrophytes that reproduce vegetatively will be generally unaffected. Harvesting of invasive macrophyte species that reproduce vegetatively can contribute to the spread of invasive species, which have a negative ecological impact. Hydro-raking has more ecological impact, due to the removal of some sediment from the bottom during hydro-raking. The potential ecological effect of hydro-raking and/or mechanical harvesting, for the purpose of aquatic nuisance vegetation management, on MESA protected flora and fauna species has been a recent topic of debate for Conservation Commissions, MassDEP, and NHESP. Foresight was recently involved in the Wetlands Protection Act and Massachusetts Endangered Species Act permitting for mechanical harvesting of aquatic nuisance vegetation within Stockbridge Bowl. The harvesting project was ultimately approved by the Stockbridge Conservation Commission and NHESP, but had to be stringently conditioned by NHESP to avoid negative impacts to protected species. This significantly limited the extent of harvesting that was permitted. The same would likely be true for a harvesting project in Laurel Lake.

Permitting & Regulations – Specific areas of vegetation harvesting can be permitted as a Wetlands Protection Act Limited Project under 310 CMR 10.53(3)(l); however this is typically limited in scope to specific proposed areas. Any harvesting or hydro-raking requires the submission of a WPA Notice of Intent. If not submitted as a Limited Project, harvesting or hydro-raking must comply with the general performance standards for the applicable Wetland Resource Areas. Public opinion on the topic of hydro-raking or harvesting can often weigh into the decision-making process of local officials, which can drastically slow the permit process. Permits for harvesting can be denied or stringently conditioned by the local Conservation Commission or NHESP and, if approved, are still subject to public appeal. All of these delays have the potential to add significant time and cost to the project, which should be considered when choosing a management strategy.

As mentioned above, Foresight was recently involved in the Wetlands Protection Act and Massachusetts Endangered Species Act permitting for mechanical harvesting of aquatic nuisance vegetation in Stockbridge Bowl. The harvesting project was ultimately approved by the

Stockbridge Conservation Commission and NHESP, but was stringently conditioned and restricted to a limited area in the process. The NHESP MESA review process also delayed the project significantly. Permitting an ongoing hydro-raking or mechanical harvesting project on Laurel Lake would likely face the same set of WPA and MESA permitting obstacles that, even if approved, are subject to public appeal.

Cost – The cost of harvesting or hydro-raking is highly dependent upon the area proposed to be harvested. It generally takes between 12 to 24 hours of work to hydro-rake about 1 acre. In addition to a hydro-raking/harvesting machine, a boat to transport removed plant biomass would likely be needed as well. Trucking cost for removal of the harvested plant biomass is another significant cost of this option. Harvesting the entire area of nuisance vegetation in Laurel Lake would be an expensive endeavor, when compared with other management strategies.

Recommendation – Foresight does not recommend the use of hydro-raking or mechanical harvesting as a long-term nuisance vegetation management strategy. The use of mechanical harvest or hydro-raking in small specific areas could be a cost-effective option for small scale, short-term management; however, the use of mechanical harvest on Eurasian watermilfoil (*Myriophyllum spicatum*) will potentially contribute to the long-term spread of the invasive species to other part of the lake associated water bodies. Harvesting can be effective to control Curly pondweed (*Potamogeton crispus*) and other macrophytes that reproduce via seed; however, Eurasian watermilfoil (*Myriophyllum spicatum*) and Curly pondweed (*Potamogeton crispus*) have been observed growing together in dense beds, so harvesting of these areas will also likely contribute to the long-term spread of Eurasian watermilfoil. Due to the high presence of Eurasian watermilfoil (*Myriophyllum spicatum*), Foresight does not recommend this management strategy in Laurel Lake.

CHEMICAL CONTROL (Recommended)

Chemical control using herbicide is a widely used and cost-effective strategy of reducing nuisance vegetation levels in freshwater ponds and lakes. Herbicide treatment for the control of nuisance vegetation, particularly Eurasian watermilfoil (*Myriophyllum spicatum*), has been an ongoing successful management practice in multiple ponds and lakes in Massachusetts. Depending on the herbicide and concentration that it is used in, herbicide treatments can be successful at controlling Eurasian watermilfoil (*Myriophyllum spicatum*) for multiple years from a single treatment. Chemical control methods can also be used in combination with other management strategies, such as a lake drawdown. EPA and MassDEP approved herbicides commonly used to control nuisance macrophytes include, Fluridone, Endothall, and Diquat.

Effectiveness – Herbicide treatment is the most effective method to control nuisance macrophytes in large bodies, such as Laurel Lake. Herbicide treatment can be easily applied to the entire target area of nuisance vegetation in a short period of time and will quickly have a significant effect upon the target species, depending upon the herbicide used. Eurasian watermilfoil (*Myriophyllum spicatum*) in particular has been successfully managed using herbicide treatment in multiple lakes throughout Massachusetts. A single treatment of the correct dosage can successfully mitigate most nuisance vegetation growth for several years. When the proper herbicide is chosen and used at the proper dosage to target the nuisance species of vegetation, herbicide treatment can successfully eliminate the majority of Eurasian watermilfoil (*Myriophyllum spicatum*) and weaken the majority of Curly pondweed (*Potamogeton crispus*) in a waterbody enough to allow native vegetation that

is less affected by the herbicide to recolonize those areas previously dominated by invasive nuisance vegetation. The effectiveness of herbicide treatment also depends upon the exchange rate of the body of water. When used in conjunction with a lake drawdown, the timing of the herbicide treatment is of critical importance, to ensure the herbicide treatment has ample time to take an effect and is not rapidly washed downstream.

Ongoing Requirements/Maintenance – One of the benefits of chemical herbicide treatment for the control of nuisance vegetation is the low need for reoccurring maintenance. Typically, an initial treatment of herbicide, with 1-2 follow up treatments depending on the exchange rate of the body of water, when correctly applied can reduce/eliminate nuisance vegetation growth for up to three years. Repeat treatments, depending upon the herbicide chosen, would likely be needed on a 3-4 year cycle to maintain control over the nuisance vegetation growth. Monitoring of the herbicide active ingredient levels in the lake would likely be an ongoing requirement.

Ecological Effect – The ecological effects of herbicide treatment is a subject that tends to generate controversy and debate among communities developing aquatic nuisance vegetation management plans. This likely stems from the many pesticides (herbicides are a subset of all chemicals known as pesticides) that were widely used in the past, then later linked to environmental and human health issues and subsequently banned from further use. Despite the past issues with certain herbicides, there are EPA and MassDEP approved chemical treatment options for the control of nuisance vegetation. The ecological and health effects of these approved chemical treatments have been thoroughly researched and extensive information is provided to the public on this matter by MassDEP. Depending on the herbicide chosen for use and the dosage at which it is used, in general, concentrations of these herbicides that are sufficient to manage nuisance vegetation, are not toxic to invertebrates, fish, birds, mammals or humans. For more information regarding the EPA and MassDEP approved chemicals suitable for aquatic vegetation management please visit: https://www.mass.gov/lists/aquatic-herbicide-active-ingredients

The potential ecological effect of herbicide treatment, for the purpose of aquatic nuisance vegetation management, on MESA protected flora and fauna species has been a recent topic of debate for the concerned public, Conservation Commissions, MassDEP, and NHESP. As mentioned above, used in the proper dosage, EPA and MassDEP approved herbicide treatments for aquatic vegetation management are not shown to have negative effects on wildlife, including MESA protected species. The Stockbridge Bowl Association is in a multi-year process of herbicide treatment to mitigate the presence of Eurasian watermilfoil (*Myriophyllum spicatum*), and monitor the herbicides effect on two MESA protected species populations, the Bridle shiner (*Notropis bifrenatus*) and the Pilsbry's spire snail (*Marstonia lustrica*), in specific test plots throughout Stockbridge Bowl.

Permitting & Regulations – Aquatic nuisance vegetation management using herbicide requires the submission of a WPA Notice of Intent to the local Conservation Commission, MassDEP, and NHESP. Management of aquatic nuisance vegetation for the purpose of "*Improving the Natural Capacity of a Resource Area*" can potentially be permitted as a Limited Project under 310 CMR 10.53(4), provided that it "*will improve the natural capacity of a Resource Area(s) to protect the interests identified in M.G.L. c. 131, § 40*". This WPA permitting process can be far simpler and more likely to be approved than other methods that would be required to meet the WPA general performance standards for each applicable Wetland Resource Areas. If management of nuisance

vegetation using chemical control can not fit the criteria of 310 CMR 10.53(4) Limited Project section, it must comply with the general performance standards for all the applicable Wetland Resource Areas. Further investigation of the Laurel Lake watershed and the potential downstream impacts of herbicide treatment would likely be needed to permit chemical treatment. As mentioned above, public opinion on the topic of herbicide treatment can often weigh into the decision-making process of local officials, which can drastically slow the permit process of herbicide treatment projects.

As mentioned above, The Stockbridge Bowl Association is in the process of herbicide treatment to mitigate the presence of Eurasian watermilfoil (*Myriophyllum spicatum*), while monitoring the populations of two MESA protected species; the Bridle shiner (Notropis bifrenatus) (a MESA protected native fish species), and the Pilsbry's spire snail (Marstonia lustrica) (a MESA protected native snail species). The same management principles could likely be applied to Laurel Lake to manage nuisance vegetation while protecting and monitor native MESA protected flora and fauna populations. Permits for herbicide treatment can be denied or stringently conditioned by the local Conservation Commission, MassDEP and particularly NHESP and, if approved, are still subject to public appeal. All of these delays have the potential to add significant time and cost to the project, which should be considered when choosing a management strategy.

Cost – Chemical control using herbicide treatment is the most cost-effective strategy to manage nuisance vegetation across the entire lake. When compared to the cost and labor of mechanical harvest, hydro-raking, benthic barrier, and dredging, chemical control is far cheaper and requires less labor to be an effective long-term management strategy. When used in conjunction with a lake drawdown, chemical control can be particularly cost effective.

Recommendation – Foresight recommends chemical control as the main strategy of nuisance vegetation management in Laurel Lake. The chemical control, through the use of herbicide, should be utilized in conjunction with the existing (or greater depth) lake drawdown. The use of herbicide is by far the most cost-effective strategy for long-term management of nuisance vegetation, particularly Eurasian watermilfoil (*Myriophyllum spicatum*).

TABULAR MATRIX OF SUBMERGED AQUATIC VEGETATION MANAGEMENT STRATEGIES IN LAUREL LAKE						
		POTENTIAL MANAGEMENT STRATEGIES				
***EVALUATION CRITERIA**		**Lake Drawdown**	**Dredging**	**Benthic Barriers**	**Harvesting/ Hydro-raking**	**Chemical Control**
	Effectivenss	3	3	2	2	3
	Ongoing Maintenance	3	1	1	1	2
	Ecological Effect	2	1	1	2	2
	Permitting & Regulations	2	1	1	2	3
	Cost	3	1	1	2	3
	TOTALS	**13**	**7**	**6**	**9**	**13**

* 1 = Lowest Benefit, 2 = Medium Benefit, 3 = Highest Benefit

ONGOING MANAGEMENT STRATEGY RECOMMENDATIONS

For the management of submerged aquatic nuisance vegetation in Laurel Lake, Foresight recommends a two-prong approach; including an approximately 5’ - 6’ annual drawdown of the lake in conjunction with chemical control in the form of herbicide treatment. Foresight recommends the continuance of the existing annual drawdown, while submitting the necessary Wetlands Protection Act and MESA permitting to increase the drawdown depth to approximately 5’ - 6’ and permit the use of herbicide treatment in the lake.

The existing 3’ drawdown has been successful at reducing the population of nuisance vegetation in the 0’-3’ depth range. The majority of the nuisance vegetation observed during the 2021 survey was located within the 3’-15’ depth range; therefore increasing the drawdown depth to 5’ - 6’ will have a significant effect upon a far larger area of nuisance vegetation. Significant areas of the northern, western, and southern coves are approximately 5’ deep; therefore increasing the depth of the drawdown to 5’ - 6’ would increase the effective management area to include large portions of the northern, western and southern coves. The herbicide treatment should be timed for when the lake is in a drawdown state. This will help minimize the amount of herbicide that is necessary to use, as well as help prevent loss of the herbicide concentration to downstream flow.

The use of herbicide treatment timed properly with the lake drawdown will be a cost-effective and efficient strategy of managing the remaining nuisance vegetation in the lake. Past examples of Eurasian watermilfoil (*Myriophyllum spicatum*) management using herbicide treatment have been particularly successful. EPA and MassDEP approved herbicides commonly used to control nuisance macrophytes include, Fluridone, Endothall, and Diquat.

Foresight has provided the above Tabular Matrix of Submerged Aquatic Vegetation Management Strategies in Laurel Lake for the purpose of summarizing the analysis of this report and the recommendations herein in a simple table format, to aid in the Laurel Lake Preservation Association’s decisions regarding nuisance vegetation management in Laurel Lake.

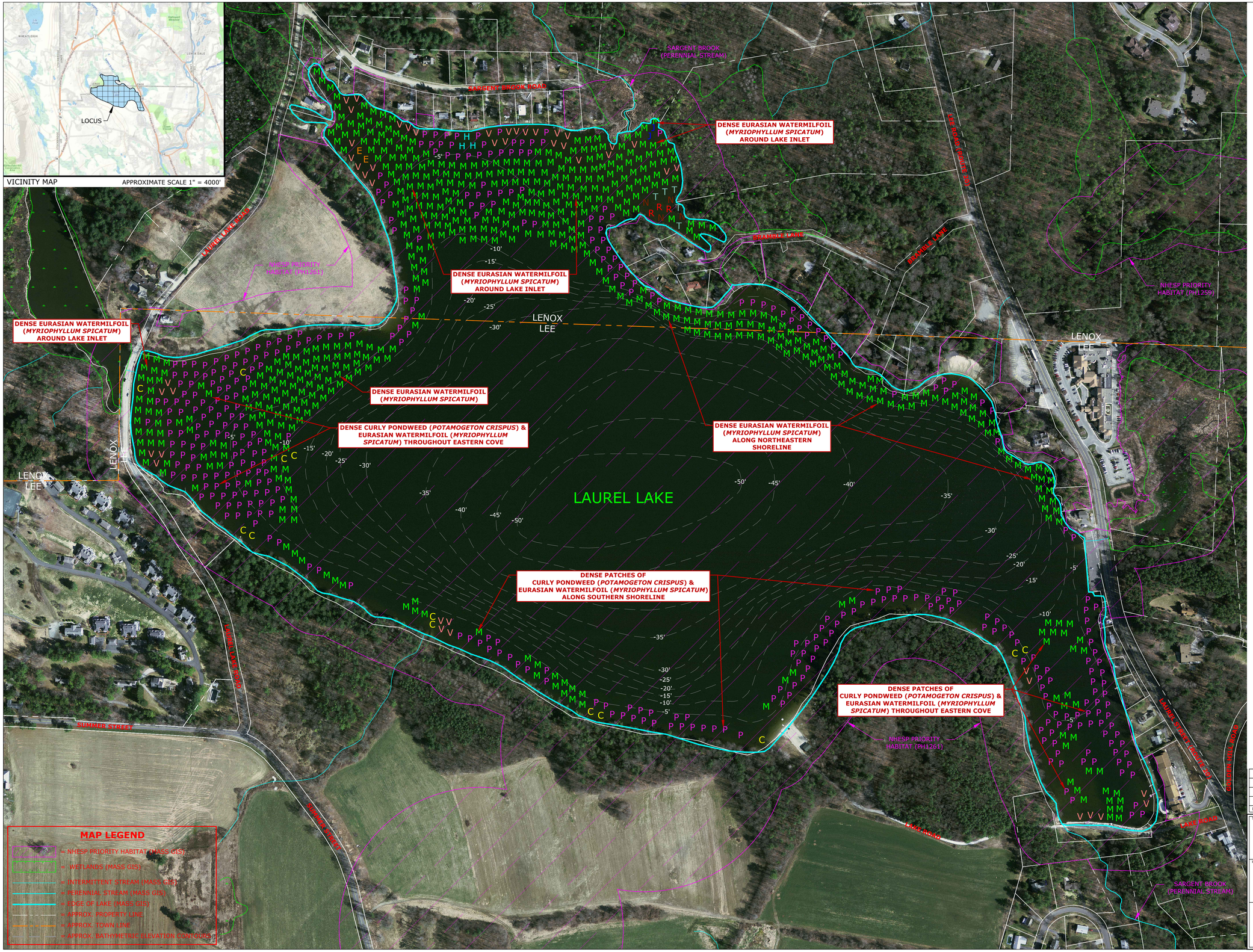
We trust the information contained within this letter will be sufficient to provide the Laurel Lake Preservation Association with the information necessary to make decision regarding nuisance vegetation management in the lake; however, please feel free to contact Foresight with any further questions on this matter.

Very truly yours,
Foresight Land Services, Inc.

Steven A. Mack, P.E.
Principal Engineer & Project Manager

Jackson T. Alberti
Environmental Analyst

Attachments: "Submerged Aquatic Vegetation GPS Survey Map", dated May 23, 2022,
Tabular Matrix of Submerged Aquatic Vegetation Management Strategies in Laurel Lake



GENERAL NOTES ABOUT COMPILED SITE PLAN BASE MAP:
The site plan base map is compiled from available sources and is not the result of a recent field survey. Compiled information includes MassGIS (Office of Geographic and Environmental Information, Commonwealth of Massachusetts Office of Environmental Affairs) Aerial Photos, FEMA flood maps, and other published sources. Property lines are compiled from deeds, record surveys and assessors mapping. Utilities are from available plans, records and direct observation.

The bathymetric topography of Laurel Lake is based upon approximate bathymetric data available from the Massachusetts Division of Fisheries & Wildlife.

All compiled information is approximate only and is subject to field verification and change.

NOTES REGARDING GPS VEGETATION SURVEY:
The location and quantity information of aquatic vegetation within Laurel Lake contained within this map was collected in field on October 7, 2021 using a handheld GPS unit. The location information collected using the GPS unit in field should be considered approximate only.

SUBMERGED AQUATIC VEGETATION LEGEND

NON-NATIVE
- **M** = Eurasian watermilfoil (*Myriophyllum spicatum*)
- **P** = Curly pondweed (*Potamogeton crispus*)
- **T** = Water chestnut (*Trapa natans*)
- **H** = Waterthyme/Hydrilla (*Hydrilla verticillata*)
- **J** = Brittle waternymph (*Najas minor*)
- **R** = Muskgrass (*Chara*)

NATIVE
- **V** = American eelgrass (*Vallisneria americana*)
- **C** = Hornwort/Coontail (*Ceratophyllum demersum*)
- **N** = Floating pondweed (*Potamogeton natans*)
- **E** = Western waterweed (*Elodea nuttallii*)

NO.	DATE	REVISION/ISSUE	BY

SHEET TITLE: LAUREL LAKE SUBMERGED AQUATIC VEGETATION - GPS SURVEY MAP

PROJECT TITLE: LAUREL LAKE PRESERVATION ASSOCIATION
Laurel Street (Route 20)
Lee, MA.

PROJECT NO.: E2962
SCALE: 1" = 200'
DATE: 5/23/2022
DESIGNED BY: JTA
DRAWN BY: JTA
CHECKED BY:
SHEET NO.: AV-1
OF SHEETS:
DRAWING NO.: E2962COMP

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