**PURCHASING DIVISION**
**CITY OF WORCESTER**
**MASSACHUSETTS 01608-1895**
**ROOM 201 - CITY HALL, 455 Main Street**
**PHONE (508) 799-1220**

**SEALED BID INVITATION**
**(Supplies, Material, Equipment, Services)**

**AN EQUAL OPPORTUNITY AFFIRMATIVE ACTION EMPLOYER**

| |
|---|
| **SEALED BID NO. 8040-W4** |
| |
| **DATE: June 14, 2023** |
| **CITY OF WORCESTER**<br>**Christopher J. Gagliastro, MCPPO**<br>**Purchasing Agent** |
| **BUYER: Christopher Gagliastro** |

NOTICE TO BIDDERS
TERMS AND CONDITIONS

All bids are subject to the terms and conditions and specificity herein set forth except where specifically deleted by the City of Worcester in Section No. 6 below.

**COMPLETE ORIGINAL COPY (including ALL pages) OF THIS BID MUST BE SUBMITTED IN A SEALED ENVELOPE**:

DATE: JULY 5, 2023 TIME: 10:00 A.M. LOCAL TIME

PLACE: Purchasing Division, Room 201, City Hall, Worcester, Massachusetts

MARK SEALED ENVELOPE **"Sealed Bid No. 8040-W4, Vegetation Management – Lake Quinsigamond / DSR"**

The name and address of the bidder must appear in the upper left hand corner of the envelope. The City of Worcester is not responsible for bids not properly marked.

## GENERAL

1. This Bid Invitation covers: provide invasive vegetation management services at Lake Quinsigamond as per the requirements and specifications of the City of Worcester Department of Sustainability & Resilience.

2. A certified check or bid bond made payable to the "City Treasurer, City of Worcester" in the Amount of $ N/A must accompany this bid.

3. All bids received will be publicly opened and read in the Bid Room at City Hall at date and time shown above. **NO BID WILL BE ACCEPTED AFTER TIME AND DATE SPECIFIED**

4. A performance bond in the amount of $ N/A of the total dollar award is required.
5. A payment bond in the amount of $ N/A of the total dollar award is required.

6. All terms and conditions are applicable to this proposal except the following section numbers which are hereby deleted from this invitation: all apply

7. **Other: Please go to http://www.worcesterma.gov/e-services/bids/closed-bids to obtain results.**

   **Questions pertaining to this bid must be directed to Christopher J. Gagliastro via e-mail at gagliastroc@worcesterma.gov**

8. The following meanings are attached to the defined words when used in this bid form.
   (a) The word "City" means The City of Worcester, Massachusetts.
   (b) The word "Bidder" means the person, firm or corporation submitting a bid on these specifications or any part thereof.
   (c) The word "Contractor" means the person, firm or corporation with whom the contract is made by carrying out the provisions of these specifications and the contract.
   (d) The words "Firm Price" shall mean a guarantee against price increases during the life of the contract.

9. Any prospective bidder requesting a change in or interpretation of existing specifications of terms and conditions must do so within five (5) days (Saturdays, Sundays and Holidays excluded) BEFORE scheduled bid opening date. All requests are to be in writing to the Purchasing Division (or e-mailed at: gagliastroc@worcesterma.gov). No changes will be considered or any interpretation issued unless the request is in our hands within five (5) days (Saturdays, Sundays and Holidays excluded) BEFORE scheduled bid opening date.

10. The contractor will be required to indemnify and save harmless the City of Worcester, for all damages to life and property that may occur due to his negligence or that of his employees, subcontractors, etc., during this contract.

11. The Contract Agreement will be in the form customarily employed by the City of Worcester and is on file in the Purchasing Division at City Hall.

12. Bids which are incomplete, not properly endorsed, or signed, or otherwise contrary to these instructions will be rejected as informal by the Purchasing Agent. **Conditional bids will not be accepted.**

13. The Bidder must certify that no official or employee of the City of Worcester, Massachusetts is pecuniarily interested in this proposal or in the contract which the bidder offers to execute or in expected profits to arise therefrom, unless there has been compliance with provisions of G.L. C. 43 Sec. 27, and that this bid is made in good faith without fraud or collusion or connection with any other person submitting a proposal.

14. As the City of Worcester is exempt from the payment of Federal Excise Taxes and Massachusetts Sales Tax, prices quoted herein are not to include these taxes.

15. All prices are to be firm F.O.B. Destination, City of Worcester, Massachusetts, unless otherwise indicated by the City. **Time reserved for award is ninety days.**

16. In case of error in the extension prices quoted herein, the unit price will govern.

17. It is understood and agreed that should any price reductions occur between the opening of this bid and delivery of any order, the benefit of all such reductions will be extended to the City.

18. The City of Worcester reserves the right to reject any and all bids, wholly or in part, and to make awards in a manner deemed in the best interest of the City.

19. Awards will be made to the bidder quoting the lowest net price in accordance with the specifications.

20. The supplier will be bound by all applicable statutory provisions of law of the Federal Government, the Commonwealth of Massachusetts, the City of Worcester, and the Department of Public Safety of the Commonwealth of Massachusetts.

21. Any bid withdrawn after time and date specified, the bidder shall forfeit deposit on bid as liquidated damages.

22. The contractor will not be permitted to either assign or underlet the contract, not assign either legally or equitably any monies hereunder, or its claim thereto without the previous written consent of the City Treasurer and of the Purchasing Agent of the City of Worcester.

23. If this bid shall be accepted by the City, and the bidder shall fail to contract as aforesaid and to give a bond in the amount as specified in Section 4, within ten (10) days, (not including Sunday or a legal Holiday) from the date of the mailing of a notice from the City to him/her, according to the address given herewith, that the contract is ready for signature, the City may by option determine that the bidder has abandoned the contract and thereupon the proposal and acceptance shall be null and void and the bid security accompanying this proposal shall become the property of the City as liquidated damages.

24. When quoting, the bidder shall submit a signed copy of this bid form, and if bid accepted by the City shall constitute part of the contract of purchase. Do not detach any part of this form 30B (Sealed Bid Goods & Services) when submitting a bid. Bidder must sign and return complete form 30B (Sealed Bid Goods & Services).

25. If in the judgment of the Purchasing Agent any property is needlessly damaged by an act or omission of the contractor or his/her employees, servants or agent, the amount of such damages shall be determined by the Purchasing Agent of the City of Worcester and such amount shall be deducted from any money due the contractor or may be recovered from said contractor in actions at law.

26. It is agreed that deliveries and/or completion are subject to strikes, lockouts, accidents and/or Acts of God.

**INSURANCE AND WORKER'S COMPENSATION**

27. COMMERCIAL GENERAL LIABILITY INSURANCE: Contractor to supply the City of Worcester with certificates of insurance evidencing general liability coverage of not less than $ 1,000,000.00 per occurrence / $ 2,000,000.00 aggregate.

28. AUTOMOBILE LIABILITY INSURANCE: Contractor to supply the City of Worcester with certificates of insurance evidencing automobile liability coverage, bodily injury and property damage combined single limit, of $ 1,000,000.00 (all owned, hired, and non-owned autos).

29. COMPENSATION INSURANCE: The contractor shall furnish the City of Worcester with certificates showing that all of his/her employees who shall be connected with this work are protected under statutory worker's compensation insurance policies.

30. The Contractor shall carry public liability insurance with an insurance company satisfactory to the City so as to save the City harmless from any and all claims for damages arising out of bodily injury to or death of any person or persons, and for all claims for damages arising our of injury to or destruction of property caused by accident resulting from the use of implements, equipment or labor used in the performance of the contractor or from any neglect, default or omission, or want of proper care, or misconduct on the part of the Contractor or for anyone of his employ during the execution of the contract.

31. Prior to starting on this contract, the Contractor shall deposit with the Contracting Officer certificates from the insurer to the effect that the insurance policies required in the above paragraphs have been issued to the Contractor. The certificates must be on a form satisfactory to the Purchasing Agent.

32. Except as may otherwise be stated herein, the Contractor shall also carry bodily injury and property damage insurance in an amount not less than those set forth above covering the operation of all motor powered vehicles owned or operated by the Contractor and engaged in this contract.

**DISCOUNT**

33. Prompt pay discounts will be considered when determining the low bid except when discounts are for a period of less than 30 days. In this event discounts will not be taken into consideration when determining low bid.

34. Time, in connection with discount offered, will be computed from date of completion and/or delivery and acceptance at destination, or from date correct bill or voucher properly certified by the contract is received if the latter date is later than the date of completion and acceptance and/or delivery and acceptance.

**GUARANTEE**

35. The bidder to who a contract is awarded guarantees to the City of Worcester all equipment, materials and or workmanship for a period of one (1) year after final inspection and acceptance and shall replace promptly any defective equipment, materials and/or workmanship required without additional cost to the City.

**DELIVERIES AND COMPLETION**

36. It is understood and agreed that in the event of failure on the part of the bidder to indicate date of delivery and/or completion, delivery and/or completion will be made within twelve (12) days from date of notification. Should the successful bidder fail to make delivery or complete contract within time specified, the City reserves the right to make the purchase on such orders at the open market and charge any excess over contract price to the account of the successful bidder, who shall pay the same.

37. The contractor shall familiarize himself with the location and facilities for storage.

38. The City through its Purchasing Division reserves the right to divert delivery from one location to another, and to allow for any change in operating conditions or for any other cause not now foreseen and to proportion deliveries according to available storage facilities.

**SAMPLING AND ANALYSIS**

39. Each bidder must state the commercial name of the product quoted, name, and address of operator or agent from whom the product will be purchased and in addition shall furnish an analysis of the product, date of analysis, by whom made and their address.

40. Samples of the product to be delivered may be taken by a representative of the City, either prior to delivery or while it is being delivered in the storage facilities at destination, or will be taken from the storage facilities to which the product has been delivered as determined from time to time by the Purchasing Agent. Bidder agrees to furnish the necessary manual labor, without additional cost required to assemble the physical samples, which is to be performed under the direction of the City representative.

41. The representative of the City taking the samples shall be given the opportunity, while sampling, to affix his or her signature to the delivery slip each item represented in his/her sample.

42. Any product after the sampling and analysis, not found meeting the requirements of the contract shall be sufficient cause for the cancellation of the contract at the option of the Purchasing Agent.

43. If any product is found that does not meet the analysis submitted by the bidder in his/her proposal, the Purchasing Agent may, at his or her option, exercise his/her right to reject the product and require that all or any part thereof shall be removed promptly by and at the expense of the contractor and replace it forthwith with a product satisfactory to the Purchasing Agent, or to retain the product and compensate the contractor in an amount as determined by the Purchasing Agent and the City Manager.

44. It is understood and agreed that it shall be a material breach of any contract resulting from this bid for the Contractor to engage in any practice which shall violate any provisions of Massachusetts General Laws, Chapter 151B, relative to discrimination in hiring, discharge, compensation, or terms, conditions or privileges of employment because of race, color, religious creed, national origin, sex, age or ancestry.

45. The undersigned as bidder, declares that the only parties interested in this proposal as principals are named herein; that this proposal is made without collusion with any other person, firm or corporation, that no officer or agent of the City is directly or indirectly interested in this bid; and he/she proposes and agrees that if this proposal is accepted he/she will contract with the City in accordance with the specifications, also the terms and conditions as spelled out in this bid form.

46. No Person, including but not limited to corporations, partnerships, limited partnerships or limited liability corporations, shall be eligible to receive a contract under this invitation to bid and/or requires for proposal if that person has been convicted of any felony offense involving the distribution of controlled substances as that term is defined under Chapter 94C of the General Laws and, for contracts to be performed for on-site services to the Worcester Public Schools, if that person or any person to be employed by that person in the performance of such on-site services has been convicted of a “sex offense” or a “sex offense involving a child” or a “sexually violent offense” or would meet the definition of “sexually violent predator” as those terms are defined in Section 178C of the General Laws and who must register with the sex offender registry board.

47. The Contractor shall at all times enforce strict discipline and good order among his employees and shall not employ for work or services relating to this contract any unfit person or anyone not skilled in the task assigned to him. In light of the fact that the performance of this contract requires the Contractor and its employees to have significant interaction

with the public, the Contractor shall require all employees who may perform services under this contract to conduct themselves in a courteous, professional manner. If the Contractor is notified by the Contract Officer that any person engaged upon the work is incompetent, unfaithful, disorderly, discourteous, or otherwise unsatisfactory, then such person shall be discharged from providing services or work pursuant to this contract. Without limiting the generality of the foregoing, intimidation, threats and/or violent conduct of any kind or nature directed to members of the public are absolutely prohibited. Failure to comply with this requirement shall be grounds for termination of the contract.

48. The Contractor's performance may be evaluated on an ongoing basis including but not limited to consideration of complaints received from members of the public. In order to facilitate this evaluation, the Contractor shall provide the City with documents and records upon request. The Contractor shall further obtain from its employees authorization that appropriate City personnel may obtain all available criminal offender information ("CORI") from the Criminal History Systems Board. A high number of unresolved complaints, any number of complaints that are particularly severe, or employment of individuals who have been convicted or assault or other violent crimes shall be grounds for the early termination or non-renewal of the contract by the City.

49. The procurement officer shall award the contract to the lowest responsible and responsive bidder. The term "responsible bidder" means "a person who has the capability to perform fully the contract requirements, and the integrity and reliability which assures good faith performance." Consistent with its duty to maintain public order and promote public safety, the City has determined that this contract is of a type and nature so as to be particularly sensitive due, at least in part, to the contractor's inherent access and dealings with the members of the general public. Therefore, the City has concluded that additional scrutiny is justified as it determines whether a particular bidder is responsible, having the integrity and reliability to properly perform the requested services. This may entail consideration of the contractor's system of oversight, training and supervision of its employees, including but not limited to its requirement of a high standard of customer service and courtesy in its dealings with the public. The bidder's care and diligence in hiring and assigning its employees will also be considered. In making its determination, the City reserves the right to examine any and all information at its disposal, including but not limited to prior City contracts, the experiences and information obtained from current and former customers (whether identified by the bidder as references or not), as well as other sources available to the City, including but not limited to court documents, newspapers, financial reports (such as DUNS), and certain police data and reports.

50. The Contractor, acting through its owner(s) or any of its employees, or its agents or sub-contractors and any of their employees, shall not engage in any behavior, whether during the course of its duties under this contract or at any other time, that is illegal, criminal or otherwise shocking or offensive to the general public. The determination whether any particular behavior is illegal, criminal or shocking to the general public shall rest in the sound judgment of the Contracting Officer or the City Manager. In making such determination, the Contracting Officer or the City Manager shall apply the general standards of the community. No criminal conviction or formal charges shall be required to make such determination. Such behavior need be something more than trivial and something which would cause the general public to have concerns either about the safety of individuals coming in contact with the Contractor or about the character and integrity of the individuals with which the City does business. Violation of this provision shall be grounds for immediate and unilateral termination of this contract by the City upon five days' notice as otherwise provided herein

GIVE FULL NAMES AND RESIDENCES OF ALL PERSONS INTERESTED IN THE FOREGOING PROPOSAL.

(NOTICE: Give first and last name in full; in case of corporations, give corporate name and names of President, Treasurer, and Manager; and in case of firms give names of the individual members)

Name Address Zip Code

_____

_____

_____

_____

KINDLY FURNISH THE FOLLOWING INFORMATION REGARDING BIDDER:

(1) If a Proprietorship

Name of Owner _____

Business Address _____

Zip Code _____ Telephone No. _____

Home Address _____

Zip Code _____ Telephone No. _____

(2) If a Partnership
Full names and addresses of all partners

Name Address Zip Code

_____

_____

_____

Business Address _____Zip Code _____

Tel. No. _____

(3) If a Corporation

Full Legal Name _____

State of Incorporation _____ Qualified in Massachusetts ? Yes _____ No _____

Principal Place of Business _____
Street P.O. Box

_____
City/Town State Zip

Telephone No. _____

Place of Business in Massachusetts _____
Street P.O. Box

_____
City/Town State Zip

Telephone No. _____

GIVE THE FOLLOWING INFORMATION REGARDING SURETY COMPANY

Full Legal Name of Surety Company _____

State of Incorporation _____ Admitted in Massachusetts ? Yes _____ No _____

Principal Place of Business _____
Street P.O. Box

_____
City/Town State Zip

Place of Business in Massachusetts _____
Street P.O. Box

_____
City/Town State Zip

Telephone No. _____

NOTE
The Office of the Attorney General, Washington, D.C. requires the following information on all bid proposals amounting to $1,000.00 or more.

F.I.D. Number of bidder _____

This number is regularly used by companies when filing their "EMPLOYER'S FEDERAL TAX RETURN, U.S." Treasury Department Form 941.

AUTHORIZED SIGNATURE OF BIDDER _____ TITLE _____
PLEASE SIGN

DATE _____ BID SECURITY $_____

The name of Customer Service Representative and the Contract Administrator responsible for servicing this account in the event of contract award are:

_____ _____
NAME (PLEASE PRINT) *Customer Service Rep.* TEL. NO.

_____ _____
NAME (PLEASE PRINT) *Contract Administrator* TEL. NO.

**FAX NUMBER** **FAX #** _____

**E-MAIL (Customer Service Rep.):** _____

**E-MAIL (Contract Administrator):** _____

UNDER MASSACHUSETTS GENERAL LAWS, CHAPTER 30B: SECTION 10, THE FOLLOWING CERTIFICATION MUST BE PROVIDED:

Section 10. A person submitting a bid or a proposal for the procurement or disposal of supplies, or services to any governmental body shall certify in writing, on the bid or proposal, as follows:

" The undersigned certifies under penalties of perjury that this bid or proposal has been made and submitted in good faith and without collusion or fraud with any other person. As used in this certification, the word "person" shall mean any natural person, business, partnership, corporation, union, committee, club, or other organization, entity, or group of individuals."

(Please Print) _____
Name of Person Signing Bid

_____
Signature of Person Signing Bid

_____
Company

**No award will be made without vendor certification of the above.**

Bidders must state and identify the product offered, such as manufacturer's name, trade name, brand name and quality next to each item. WE MUST KNOW WHAT HAS BEEN OFFERED.

The quantities shown herein are estimated only and the Contractor will be required to furnish all quantities ordered by the City during the period of the contract.

YES X NO_____

Delivery to be made to: _Worcester, MA

This Bid includes addenda numbered _____

**NO PRICE ADJUSTMENTS ALLOWED. PRICES QUOTED ARE FINAL. CHECK BEFORE SIGNING!**

**BIDDER TO COMPLETE ITEMS BELOW**

| Item No. | Estimated Quantity | Description | Mfg. | Model No. | Unit Price | Total Amount |
|---|---|---|---|---|---|---|
| | | **Provide invasive vegetation management services at Lake Quinsigamond per the attached requirements and specifications of the City of Worcester Department of Sustainability & Resilience**<br><br>**Award to be made in the aggregate. Must bid all items.**<br><br>**Any and all questions regarding this bid must be directed to Chris Gagliastro at gagliastroc@worcesterma.gov** | | | | **See pricing pages** |

**TERMS, PROMPT PAY DISCOUNT _____% 30 DAYS, NET 45 DAYS.**

**DELIVERY AND/OR COMPLETION TO BE MADE WITHIN as required by the City_ DAYS FROM DATE OF NOTIFICATION BY THE CITY.**

**NAME OF BIDDER_____**

**Worcester Lakes and Ponds Invasive Aquatic Plant Control**
**Specifications for Management at Lake Quinsigamond**

OVERVIEW

The City of Worcester Department of Sustainability and Resilience (DSR) seeks a qualified Contractor to manage invasive aquatic vegetation in the northern portion of Lake Quinsigamond (Management Zone A) in Worcester, Massachusetts. The Contractor will treat the invasive aquatic plants Fanwort *(Cabomba caroliniana)*, Eurasian Milfoil (*Myriophyllum spicatum),* and Variable Leaf Milfoil (*Myriophyllum heterophyllum)*, using herbicide applications. Determination of necessity will be made in collaboration with Worcester DSR.

DSR will be responsible for obtaining approvals from the Worcester, Shrewsbury, and Grafton Conservation Commission under the Massachusetts Wetlands Protection Act.

**TASK BREAKDOWN**

The Contractor will perform the following tasks on a directed basis:

(1) ***Cabomba caroliniana*** **Treatment:** Chemical treatment with flumioxazin about 6 acres of *Cabomba carolinian* as indicated in Figure A.

(2) ***Myriophyllum spicatum*** **and** ***Myriophyllum heterophyllum*** **Treatment:** Chemical treatment with Florpyrauxifen-benzyl of about 25 acres of *Myriophyllum spicatum* and *Myriophyllum heterophyllum* as indicated in figures B & C.

Bidders should include their prices the total and per-acre costs of Tasks (1) & (2).

**PROBLEM IDENTIFICATION/HISTORY**

Lake Quinsigamond is listed on the Massachusetts Impaired Waters 303d List as Category 4a for: Non-native aquatic plants, *Enterococcus* bacteria, excess algal growth and low dissolved oxygen. It received a Total Maximum Daily Load (TMDL), a “nutrient budget”, in 2002 for phosphorus. At that time, it was suggested that management plans be created to achieve 200 days supply of oxygen in the hypolimnion (deep, colder layer) during the summer months. The TMDL also identified Flint Pond, the southern section of Lake Quinsigamond, as being impaired for turbidity, because it had an average Secchi transparency of below 4 feet, which is both an ecological health and human recreational safety concern. Additionally, the lake is host to at least six invasive aquatic plants, including Eurasian Milfoil (*Myriophyllum spicatum*)*,* Variable Leaf Milfoil (*Myriophyllum heterophyllum*), Fanwort (*Cabomba carolinianais*), Brittle Naiad (*Najas minor*), Curly Leafed Pondweed (*Potamogeton crispus*), Water Chestnut (*Trapa natans*) and Sacred Lotus (*Nelumbo nucifera*). It also hosts the invasive mollusk, *Corbicula fluminea.*

The Lake Quinsigamond Commission (LQC) began to implement an invasive aquatic plant management plan in 2018 in order to reduce the density of six invasive aquatic plants that were identified by a survey the previous year. Management activities include an annual 3-foot drawdown of the lake, as well as chemical treatment with herbicides, though these treatments are complicated by the presence of an endangered pondweed that also resides in the lake. As of 2021, Water Chestnut was identified in several regions of the lake, resulting in several community run Water Chestnut hand-

pulling events throughout the summer of 2022. Management of the lake is complicated by the fact that the lake hosts a rare plant, *P. vaseyi.* Previously, in order to reduce potential impact to this plant by herbicides, the lake was divided into three management zones: A, B, and C (see attachment). Zone A is the northern potion of the main lake, from “The Narrows” North to the Main Street culvert. Zone B stretched from the Narrows south to Rt 20, and Zone C is Flint Pond.

In 2023, the Management of Lake Quinsigamond was split between the City of Worcester and the Lake Quinsigamond Commission (LQC) for billing and logistics purposes. The present bid specifications targets Management Zone A and are being released at approximately the same time as the bid specs from LQC.


*Figure A: Map of Fanwort infestation to be treated with flumioxazin.*

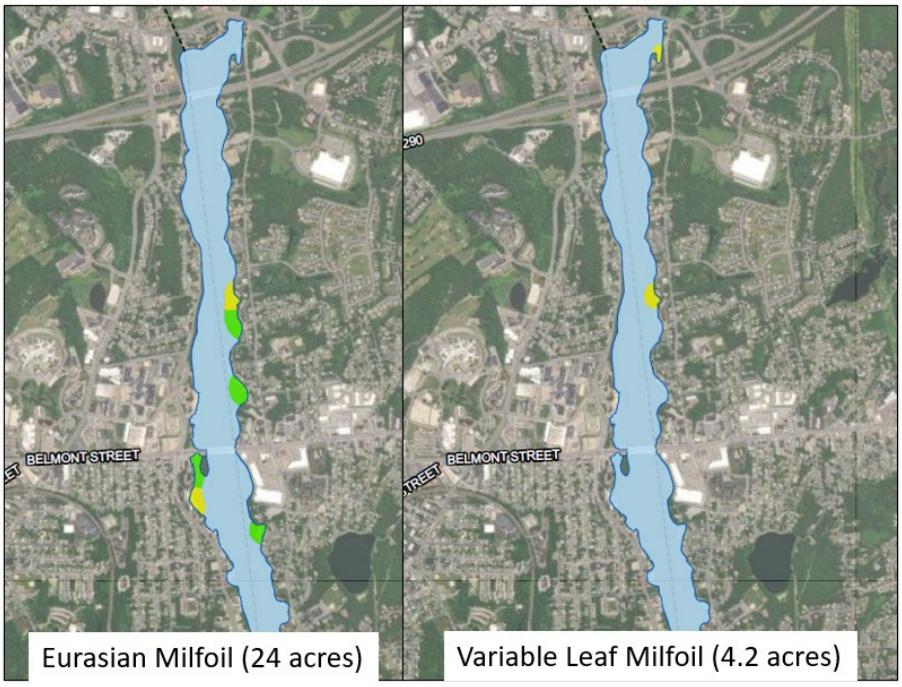



*Figure B & C: Map of Milfoil infestations to be treated with Florpyrauxifen-benzyl.*

## PROJECT LOCATION AND PARAMETERS

Lake Quinsigamond is a naturally formed, 4 mile long, 475 acre lake nestled between eastern Worcester and western Shrewsbury, with Grafton to the south. It empties into Flint Pond to the south and later into the Quinsigamond River, ultimately joining the Blackstone River. Lake Quinsigamond and Flint Pond are generally managed as one system, given the direct flow between them. The waterbody has a maximum depth of 90 feet, and a water residence time of about 6 months The Commonwealth considers Lake Quinsigamond a “great pond”, meaning that it was larger than 10 acres in its original state, and is therefore within the jurisdiction of Chapter 91, a law which protects public rights to access a waterway. There are 7 major tributaries that feed the lake from both the Worcester and Shrewsbury side. The Lake is crossed by three major roadways, Interstate 290, Route 9, and Route 20.

Access to the lake is though the public boat ramp at 37 Tamarack Ln, Shrewsbury, MA 01545.

Arrangements for bidders to view the site can be made directly with Jacquelyn Burmeister, Lakes and Ponds Program Coordinator with the Department of Sustainability and Resilience at 508-929-1300 x49353 or burmeisterj@worcesterma.gov.

## TREATMENT AREA

All treatments will take place in Management Zone A, which spans from the Mine Street Culvert in the north to the Narrows in the South. Chemical treatment with flumioxazin will be applied to the single Fanwort stand north of 290, as well as any other Fanwort found in Management Zone A at a per-acre price. Chemical treatment with Florpyrauxifen-benzyl will occur on about 5 stands of Eurasian milfoil and/or Variable Leaf Milfoil along the Shrewsbury and Worcester shoreline, as well as any addition Milfoil stand found at a per-acre price.

## TREATMENT APPLICATION PERSONNEL

Chemical applications must be performed by a qualified lake management professional with at least 5 years of experience in the application of herbicides. The Contractor must have all necessary licenses and certifications for algaecide and herbicide applications.

The Contractor will provide and be responsible for all labor, mobilization, demobilization, materials, equipment, and incidentals required to complete the work specified in this proposal including chemicals, application equipment, sampling equipment, storage equipment, spill containment equipment, etc.

## TREATMENT APPLICATION SCHEDULE

It is important to complete any treatments in as short of a time as possible to minimize the impacts to lake recreational use. Treatments will begin no earlier than May 1, 2023 and end no later than September 30, 2023.

## PROJECT COORDINATION

Invasive plant treatment implementation will be designed by the Contractor with approval by DSR. Once approved, the Contractor will work independently to complete assigned tasks, providing materials and personnel, and providing a brief reports to DSR within two weeks of each treatment implementation and recommendations.

## SAFETY, STORAGE & HANDLING

The Contractor shall be responsible for all safety issues related to recommended treatment. This includes employee training, storage, handling, and distribution of material. The Contractor shall be responsible for providing any temporary storage of equipment, materials, or supplies. During applications, the Contractor must ensure that full containment of chemical be maintained at all times to ensure no contamination of the lake.

## EMERGENCY NOTIFICATIONS

The Contractor shall be responsible for providing notification to the DSR of any incidents with local property owners, accidents, and/or issues with the application of the treatment to the lake. Additionally, the Contractor will alert the City at least 48 hours prior to any application of chemicals to ensure that the City has proper time to alert the public about any subsequent lake closures.

## REPORTING

After each treatment, the Contractor will prepare a treatment report summarizing all practices and observations during treatment. This report will be due to DSR within 10 days of the treatment date.

## AWARD

Contract award will be based on the proposal that matches the above specifications and at the lowest price. Bidders should include their prices for Task (1) and (2)

## ATTACHMENTS

2022 Lake Quinsigamond Aquatic Vegetation Maps

2022 Lake Quinsigamond Water Quality Report (water-quality-report-2022-lake-quinsigamond.pdf (worcesterma.gov))

## PRICING PAGE: VEGETATION MANAGEMENT – LAKE QUINSIGAMOND / DSR

The Contractor will perform the following tasks on a directed basis:

1. ***Cabomba caroliniana* Treatment:** Chemical treatment with flumioxazin about 6 acres of *Cabomba carolinian* as indicated in Figure A.

2. ***Myriophyllum spicatum* and *Myriophyllum heterophyllum* Treatment:** Chemical treatment with Florpyrauxifen-benzyl of about 25 acres of *Myriophyllum spicatum* and *Myriophyllum heterophyllum* as indicated in figures B & C.

| Task: | Description: | Est. Qty: | Unit Price | Total Price |
|---|---|---|---|---|
| Task 1: | ***Cabomba caroliniana* Treatment** | **6 acres x** | **$_____ = Per acre** | **$_____** |
| Task 2: | ***Myriophyllum spicatum & Myriophyllum heterophyllum* Treatment** | **25 acres x** | **$_____ = per acre** | **$_____** |

**TOTAL PRICE ALL TASKS: $_____***

***award to be based on the total price**

MASSACHUSETTS
100 Fifth Avenue, 5th Floor
Waltham, Massachusetts 02451
p +1 781.419.7696

RHODE ISLAND
10 Hemingway Drive, 2nd Floor
East Providence, Rhode Island 02915
p +1 401.434.5560

VIRGINIA
999 Waterside Drive, Suite 2525
Norfolk, Virginia 23510
p +1 757.777.3777

December 9, 2016

Mr. Peter Collins
Chairman
Lake Quinsigamond Commission
106 Maple Street
Shrewsbury, Massachusetts 01545

***Re: Amended Lake Quinsigamond Long-term Vegetation Management Plan***
***Worcester, Shrewsbury and Grafton, Massachusetts***
***ESS Project No. L189-001***

Dear Mr. Collins:

ESS Group, Inc. (ESS) is pleased to present this amended Long-term Vegetation Management Plan for Lake Quinsigamond to the Lake Quinsigamond Commission (the LQC). This plan is intended to provide the LQC with a comprehensive approach for managing nuisance aquatic vegetation growth in Lake Quinsigamond over the next five years.

## BACKGROUND

### Setting

Lake Quinsigamond is an approximately 772 acre Great Pond, located primarily in Shrewsbury, although western portions of the lake are within Worcester city boundary and southernmost portion of the lake is located in Grafton. The lake is divided into multiple basins; the long upper basin is narrow and has a relatively simple shoreline with depths that increase quickly away from shore, reaching as deep as 80 feet. The southern portion of the lake consists of a complex network of shallow basins and coves, the southernmost portion of which is collectively known as Flint Pond (sometimes also referred to as Flint's Pond). The lake outlet is located at the southeastern end of Flint Pond, where it is regulated by the Irish Dam. Outflow from Lake Quinsigamond discharges into an emergent wetland just downstream of the dam and flows from there into Hovey Pond.

**Developed shoreline typical of the northern basin of Lake Quinsigamond.**

The shoreline of Lake Quinsigamond is intensely developed, primarily with residences, although some commercial and recreational development is also present, and two major bridges bisect the northern basin. Recreational activities such as boating, fishing, swimming and water skiing are popular, in general. The northern basin is more readily accessible to the public and experiences the heaviest recreational usage. The waters of Flint Pond are less accessible due to shallow water, extensive aquatic plant growth, low bridges and narrow connecting channels between basins. Although recreational activity is less pronounced on Flint Pond, it is also used for similar activities, including water skiing.

## Nuisance Vegetation

### Aquatic Plants

Lake Quinsigamond is listed by the state as a Category 4A impaired water body. This indicates that it is impaired by nuisance aquatic plants and is covered by a total maximum daily load (TMDL) to address excess algal growth and dissolved oxygen impairments.

Nuisance aquatic plants currently documented in Lake Quinsigamond include the following:

Perennial plants that spread primarily through fragmentation

- Fanwort (*Cabomba caroliniana*)
- Eurasian milfoil (*Myriophyllum spicatum*)
- Variable-leaf milfoil (*Myriophyllum heterophyllum*)

Annual plants that spread primarily by turions (hardy winter buds) or seeds

- Brittle naiad (*Najas minor*)
- Curly-leaf pondweed *(Potamogeton crispus*)
- Water chestnut (*Trapa natans*)

ESS visited Lake Quinsigamond on September 23, 2015 and October 26, 2016 to examine the level of nuisance species infestation and discuss current management challenges with Peter Collins, Chairman of the Lake Quinsigamond Commission. Although completing a plant survey was not part of ESS's scope, we were able to review recently completed maps prepared by others as well as make first-hand qualitative field observations, as follows:

**Water chestnut often forms a dense monoculture, completely changing the character of shallow waters if not controlled.**

- Eurasian milfoil and fanwort grow in extensive beds, particularly in the southern portion of Lake Quinsigamond and Flint Pond.
- Variable-leaf milfoil was much less widespread, confined mainly to the northernmost coves of Lake Quinsigamond.
- Water chestnut was observed as a single plant in the northernmost portion of Lake Quinsigamond during the 2016 visit. However, this plant grows more extensively just upstream in the water body on the north side of Main Street, suggesting the potential for it to continue its spread into Lake Quinsigamond.
- The other two species (brittle naiad and curly-leaf pondweed) were not directly observed but ESS assumes they are present at nuisance levels based on prior documentation (ACT 2014, Padgett 2015).

**Emergent Plants**

The primary exotic emergent plant of concern in Lake Quinsigamond is sacred lotus (*Nelumbo nucifera* or possibly a hybrid). This infestation was limited to a small cove just south of the Route 20 bridge over Flint Pond (adjacent to Flagg Road residences) in 2015, where it formed a very dense bed. However, by the time of the October 2016 field visit, sacred lotus had spread significantly and was also found growing along the opposite shoreline in this area.

**Dense patch of sacred lotus near residence in Flint Pond. This photo was taken in 2015. Since then, the bed has significantly increased in size.**

Other exotic species observed along the shoreline of Lake Quinsigamond include common reed (*Phragmites australis*) and purple loosestrife (*Lythrum salicaria*). Both of these species are capable of quickly colonizing shallow-water and shoreline areas. Common reed, in particular, can send out stolons and rhizomes at some distance from the parent plant, forming a dense matrix is capable of smothering native plant species and trapping sediments.

**Rare Species**

The portion of Lake Quinsigamond extending from Half Moon Bay north along the eastern shoreline to the area opposite Quinsigamond State Park is located within designated Priority Habitat 1303, which is known to host the state-endangered Vasey's pondweed (*Potamogeton vaseyi*). Surveys conducted by Padgett (2015) also documented this species in Flint Pond north of Route 20.

Vasey's pondweed has an annual growth cycle, starting growth from seed or turions (hardy winter buds) once the growing season has begun, reaching maximum size in July or August, then setting seed and senescing quickly thereafter. One of the primary threats to Vasey's pondweed populations is competition from other more aggressive plant species. Padgett (2015) acknowledged the general threat from invasive plant species and specifically identified brittle naiad as a particular threat, given its dense growth where co-occurring with Vasey's pondweed. Without action to target and manage non-native species, the existence of Vasey's pondweed in Lake Quinsigamond is threatened.

**Goals**

The management of nuisance plant growth in Lake Quinsigamond is intended to address the following goals:

- Improve recreational opportunities associated with existing access conditions
- Improve navigation and safety
- Prevent the establishment of new invasive plants in the lake
- Improve ecological resources, including fish habitat
- Enhance aesthetic resources

Each of these goals should be addressed in a manner that is protective of the viability of the state-endangered Vasey's pondweed population.

## MANAGEMENT RECOMMENDATIONS

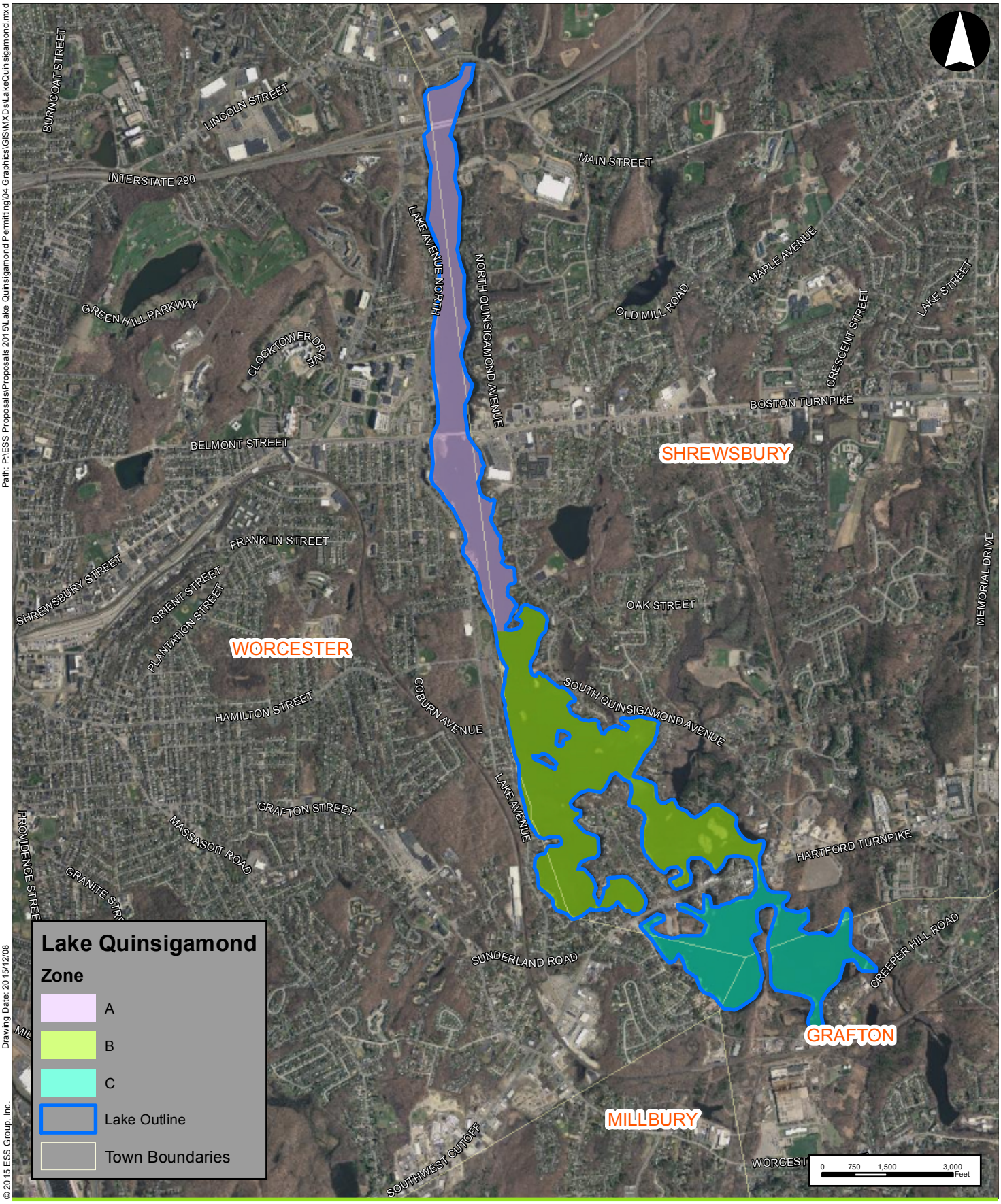
As a large and varied water body with multiple nuisance aquatic plant species, Lake Quinsigamond will require a multi-pronged management approach. Furthermore, correspondence with Massachusetts Natural Heritage and Endangered Species Program (NHESP - Attachment A) suggests that they will impose restrictions limiting the management options for areas of the lake known to harbor Vasey's pondweed. For these reasons, ESS has divided the lake into three Management Zones (Figure 1).

**Management Zone A** encompasses most of the northern basin of the lake, where it is narrow and deep. This area is characterized by nuisance growth of aquatic plants that is mostly relegated to a narrow strip of shallow water along the shoreline and in a few small coves. NHESP has indicated that they would not seek to restrict management actions in Management Zone A.

**Management Zone B** extends from approximately Hamilton Street/Lake Avenue in the north to Route 20 in the south. This part of the lake includes mostly shallow waters and extensive coves that harbor scattered beds of Vasey's pondweed. This area also hosts beds of multiple nuisance aquatic plants, including Eurasian milfoil, fanwort and brittle naiad, at a minimum. NHESP has indicated that management actions in Management Zone B will be restricted to protect Vasey's pondweed. However, some actions may be permitted, as long as NHESP guidelines are followed and conditions are met.

**Management Zone C** includes Flint Pond south of Route 20, which is characterized by shallow waters and widespread growth of Eurasian milfoil, with beds of fanwort also present, particularly near the dam. NHESP has indicated that it would not restrict management actions in Management Zone B under positive flow conditions. Some restriction on chemical treatment could occur under low-flow conditions.

The primary management options for each Management Zone are summarized in Table A. Each of the recommended management actions are described in more detail in the following sections. Additionally, a matrix of management actions and estimated costs over the next five years is presented in Attachment B.

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Drawing Date: 2015/12/08



**Lake Quinsigamond**

Worcester/Shrewsbury, Massachusetts

1 inch = 3,000 feet

Source: 1) MassGIS, Half-Meter Resolution, 2013 - 2014
2) MassGIS, Municipal Boundaries
3) MassGIS, Roads

**Management Zones**

**Figure 1**

**Table A. Summary of Options by Management Zone**

| Management Option | Management Zone | | |
|---|---|---|---|
| | A | B | C |
| **Water Level Control (Drawdown)** | X | X | X |
| **Chemical Controls** | | | |
| 2,4-D | X | C | X |
| Fluridone | X | | C |
| Diquat dibromide | X | | C |
| Flumioxazin | X | | C |
| Imazamox | X | | |
| Glyphosate | | | X |
| Algaecides | X | | C |
| **Harvesting** | | | |
| Hand | X | C | X |
| Diver-assisted Suction Harvesting (DASH) | X | C | X |
| Mechanical | | | X |
| **Hydroraking** | X | | X |
| **Dredging** | F | F | F |

X=Available option
C=Available option, subject to conditions by NHESP
F=Potentially available option but would require separate feasibility study followed by more extensive design and permitting than other options

Management of any kind will require a valid Order of Conditions under the Wetlands Protection Act and local wetlands bylaws/ordinances. The costs to submit a new Notice of Intent are anticipated to range from $5,000 to $6,000 in each municipality, exclusive of required abutter notification costs. Additionally, NHESP review would be required for any work planned within Priority Habitat 1303 or beds of Vasey's pondweed. The official NHESP review fee for aquatic plant management projects is usually $300. However, additional costs for and pre- and post-management studies and annual revisions of the management plan for NHESP review should also be anticipated.

Dredging would require significantly more complex design and permitting than other options. These are further described in the section specific to dredging.

Additional costs anticipated for design, permitting and implementation of specific management actions are noted in the following sections.

**Water Level Control (Drawdown)**

Drawdown involves lowering the water level of a lake 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. One of the most attractive advantages of winter drawdown is the low operational cost, once the program has been permitted.

Winter drawdown is most effective against species that reproduce mainly by vegetative means, including fanwort, Eurasian milfoil, and variable-leaf milfoil. Drawdown has less of an impact on species that reproduce by seed or turions, such as brittle naiad, curly-leaf pondweed and native pondweeds, including Vasey's pondweed.

Drawdown at Lake Quinsigamond has been limited to three feet or less under current permits. As part of our field visit, ESS examined the discharge structure at the dam to assess whether a greater drawdown depth would potentially be feasible from a hydraulic perspective in the future. Unfortunately, drawdown appears to be limited both by the configuration of the current spillway structure and, more importantly, by the elevation of the downstream receiving water, which is not significantly greater than three vertical feet below the spillway. Therefore, it appears that drawdown in excess of three feet would not be feasible without significant cost to engineer, permit and construct a diversion pipe to funnel additional water to a lower elevation in Hovey Pond or even the Quinsigamond River some distance below the dam. Even under such a scenario, the gain in drawdown depth would only be marginal. Alternatively, it may be possible to achieve a slight increase in drawdown depth if Hovey Pond were also drawn down on a coordinated schedule. However, this option would require additional study to better determine the costs and incremental benefits of such an effort.

**The level of ponded water directly downstream of spillway indicates drawdown beyond three feet will be difficult to achieve**

Despite the apparent limitations to drawdown as a management tool in Lake Quinsigamond, ESS recommends its continued implementation on an as-need basis to help control nuisance growths in marginal shallow waters. The need for winter drawdown should be re-evaluated on an annual basis, based on monitoring results during the growing season.

If drawdown is expected to continue as a management strategy at Lake Quinsigamond over the next five years, the Order of Conditions issued under the Wetlands Protection Act and local wetlands bylaws/ordinances in each of the three municipalities must be extended or re-issued. Drawdown also requires concurrence by NHESP as it may affect areas known to harbor state-endangered Vasey's pondweed. Additionally, as a Great Pond, Lake Quinsigamond/Flint Pond may require Chapter 91 (Waterways) permitting to alter water levels. Filing under Chapter 91 would be expected to add between $2,500 and $3,500 additional cost. The schedule and costs associated with permitting, implementation and monitoring of these actions over the next five years are presented in Attachment B.

This assumes a maximum drawdown of three feet. If the LQC desires to pursue a greater drawdown, significant additional engineering, permitting and possibly operational costs would be expected.

## Chemical Controls

### Herbicides

In the short-term, herbicide treatment is usually the most cost-effective means by which to rapidly achieve the goal of reducing aquatic weed biomass over a large area. Herbicides may also be used over the long-term as part of a comprehensive management plan to treat areas of recurring infestations that are not readily controllable through other means.

Due to the presence of state-endangered Vasey's pondweed (*Potamogeton vaseyi*) in Management Zone B, NHESP is likely to restrict herbicide use in this area and, during low-flow conditions, also in Management Zone C.

Any aquatic herbicide treatment program in Lake Quinsigamond will require an Order of Conditions under the Wetlands Protection Act and local wetlands bylaws/ordinances. Proposed treatments would also require review by NHESP. The schedule and costs associated with permitting, implementation and monitoring of these actions over the next five years are presented in Attachment B.

The five herbicide options with potential to be useful for aquatic plant control in Lake Quinsigamond are fluridone, 2,4-D, diquat dibromide and glyphosate. These options are discussed in more detail below.

***2,4-D – Systemic Herbicide***: 2,4-D is a growth regulating systemic herbicide that is selective for dicots, which means that it will be effective on variable-leaf and Eurasian milfoil while having less impact or no impact on desirable plant species such as native pondweeds. Unfortunately, 2,4-D is not effective against fanwort. Various formulations of 2,4-D are approved for aquatic use under multiple trade names in Massachusetts.

A drawback to the use of 2,4-D is the potential for the herbicide to migrate through soils and into wells. It cannot be used in Interim or Zone II Wellhead Protection Areas or in a Zone A, B or C for a public surface water supply without additional hydrologic or hydrogeologic assessments.

Additionally, setbacks from private wells are required to minimize the potential for 2,4-D treated water to be drawn into these wells. Setbacks vary from 25 to 200 feet, depending on geology. If applied within the setback distance, testing of downgradient private wells may be conditioned in the Herbicide Application License. NHESP would potentially allow use of 2,4-D in all Management Zones. However, a pilot study application in a small area of Management Zone B (e.g., Half Moon Bay) would be required as a first step before wider application would be allowed. Careful monitoring of Vasey's pondweed in the treatment area would need to be included in the pilot study treatment.

2,4-D is one of the most cost-effective systemic herbicides available, typically costing on the order of $450 to $500/acre to apply, not inclusive of any required monitoring.

***Fluridone – Systemic Herbicide:*** Fluridone (trade name Sonar) is a systemic herbicide that reduces photosynthesis in affected plants, leading to the eventual starvation of the entire plant. Fluridone is highly effective on fanwort and Eurasian milfoil and also provides some control of variable-leaf milfoil. However, fluridone concentrations must be maintained at treatment levels for as long as 90 days to achieve effective treatment. Due to the slow action of this herbicide, plant dieback is gradual and dissolved oxygen sags are rarely problematic.

In Lake Quinsigamond, fluridone could be applied in either liquid or pellet form, as a spot or partial-lake treatment in Management Zone A or C. It is most effective when applied in late spring or early summer. Fluridone is one of the more expensive herbicides on the market and treatments are typically on the order of $800 to more than $1,000/acre, depending on the formulation used and the need for "booster" treatments to maintain the concentration of the herbicide at an effective level over the treatment period. Therefore, its use should be relegated to areas of Management Zone A or C, where it

***Diquat dibromide – Contact Herbicide:*** Diquat dibromide, also known as diquat or by its trade name (Reward) works quickly by interrupting the photosynthetic process, resulting in the dieback of leaf and stem cells. As a contact herbicide, its It offers immediate control of Eurasian milfoil, variable-leaf milfoil, brittle naiad and curly-leaf pondweed but is not effective on fanwort. Additionally, diquat only provides single-season control because it targets exposed parts of the plant and does not directly kill the roots.

At Lake Quinsigamond, diquat could be used for spot treatment of milfoils, brittle naiad and/or curly-leaf pondweed in Management Zones A and C.

Diquat is one of the least expensive herbicides on the market and treatments typically cost between $200 and $250/acre.

***Flumioxazin – Contact Herbicide:*** Flumioxazin (trade name Clipper) works by inhibiting protoporphyrinogen oxidase (PPO), an enzyme necessary for photosynthesis. Inhibition of PPO causes destruction of plant cell plasma membranes in the presence of sunlight, resulting in rapid dieback of plant tissues. 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 during the subsequent growing season. Flumioxazin can be applied at any time of the year when the plant is actively growing but works best if applied before too much canopy shading has developed.

The primary advantage of flumioxazin is that it is the only contact herbicide permitted for use in Massachusetts that is effective on fanwort. At Lake Quinsigamond, flumioxazin could be used for spot treatments to control fanwort or mixed species beds in Management Zones A and C.

However, the cost of flumioxazin is significantly higher than most other contact herbicides, ranging up to $1,000/acre for treatment. Treatment costs can sometimes be reduced if flumioxazin is used in combination with diquat dibromide.

***Imazamox – Systemic Herbicide:*** Imazamox (trade name Clearcast) is a widely used systemic herbicide in both upland and aquatic environments. This herbicide is effective on water chestnut as a foliar spray.

The primary advantages of imazamox include the following:

- Imazamox is effective on water chestnut and is a cost-effective alternative to mechanical or hand harvesting.
- As a systemic herbicide, imazamox kills the entire target plant, preventing development of late-season water chestnut rosettes

The primary limitations of imazamox include the following:

- Imazamox received recent approval for use in Massachusetts, so its effectiveness in this region has not been as thoroughly vetted as other systemic herbicides

In Lake Quinsigamond, imazamox could be useful for control of water chestnut where it has spread to form expansive beds (e.g., in the basin north of Main Street) or elsewhere where hand or mechanical harvesting would be difficult to implement due to limitations on access and cost. Typically, imazamox is applied in two treatments: one when the rosettes first emerge (late spring/early summer) and another about a month later.

As with other methods that target water chestnut, achieving control with imazamox requires persistence to exhaust the seed bank. Five to ten years of repeated treatment may be required to bring more established beds under control.

Imazamox treatments typically cost between $500 and $800/acre.

***Glyphosate – Systemic Herbicide:*** Glyphosate is a widely used systemic herbicide in both upland and aquatic environments. Special formulations (e.g., Rodeo) are available for use in aquatic treatments.

At Lake Quinsigamond, glyphosate is recommended specifically for the control of emergent beds of sacred lotus. As a broad-spectrum systemic herbicide, it can also be used to control other emergent invasive species, such as common reed (*Phragmites australis*) and purple loosestrife (*Lythrum salicaria*). Use of glyphosate for sacred lotus control is currently recommended only for Management Zone C.

The cost of glyphosate treatments varies, depending on the application method used (spray, snip-and-drip, etc.). However, ESS recommends the LQC budget at least $2,500 per year for initial treatment of the existing sacred lotus bed, which would consist of one to two treatments in the first year. Treatment costs may gradually decline over time as the tuber and seed bank is depleted.

**Algaecides**

Registered algaecides are primarily copper-based and result in almost immediate control of a broad spectrum of planktonic and filamentous algae. Although algal proliferation did not appear to be a problematic during ESS's visit to Lake Quinsigamond, aquatic vegetation control is sometimes associated with an increase in algal growth, due to reduced competition for light and nutrients in managed areas. Therefore, algaecides may be a useful additional management tool for Lake Quinsigamond.

Algaecides would only be recommended if algal growth reaches nuisance levels and it is possible that they would not be needed at all over the course of the vegetation management program at Lake Quinsigamond. Algaecides could potentially be used in Management Zones A and C, if needed. Use of algaecides in Zone B is unlikely to be permitted by NHESP, as Vasey's pondweed is considered to be sensitive to copper.

Any application of algaecides would require an Order of Conditions under the Wetlands Protection Act and local wetlands bylaws/ordinances. Additionally, NHESP review would be required for any algaecide work planned within Priority Habitat 1303 or that could affect Vasey's pondweed.

Algaecide treatments can be expected to cost on the order of $250 to $500/acre for most formulations, although some specialty formulations may exceed this cost.

**Harvesting**

Macrophyte harvesting covers a wide range of techniques, including mechanical harvesting, hand harvesting (often conducted by divers), and diver assisted suction harvesting (DASH). Of these, ESS recommends hand harvesting and DASH as precision techniques that can provide effective control over small areas. Mechanical harvesting is not recommended, unless the LQC desires to simply open up key recreational coves or boating channels on an annual basis.

Harvesting of any kind requires an Order of Conditions under the Wetlands Protection Act and local wetlands bylaws/ordinances. Additionally, NHESP review would be required for any harvesting work planned within Priority Habitat 1303 or beds of Vasey's pondweed. The schedule and costs associated with permitting, implementation and monitoring of these actions over the next five years are presented in Attachment B.

The three primary techniques are discussed further below.

***Hand Harvesting:*** The simplest form of harvesting is hand pulling of selected plants. Depending on the depth of the water at the targeted site, hand harvesting may involve wading, snorkeling, or SCUBA diving. Pulled plants and fragments are placed in a mesh bag or container that allows for transport and disposal of the vegetation. Hand harvesting of submerged vegetation aims to remove entire plants, including the roots, thereby preventing re-growth in subsequent seasons. In practice, it is difficult to achieve 100 percent removal, except where beds are isolated or represent pioneer infestations. Where hand harvesting is used to control established weed beds, some re-growth should be expected in subsequent seasons. With diligence, control may be achieved after a few consecutive seasons of hand harvesting.

At Lake Quinsigamond, hand harvesting could be used to provide precision control of target species near Vasey's pondweed populations. It may also be useful around docks, beaches and shallow shorelines or coves, or to control pioneer infestations of new invasive species. This technique is also an excellent means of controlling small (generally less than one acre) beds of water chestnut, as long as it is completed prior to seed drop (i.e., by August). Hand harvesting could be implemented in Management Zones A and C without restriction by NHESP. If hand harvesting is proposed for use in Management Zone B, NHESP would likely condition it to require oversight by a qualified biologist to prevent negative impacts to Vasey's pondweed.

**Hand harvesting is effective against small infestations of water chestnut.**

Hand harvesting of submerged aquatic plants can be conducted on smaller scales (up to a few hundred square feet) by trained homeowners and volunteers. Larger scale work is a major effort that may span weeks or even months and is usually conducted by professionals.

Costs for hand harvesting vary with bed density and expertise of the staff conducting the operation but typically range from $2,500/acre for lighter infestations to more than $4,000/acre for very dense beds.

***DASH:*** DASH is similar to hand harvesting but more efficient because entire plants are fed into a suction hose and lifted to a collection vessel at the surface, thereby significantly reducing the time it takes for the diver to handle and return plants to the surface. DASH can also reduce the potential for release of plant fragments.

At Lake Quinsigamond, DASH could be used to provide precision control of target species near Vasey's pondweed populations or, as a non-herbicide alternative, to clear target management areas up to a few acres in size. As with hand harvesting, DASH is unlikely to result in full control after a single harvesting event. However, DASH costs within a targeted area would be expected to decline over time, as control is achieved. DASH could be implemented in Management Zones A and C without restriction by NHESP. If DASH is proposed for use in Management Zone B, NHESP would likely condition it to require oversight by a qualified biologist to prevent negative impacts to Vasey's pondweed.

Costs for DASH are similar to those for hand harvesting. Although mobilization fees and daily rates are likely to be higher, the operation is more efficient, thereby allowing harvesting to be completed in a shorter period of time.

***Mechanical Harvesting:*** Mechanical harvesting involves cutting and pulling of aquatic plants from a specially-equipped watercraft and is the most efficient form of harvesting for short term control. The harvester is effective where water depths are greater than two feet over a substantial area. However, mechanical harvesting is a non-selective method, meaning that all plants in the managed area will be impacted. Therefore, it is unlikely to be permitted by NHESP in areas near Vasey's pondweed beds until late summer. Additionally, mechanical harvesting does little to prevent re-growth of most plants in subsequent seasons and may actually spread many of the target nuisance species by increasing fragmentation. One exception to this is water chestnut; mechanical harvesting may be a suitable control method where water chestnut beds are extensive (typically greater than one acre) and access is sufficient to allow mobilization and operation of the harvester.

At Lake Quinsigamond, mechanical harvesting could potentially be used to maintain target management areas clear of vegetation during the summer months. Although it could be used in Management Zone A, the existing beds of target species in this area are not currently extensive or dense enough to be effectively managed by mechanical harvesting. Therefore, mechanical harvesting would primarily be an option to consider for Management Zone C. However, should water chestnut beds become established over larger areas, mechanical harvesting could potentially provide a viable control option in Zones A and C.

Mechanical harvesting costs are dependent on area and density of weed growth, distance from harvesting areas to dewatering areas, and arrangements for disposal. In general, costs can be expected to range from $1,000 to $2,000/acre.

**Hydroraking**

Hydroraking uses a backhoe-like machine mounted on a barge to remove plants directly from pond sediments. Depending on the attachment used, plants are scooped, scraped, or raked from the bottom and deposited on shore for disposal. Hydroraking is most useful for local control of plants with large rhizomes or tubers, such as sacred lotus or water lilies, as these methods can physically remove or destroy the bulky portions of the plant.

One of the drawbacks of hydroraking is that it is relatively non-selective. Although hydroraking would be expected to target sacred lotus, the rake attachments are coarse tools that would be expected to capture some bycatch of non-target aquatic plants and animals (primarily invertebrates).

Hydroraking is recommended as a non-herbicide alternative to glyphosate (herbicide) treatment of sacred lotus or in areas of Management Zones A and C where water lilies are considered to be problematic grow to nuisance levels. It is not recommended for control of submerged invasive plants, such as Eurasian milfoil and fanwort. Furthermore, its use in Management Zone B would likely be restricted or prohibited by NHESP.

Costs to perform hydroraking vary depending upon a number of factors, including plant density, distance of the target beds from shore, disposal of the raked material, and size of the area to be managed. However, an approximate cost of $10,000 to $15,000 per acre should be anticipated. If used alone, it is likely that hydroraking would need to be repeated for multiple years (five to ten, at least) to exhaust the seed bank and gain control over sacred lotus.

**Dredging**

Dredging is primarily used to improve navigation, recreation, water circulation, or control nuisance vegetation and restore open-water habitat. As a vegetation control technique, dredging can be highly effective if correctly planned and implemented. Vegetation control is achieved through light limitation imposed by increased water depth and by removal of nutrient-rich soft sediments to reveal a less hospitable substrate for plant growth (e.g. hard bottom or other nutrient-poor substrate).

ESS understands that priority areas of interest for potential dredging include locations where stormwater runoff or excessive vegetation growth have resulted in filling of the lake with sediments, which in turn restricts navigation, inhibits recreation, and further encourages the growth of invasive plants. Examples of these areas include the passage between Half Moon Bay and Flint Pond at Route 20 and portions of the basin between the Stringer Dam and Route 20.

Prior to recommending a dredging project, a feasibility assessment should be completed that includes the mapping and testing of sediments in the area targeted for removal. Physical properties and chemical content of the material to be dredged are an important consideration in determining the feasibility of sediment reuse or disposal.

Costs for a feasibility study vary depending on the number and extent of areas to be assessed. However, in most cases, at least $10,000 should be anticipated for a basic study. Larger areas will require more sediment cores to be collected and tested and costs could be substantially higher.

**Dredging "in the dry" is usually completed in the winter to simplify sediment management.**

If determined to be feasible, the next step would be to complete a full dredging design study and permit the project. Environmental permitting for dredging projects is moderately complex and typically require at least one year to receive all required approvals. Even for a small project, federal (Section 404), state (e.g., Section 401 Water Quality Certificate, Chapter 91 Waterways) and local permits (Notice of Intent filed for Order of Conditions) are likely to be required, and would necessitate considerable advance information and review time. Larger, more complex dredging projects may require completion and approval of an Environmental Impact Report (EIR) for compliance with the Massachusetts Environmental Policy Act (MEPA) and/or an individual Section 404 permit from the Army Corps of Engineers, which can extend the timeline required for permitting. Additionally, any dredging proposed for areas within the known distribution of Vasey's pondweed will also require approval from NHESP.

Actual dredging costs vary significantly depending on approach. However, a range of $20 to $30 per cubic yard should be anticipated. The lower end of the range would apply to clean sediments removed using conventional "dry" dredging techniques, where the area is dewatered prior to removing sediments. Increased costs should be anticipated if hydraulic or "wet" dredging approaches are used. Additionally, if offsite disposal is required, the cost could increase substantially, to $40 or more per cubic yard.

## VEGETATION MONITORING PROGRAM RECOMMENDATIONS

At a minimum, aquatic vegetation in Lake Quinsigamond should be mapped on an annual basis. This is critical to evaluating the success of the management program and providing the information necessary to fine-tune and optimize it. Annual mapping of vegetation also 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. Given the size of the lake and the complexity of its shallow basins, thorough mapping would likely require a two-day field effort. A mapping program at this level of effort, including a report with updated management recommendations, could be achieved for approximately $5,000 to $6,000/year.

In addition to the recommended monitoring, it is possible that any of the state or local permits or approvals received may be conditioned with requirements for additional monitoring. For example, NHESP will likely require mapping of Vasey's pondweed in accordance with pre-approved botanical survey protocols. Although it is difficult to anticipate all the conditions that may accompany the necessary permits, the LQC should plan on an annual budget of at least $6,000/year to accommodate monitoring required for compliance with permit conditions.

The schedule and costs associated with these actions over the next five years are presented in Attachment B.

**SUMMARY OF RECOMMENDATIONS**

In sum, the vegetation management program proposed for Lake Quinsigamond over the next five years consists of the following elements:

1. Winter drawdown, which may be effective in controlling nuisance aquatic plant growth in a small fraction of the lake area. However, given the large size of Lake Quinsigamond, even a small fraction can have a significant impact on overall control effort and cost.

2. Herbicide treatments, to be applied in the locations and within the time-of-year windows allowed by NHESP. The primary focus would be on an initial systemic herbicide treatment to control large beds of nuisance milfoils and fanwort, as well as a dense infestation of sacred lotus. 2,4-D, a systemic herbicide that controls Eurasian milfoil, is the ***only*** herbicide that NHESP is likely to allow at this time in Management Zone B. In Management Zones A and C, fluridone may be used as a systemic control that is effective on both fanwort and milfoils. Glyphosate may also be used to control sacred lotus in Management Zone C. This is anticipated to be the most cost-effective means of nuisance aquatic plant control over the short term.

   Supplemental contact herbicide treatments using diquat dibromide or flumioxazin may also be useful for spot treatments in Management Zones A and C.

   Lastly, imazamox may be of use in controlling the more extensive water chestnut growth in the basin to the north of Main Street. This would help prevent the spread of this species into Lake Quinsigamond.

3. Algaecide treatments, which are recommended in case algal blooms are encountered during the management program. Given the ability of algae blooms to develop rapidly, the strategy would be to permit the use of algaecides in Lake Quinsigamond so that the lake can be treated with minimal delay, if treatment becomes necessary. Currently, algaecide treatments appear to only be a viable option for Management Zones A and C.

4. Hand harvesting and DASH are recommended where the LQC cannot or does not wish to use herbicides to control nuisance aquatic plant beds. These methods can also be used to eradicate pioneer infestations of new exotic species, address nuisance growths in shallow waters near docks and shorelines, and as a follow-up to control recolonization after herbicide treatments. Hand harvesting is likely to be the primary control measure for isolated or scattered growths of water chestnut. Hand harvesting and DASH could potentially be implemented in any Management Zone. However, work in Management Zone B may require oversight by a qualified biologist to ensure the effort is protective of Vasey's pondweed.

   Mechanical harvesting is only conditionally recommended as a maintenance measure in Management Zone C, should the LQC desire a physical alternative to chemical treatments for temporarily clearing large areas of aquatic vegetation in a relatively short period of time. Likewise, mechanical harvesting may potentially be used as a non-herbicide alternative for controlling water chestnut where the beds are extensive but accessible.

5. Hydroraking is a non-herbicide option for physical removal of sacred lotus. It may also be used for control of heavily rooted vegetation (e.g., water lilies) elsewhere in Management Zones A and C. However, hydroraking is unlikely to be approved for use near Vasey's pondweed beds in

Management Zone B. Additionally, hydroraking has a higher per-acre cost to implement than most other options.

6. Dredging is a more complex management option that would require further study before recommendations could be made. Should the LQC desire to pursue dredging, ESS would first recommend completion of a feasibility study to assess the physical and chemical characteristics of the sediments.
7. Ongoing annual vegetation monitoring is recommended to evaluate the success of the management program and providing the information necessary to fine-tune and optimize it. Monitoring focused on Vasey's pondweed is also recommended and will likely be required to demonstrate to NHESP that the management program is protective of this state-endangered species.

**REFERENCES**

Aquatic Control Technology, LLC [ACT]. 2014. Lake Quinsigamond/Flint Pond. Aquatic Plant Survey Results and Review of Management Strategies.

Padgett, D. J. 2015. Botanical Survey of Lake Quinsigamond and Flint Pond, Shrewsbury/Worcester, Massachusetts. Prepared for Lake Quinsigamond Commission.

It has been a pleasure working with you on this project. Please do not hesitate to contact the undersigned at 401.330.1224 with any questions.

Sincerely,

**ESS GROUP, INC.**

Carl Nielsen, CLM
Vice President
Ecological Science and Environmental Permitting

Matt Ladewig, CLM
Project Scientist

Attachments

# Attachment A

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## NHESP Correspondence

| | |
|---|---|
| **From:** | Marold, Misty-Anne (FWE) |
| **To:** | Matt Ladewig |
| **Cc:** | Glorioso, Lauren (FWE) |
| **Subject:** | RE: Lake Quinsigamond, trmt options post survey |
| **Date:** | Thursday, November 19, 2015 3:13:06 PM |

*RE: Lake Quinsigamond #06-20539, MESA status- pre-filing*

Matt,

Thanks for taking time to discuss this project. Here are the highlights from my notes based on our conversation on 11/18/2015. You were going to discuss with the town and lake/pond association to determine the next steps and actual parameters of a potential treatment plan toward a formal MESA filing:

1) No concerns for the use of herbicides north of the Hamilton Street/Lake Avenue (where the lake narrows near the beach in the park), provided concentration of herbicides low at this point.
2) No concerns for the use of herbicides south of Route 20 (Hartford Turnpike) during normal flow conditions (i.e., during the low-flow season of summer there may or may not be enough southward flow to eliminate concerns)
3) Rare plant concern focused between Hamilton Street/Lake Avenue south to Route 20, based on current knowledge of rare plant distribution.
    a) Unclear that can use most herbicides or manual harvesting given inter-mix and distribution of rares and invasives and avoid impacts to rare plant.
    b) DASH may be possible with careful planning and implementation under botanist oversight.
    c) Use of straight-line buffer distance not well supported in literature given variation in flow, floc in the water and sediment in the water. Difficult on the day of treatment to conduct appropriate measurements to ensure adequate safety margin off rare.
    d) Late season use of diquat (cell membrane disruptor) or fluridone (Chlorophyll/Carotenoid Pigment Inhibitors) was previously mentioned. In looking at other related species, there is not much in the literature about the exact timing between the visible plant die-back, development of turions and their subsequent dormancy or if in dormancy there remains any risk of uptake of herbicide (given they have some biological activity). Turions are likely an important part of re-growth for these plants which are often referred to as a 'winter annual'. There is just not enough known about turion development and uptake of these herbicides. For example, non-native Curleaf Pondweed has been studied and it known to develop turions when temperatures reach 15-20C; experimental herbicide treatment was conducted at temps between 10-18C specifically to inhibit turion development (see James A Johnson, MS Thesis, University of Minnesota, 2010). This would assume turion activity before visible development. But, what temps/photoperiods trigger these events on/off for the rares is unknown. However, we remain open to discussion as research is published.
    e) Pilot project with use of 2-4,D or triclopry + monitoring of rares?
    f) Padgett suggested treatment of *Najas minor* would help the rare plant. While we concur, the NHESP was unable to identify a MA registered herbicide (or other control

method save for DASH) that would allow control of N. minor along with protection of the P. vaseyi.

g) Algal Bloom?
   i) Copper sufate or copper chelate both raise toxicity concerns for rares, but formulation and dose may allow some selectivity. If town is ordered by MA DEP to treat bloom, we will work with town to resolve issue.
   ii) Low-dose alum, well buffered, and monitored raise less concern if focused on deep water (> 20 feet). Details matter in terms of drift of floc and timing.

Best, Misty-Anne

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***Misty-Anne R. Marold, Senior Endangered Species Review Biologist***
*Massachusetts Division of Fisheries & Wildlife*
*Natural Heritage & Endangered Species Program*
*1 North Drive, Rabbit Hill Road*
*Westborough, MA 01581*
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# Attachment B

# Five-Year Management Matrix

**Proposed Long-term Vegetation Management Plan for Lake Quinsigamond - 2016**

| Management Action* | Treatment Costs by Year | | | | | Five-Year Projected Costs | | | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | Design/Permitting | Implementation | Monitoring/Reporting | Overall | |
| **Action 1 - Permitting and Agency Reporting** | | | | | | | | | | |
| *Task 1. Develop Drawdown O&M Plan (if needed)* | $10,000 | | | | | $10,000 | | | $10,000 | -Includes hydrologic/hydraulic calculations, operations guidance/forms and plan for monitoring during and post-implementation each year |
| *Task 2. Submit Initial Management Plan for NHESP Review* | $2,500 | | | | | $2,500 | | | $2,500 | -Assumes use of Padgett (2015) report for Year 1. Assumes LQC directly responsible for filing fees. |
| *Task 3. Submit NOI/Obtain OOC from Shrewsbury, Worcester and Grafton* | $18,000 | | | | | $18,000 | | | $18,000 | -Assumes LQC directly responsible for filing fees/notices to abutters |
| *Task 4. Submit Chapter 91 Application* | $3,250 | | | | | $3,250 | | | $3,250 | -Assumes LQC directly responsible for filing fees |
| *Task 5. Annual Management Plan Updates for NHESP Review and Approval* | | $6,000 | $6,000 | $6,000 | $6,000 | | | $24,000 | $24,000 | -Includes up to $4,000 for annual Vasey's pondweed field survey effort plus updated management recommendations and reporting to NHESP. Will be essential for any work done in Management Zone B. |
| **Action 1- Subtotal** | **$33,750** | **$6,000** | **$6,000** | **$6,000** | **$6,000** | **$33,750** | **$0** | **$24,000** | **$57,750** | |
| **Action 2 - Vegetation Monitoring** | | | | | | | | | | |
| *Task 1. Annual Lakewide Vegetation Mapping* | $5,500 | $5,500 | $5,500 | $5,500 | $5,500 | | | $27,500 | $27,500 | -Includes annual lakewide vegetation monitoring but not extra conditions or mitigation measures that may be required by Conservation Commission or NHESP |
| **Action 2 - Subtotal** | **$5,500** | **$5,500** | **$5,500** | **$5,500** | **$5,500** | **$0** | **$0** | **$27,500** | **$27,500** | |
| **Action 3 - Management of Submerged Aquatic Plants. Winter Drawdown (Max 3').** | | | | | | | | | | |
| *Task 1. Implement Drawdown, as Recommended in Annual Management Update Reports* | $0 | $0 | $0 | $0 | $0 | | $0 | | $0 | -Does not include additional monitoring during and post-implementation that may be required by permit conditions |
| **Action 3- Subtotal** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | |
| **Action 4 - Management of Submerged Aquatic Plants. Chemical Treatment.** | | | | | | | | | | |
| *Task 1. Systemic Pilot Treatment with 2,4-D* | $10,000 | | | | | | $10,000 | $6,000 | $16,000 | -Assumes up to 20 acres of pilot treatment in Management Zone B. Does not include cost of any well monitoring or geohydrological studies. Need for these would be determined once treatment area is defined. |
| *Task 2. Systemic Treatment with Fluridone* | $100,000 | | | | | | $100,000 | | $100,000 | -Assumes up to 100 acres of treatment in Management Zones A and/or C. |
| *Task 3. Spot Treatments with Contact Herbicide (Diquat and/or Flumioxazin)* | $9,000 | $9,000 | $9,000 | $9,000 | $9,000 | | $45,000 | | $45,000 | -Assumes treatment of up to 20 acres each season in Zones A and/or C, if needed. Costs likely lower if diquat, higher if flumioxazin. |
| *Task 4. Systemic Treatment with 2,4-D* | | $50,000 | | | | | $50,000 | | $50,000 | -Assumes NHESP finds no significant impact on Vasey's pondweed in Task 1. Assumes additional treatment of up to 100 acres in Management Zone B. |
| *Task 5. Water Chestnut Treatment with Imazamox* | $5,000 | $5,000 | $5,000 | $5,000 | $5,000 | | $25,000 | | $25,000 | -Assumes treatment of 6 to 10 acres in basin to north of Lake Quinsigamond |
| **Action 4 - Subtotal** | **$124,000** | **$64,000** | **$14,000** | **$14,000** | **$14,000** | **$0** | **$230,000** | **$6,000** | **$236,000** | |

**Proposed Long-term Vegetation Management Plan for Lake Quinsigamond - 2016**

| Management Action* | Treatment Costs by Year | | | | | Five-Year Projected Costs | | | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | Design/Permitting | Implementation | Monitoring/Reporting | Overall | |
| **Action 5 - Lotus Control. Chemical Treatment** | | | | | | | | | | |
| *Task 1. Initial Treatment w/Glyphosate* | $2,500 | | | | | | $2,500 | $500 | $3,000 | -Assumes up to 1.0 acre of initial treatment in Management Zone C |
| *Task 2. Follow-up Treatments w/Glyphosate* | | $2,000 | $2,000 | $1,500 | $1,500 | | $7,000 | $1,000 | $8,000 | -Assumes declining treatment area over time |
| **Action 5 - Subtotal** | **$2,500** | **$2,000** | **$2,000** | **$1,500** | **$1,500** | **$0** | **$9,500** | **$1,500** | **$11,000** | |
| **Action 6 - Algaecide Treatment** | | | | | | | | | | |
| *Task 1. Algaecide Treatments, as Needed* | $5,000 | $5,000 | $5,000 | $5,000 | $5,000 | | $25,000 | | $25,000 | -Assumes up to 10 acres of treatment per year in Management Zone A and/or C |
| **Action 6 - Subtotal** | **$5,000** | **$5,000** | **$5,000** | **$5,000** | **$5,000** | **$0** | **$25,000** | **$0** | **$25,000** | |
| **Action 7 - Harvesting** | | | | | | | | | | |
| *Task 1. Hand Harvesting and/or DASH* | $43,000 | $43,000 | $43,000 | $43,000 | $43,000 | | $200,000 | $15,000 | $215,000 | -Assumes up to 10 acres of harvesting per year in areas that cannot be controlled through other means. Assumes some oversight by qualified biologist will be required for operations in Management Zone B. |
| **Action 7 - Subtotal** | **$43,000** | **$43,000** | **$43,000** | **$43,000** | **$43,000** | **$0** | **$200,000** | **$15,000** | **$215,000** | |
| **Action 8 - Dredging Feasibility Assessment** | | | | | | | | | | |
| *Task 1. Dredging Feasibliity Study* | $15,000 | | | | | | | $15,000 | $15,000 | -Assumes small area for feasibilty assessment (less than 10 sediment cores collected)<br>-Costs for initial study only. Does not include design, permitting, or dredging costs. |
| **Action 6 - Subtotal** | **$15,000** | **$0** | **$0** | **$0** | **$0** | **$0** | **$0** | **$15,000** | **$15,000** | |
| **Totals** | **$228,750** | **$125,500** | **$75,500** | **$75,000** | **$75,000** | **$33,750** | **$464,500** | **$89,000** | **$587,250** | |

*Costs for mechanical harvesting and hydroraking not included in this matrix, as these options are only conditionally recommended