MASSACHUSETTS
watershed·based plans

WATERSHED-BASED PLAN

Lake Garfield

August 26, 2022

Prepared By:

Berkshire Regional Planning Commission
1 Fenn St. Suite 201
Pittsfield, MA 01201

On Behalf Of:

Town of Monterey
435 Main Rd. PO Box 308
Monterey, MA 01245

Prepared For:

MassDEP
Commonwealth of Massachusetts
Department of Environmental Protection

Contents

Executive Summary

Lake Garfield is a 275-acre lake located in the rural community of Monterey in western Massachusetts, Berkshire County. The lake is an impounded section of the Konkapot River connected to adjoining Brewer Lake through three culverts under Tyringham Road. Lake Garfield is classified as a "Great Pond" and serves as an important recreational resource to visitors and residents of Monterey. Watershed land use is primarily forest with pockets of low to medium-density residential neighborhoods. There are approximately 75 dwellings, many of which are seasonal second homes.

Lake Garfield is listed in the *2018/2020 Integrated List of Impaired Waters* by the State of Massachusetts as Category 5 for mercury in Fish Tissue, dissolved oxygen, phosphorus, and aquatic invasive plant species. Category 5 waters are listed as impaired and in need of a total maximum daily load (TMDL). For a full list of impairments see Table A-3.

Berkshire Regional Planning Commission (BRPC) completed this Watershed-Based Plan with funding from Massachusetts Department of Environmental Protection (MassDEP) Clean Water Act Section 319 Regional Coordinator Program. It includes conceptual design plans for Hupi Road stormwater treatment, a project completed with Clean Water Act 604(b) grant funding. These designs and information gathered through the Hupi Road project were integrated into this plan. BRPC worked with engineering firms Foresight Land Services and Comprehensive Environmental Inc. (CEI), town officials, and community groups such as Friends of Lake Garfield and Lake Garfield Working Group to identify possible Best Management Practices (BMPs), both structural and non-structural, in order to address aquatic invasives plants and phosphorus pollutant loading. A 2016 study of phosphorus sources funded by the MassDEP 604(b) program and completed by Water Resource Services, Inc. (Water Resource Services, 2018) informed the process for determining structural BMPs listed in this Watershed-Based Plan.

Feedback on the draft Watershed-Based Plan was collected through information listening sessions and presentations to the community groups, the Town of Monterey and the larger Monterey community. Feedback gathered during the outreach process has been integrated into this plan.

For more information, questions, or to provide input on this Lake Garfield Watershed-Based Plan, please contact Courteny Morehouse, Energy & Environmental Senior Planner at Berkshire Regional Planning Commission at cmorehouse@berkshireplanning.org.

Introduction

What is a Watershed-Based Plan?

Purpose and Need

A watershed-based plan is a holistic and adaptive document that provides guidance to local resource managers such as watershed and lake associations, local municipalities, resource owners and stakeholders for the assessment and management of resources within a geographically defined area – the watershed.

The purpose of a Massachusetts Watershed-Based Plan (WBP) is to organize information about Massachusetts' watersheds and present the information in a format that will enhance the development and implementation of projects that will restore water quality and beneficial uses in the Commonwealth. The Massachusetts WBP follows the United States Environmental Protection Agency's (EPA's) recommended format for "nine-element" watershed plans, as described below.

All states are required to develop WBPs, but not all states have taken the same approach. Most states develop WBPs only for selected watersheds. MassDEP's approach has been to develop a tool to support statewide development of WBPs so **that good projects in all areas of the state may be eligible for federal watershed implementation grant funds** under Section 319 of the Clean Water Act.

EPA guidelines promote the use of Section 319 funding for developing and implementing WBPs. WBPs are required for all projects implemented with Section 319 funds and are recommended for all watershed projects, whether they are designed to protect unimpaired waters, restore impaired waters, or both.

Watershed-Based Plan Outline

This WBP includes nine elements (a through i) in accordance with EPA Guidelines:

a) An **identification of the causes and sources** or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this WBP and to achieve any other watershed goals identified in the WBP, as discussed in item (b) immediately below.

b) An **estimate of the load reductions** expected for the management measures described under paragraph (c) below, recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time.

c) A **description of the nonpoint source (NPS) management measures** needed to achieve the load reductions estimated under paragraph (b) above as well as to achieve other watershed goals identified in this WBP and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

d) An **estimate of the amounts of technical and financial assistance needed**, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, United States Department of Agriculture's (USDA's) Environmental Quality Incentives Program and Conservation Reserve Program,

and other relevant federal, state, local, and private funds that may be available to assist in implementing this plan.

e) An **information/education component** that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the NPS management measures that will be implemented.

f) A **schedule for implementing the NPS management measures** identified in this plan that is reasonably expeditious.

g) A description of **interim, measurable milestones** for determining whether NPS management measures or other control actions are being implemented.

h) A set of **criteria to determine if loading reductions are being achieved** over time and substantial progress is being made toward attaining water quality standards and, if not, the criteria for determining whether this WBP needs to be revised or, if a NPS TMDL has been established, whether the TMDL needs to be revised.

i) A **monitoring component** to evaluate the effectiveness of the implementation efforts over time measured against the criteria established under item (h) immediately above.

Project Partners and Stakeholder Input

This plan would not have been possible without the funding support of the MassDEP Clean Water Act 319 Regional Coordinator Program. This plan was created with input from a number of groups including the Town of Monterey, Lake Garfield Working Group, Friends of Lake Garfield, Lakes and Ponds Association of Western Massachusetts (LAPA West), Housatonic Valley Association (HVA), and the Town of Monterey.

BMP siting, conceptual designs, and alternative BMP considerations were completed by engineering contractor Foresight Land Services with input from Town of Monterey Highway Department and BRPC. Load reductions for structural BMPs (Table C-2), the Land Use map (Figure C-1), and the Soils map (Figure C-2) were calculated and created by Comprehensive Environmental Inc. (CEI) and BRPC.

A special thanks to Dennis Lynch who volunteered countless hours and spearheaded grant application, administration, and outreach on behalf of the Town of Monterey.

Data Sources

- This WBP was developed using the framework and data sources provided by MassDEP's WBP Tool.
- BMPs targeting invasive aquatic vegetation were developed based on aquatic invasive species survey reports conducted in 2013, 2014, 2016, 2017, and 2018 by New England Aquatic Services, Water Resource Services, Inc., and Stockman Associates Inc.
- Phosphorus sources and subsequent BMPs were created based on the 2018 Final Report titled "Phosphorus Loading Assessment for Lake Garfield, Monterey, MA" prepared by Water Resource Services, Inc., funded by a MassDEP 604(b) grant (16-01/604).
- Project areas for high-priority structural stormwater BMPs were selected through site reconnaissance and design plans funded through a follow-up MassDEP 604(b) grant (20-01/604).
- Water quality data and cyanobacteria counts were provided by LAPA West through their annual lakes and ponds monitoring program.

Summary of Completed Work

Non-structural BMPs are ongoing throughout the Lake Garfield watershed including:

- **Diver Assisted Suction Harvesting (DASH)**: Every year, Friends of Lake Garfield with support funding from the Town of Monterey Lake Garfield Working Group hire a contractor to complete DASH of Eurasian milfoil and other aquatic invasive plants. DASH is the extraction of plants using a diver, suction tube, a unique set of pumps mounted on a boat and a bagging or filtration system. Suction harvesting is one of method of suppressing the proliferation of invasive plants because the entire plant is removed in its connective rooting system.

DASH in Lake Garfield, Photo by Justin Edelstein

- **Outreach and Education**: Efforts facilitated by the Monterey Conservation Commission, Friends of Lake Garfield, and BRPC target lakeside residents and residents watershed wide to encourage sustainable landscaping, installation of rain gardens and vegetative buffer plantings to reduce pollution from stormwater sources as well as septic system upkeep. These efforts include outreach through the Friends of Lake Garfield website, presentations at meetings town-wide and during annual meetings, and pamphlet brochures distributed in Town Hall.
- **Lake Drawdown**: Lake Garfield is an impounded section of the Konkapot River. The dam that creates this impoundment is controlled by the Town of Monterey's Highway Department. Every fall, the Highway Dept. opens the flood gates to lower the lake level by approximately 8' feet every year. The drawdown serves two purposes. First is prevents damage to the shoreline and properties caused by ice and high springtime rains. Second, it controls shoreline invasive plants be exposing them to freezing winter weather thereby killing them or thinning their growth.

No structural BMPs have been installed to mitigate water quality issues as of this plan's writing.

Element A: Identify Causes of Impairment & Pollution Sources

Element A: Identify the causes and sources or groups of similar sources that need to be controlled to achieve the necessary pollutant load reductions estimated in the watershed based plan (WBP).

General Watershed Information

Lake Garfield Watershed is located entirely in Monterey, MA, a small town in the Berkshire region, the western-most county in Massachusetts. The 2,440 acres that make up the watershed are largely rural in nature. Land use is predominantly forest with a smattering of houses throughout the watershed, more densely packed closer to the lake, especially on the southwestern side where the Konkopot feeds into Brewer Lake. Residents are a mixture of full-time residents and seasonal homeowners who summer near the Lake. There are some agricultural operations in the south side of the lake, which may impact runoff coming from the Konkopot. There are two parcels of protected open space in the watershed. The largest is Beartown State Forest, 173.2 acres managed by Department of Conservation & Recreation (DCR) on the northeast upland area of the watershed north of Hupi Rd. Closer to the Lake itself near Jayson Camp is a small parcel of 0.16 acres, protected by Monterey Preservation Land Trust.

Table A-1: General Watershed Information

Watershed Name (Assessment Unit ID):	Lake Garfield (MA21040)
Major Basin:	HOUSATONIC
Watershed Area (within MA):	2,440 (ac)
Water Body Size:	257 (ac)

The watershed is split between two ecoregions, the Lower Berkshire Hills and the Western New England Marble Valley which extends into New York's Taconic range and southward into western Connecticut through the Housatonic Valley. Soils within the watershed generally fall into three categories, Farmington, Berkshire, or Peru. These three soils are categorized as well drained, some areas in the upland areas are excessively well drained. Topography of the watershed is hilly. There are steep grades along the southeastern side of the watershed leading down to the Lake in a great bowl. The northwestern areas of the watershed are more calm but with poorly draining wetland soils near the Town Beach. Both aspects make BMP installation difficult either because water is traveling too fast (steep grade) or opportunities to infiltrate stormwater are challenging due to poorly draining soil. Therefore, areas with less grade and better draining soil in the north middle of the watershed are more ideal.

Lake Garfield (MA21040) is an impounded section of the Konkapot River. The Lake is classified as a "Great Pond" under Massachusetts law (MGL Chapter 131 Section 45). Great Ponds are defined as ponds or lakes at least 10 acres in size. Lake Garfield is 257 acres including the adjoining Brewer Lake connected by three culverts that pass under Tyringham Road. The average depth of Lake Garfield is 16 feet. The maximum depth is 35 feet in an area sometimes referred to as the “Big Bowl” or “Deep Hole” located in a northeastern section of the lake. See Figure A-2 for the bathymetric map.

In terms of habitat, Lake Garfield and the surrounding upland areas are classified by Massachusetts BioMap2 as a Priority Conservation Area of Aquatic Core Habitat. That is to say, the lake serves as integral to the Konkapot river system. Moreover, the lake serves as habitat for Massachusetts listed species. Namely the endangered Vasey’s pondweed, a floating aquatic plant and the Bridle shiner, a small, straw-colored minnow on the species of special concern list.

In addition to its ecological value, Lake Garfield is a significant recreational resource to the community. There is an active seasonal second-home community as well as full-time residents that make up a total of approximately 75 dwellings along the shoreline. As a great pond, the lake is required to have public access and remain open for public fishing and boating. A boat launch and public beach allow for boating, fishing, and swimming.

Lake health and issues are monitored and addressed by the Town of Monterey Board of Health, Friends of Lake Garfield, and LAPA West.

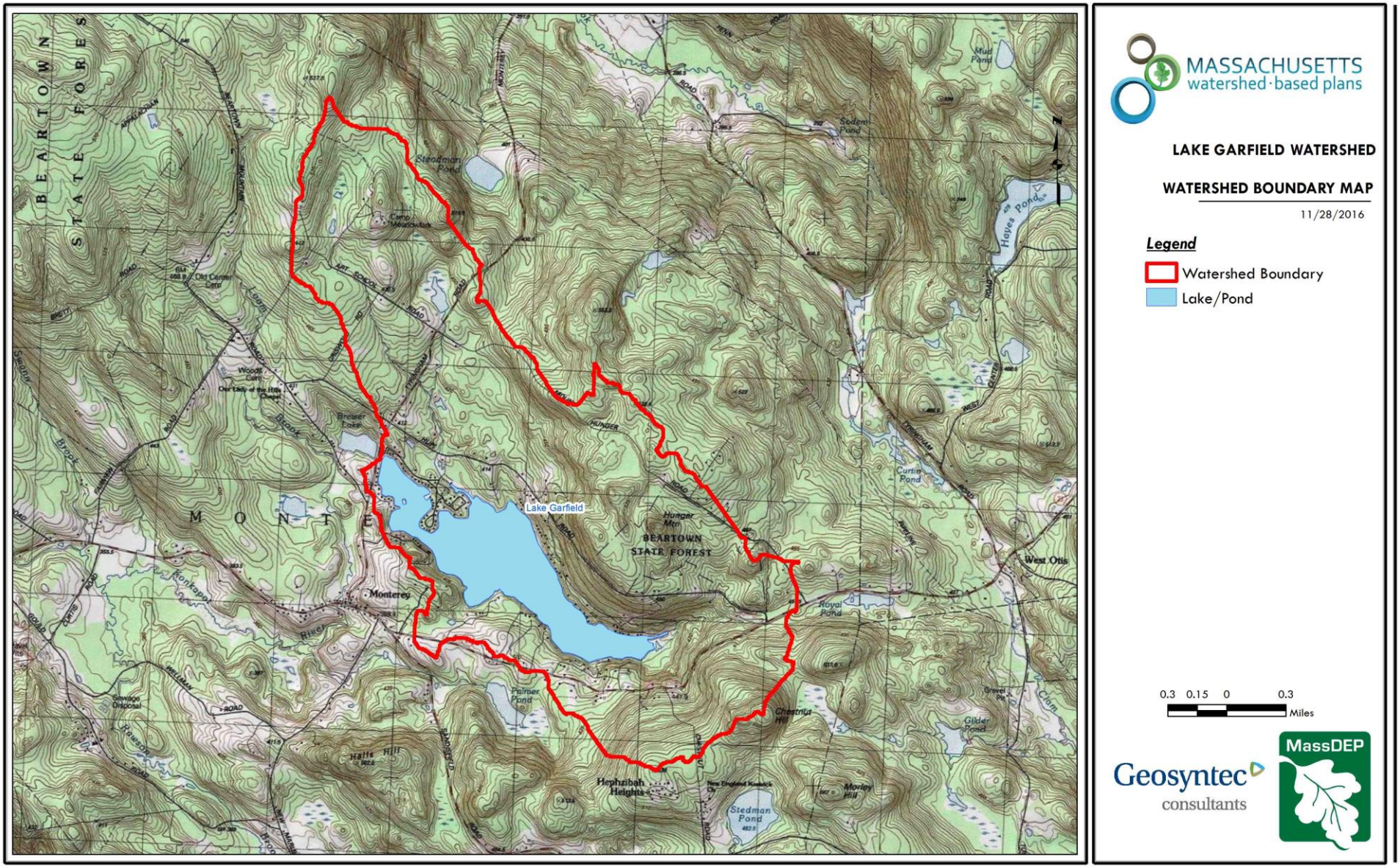

Figure A-1: Watershed Boundary Map (MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Ctrl + Click on the map to view a full-sized image in your web browser

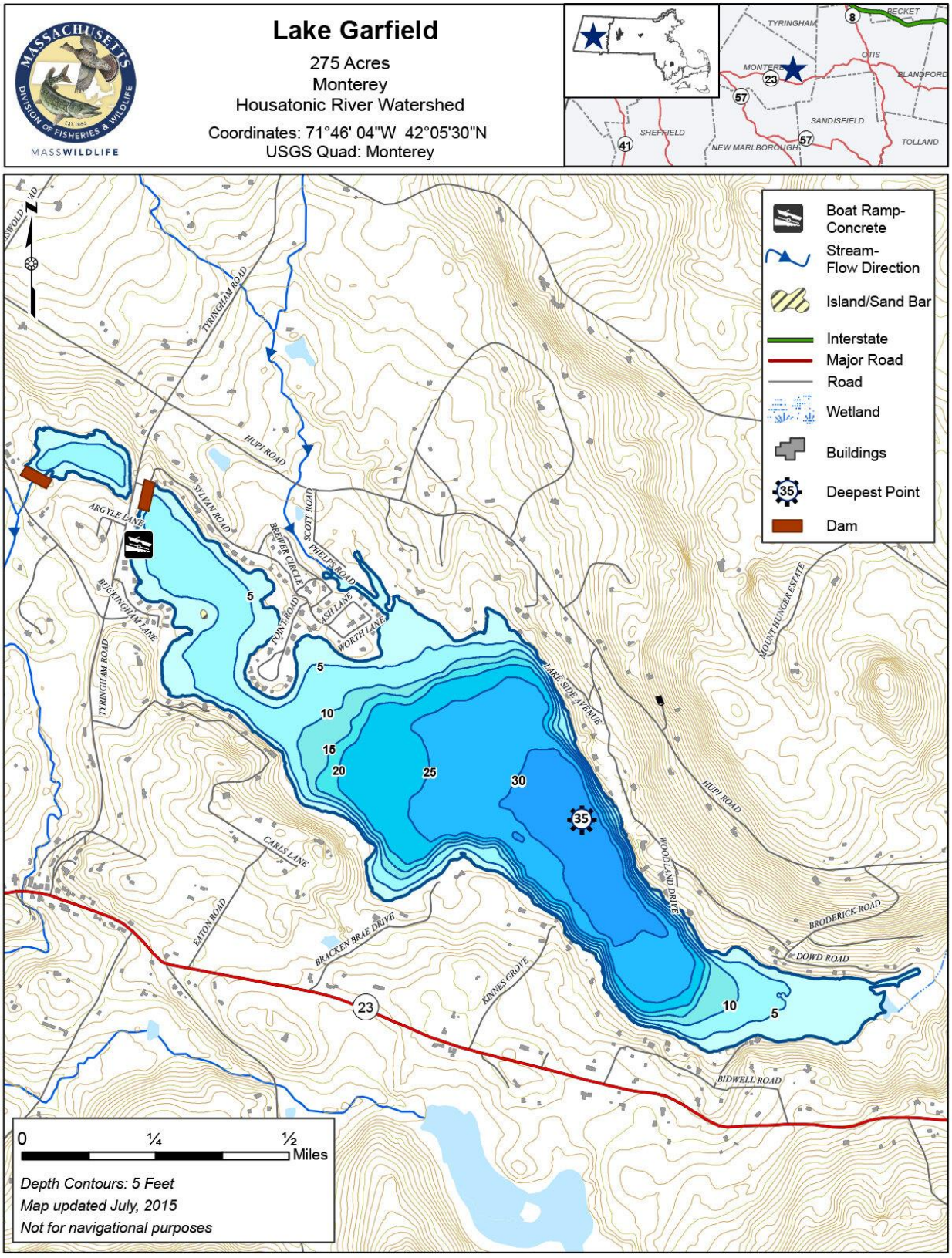

Figure A-2: Lake Depth Contours Map (USGS, 2015)

MassDEP Water Quality Assessment Report and TMDL Review

The 1972 Clean Water Act is a federal law enforced by the Environmental Protection Agency (EPA) that regulates the water quality of surface waters throughout the United States. One of the many ways the Clean Water Act does this is to set federal water quality standards that in turn are adopted and/or revised by each state. The Massachusetts Water Quality Standards establish the foundation of waterbody management across the state, including pollution discharge permits, impairment listings, and the development of Total Maximum Daily Loads (TMDL). Under Section 303 of the Clean Water Act, Massachusetts is required to list waters that do not meet state and/or federal water quality standards according to designated uses (ex. drinking, swimming, fishing). A review of the state water quality standards is conducted every three years by Mass DEP and waters are given a classification for appropriate use (AA, A, B, and C for freshwater). Lake Garfield is a Class B waterbody and therefore designated as habitat for fish, other aquatic life, and wildlife as well as primary (swimming) and secondary (boating) recreational contact. Class B waters are required to remain healthy enough for irrigation and other agricultural uses and compatible industrial cooling and process use. For more on the water quality requirements of Class B waters go to Mass.gov website page on 314 CMR 4: The Massachusetts Surface Water Quality Standards.

Total Maximum Daily Load (TMDL)

A TMDL is a calculation of the maximum amount of a pollutant allowed to enter a waterbody so that the waterbody will meet water quality standards. In effect, the TMDL is a "pollution diet" that restricts a certain pollutant to ensure that the waterbody is and remains healthy.

Under Clean Water Act Section 305(b), Massachusetts is required to monitor and report on water quality of the state's waters to assess whether a body of water is meeting the designated uses. Lake Garfield's assessment was part of Housatonic River Watershed Water Quality Assessment Report completed in 2002. This Water Quality Assessment presents water quality data and information on listed waterbodies within the Housatonic River Watershed to assess the status of the designated uses (with the exception of drinking water). Lake Garfield was assessed for aquatic life, primary contact, secondary contact, and aesthetics.

According to this report and the *Massachusetts 2018/2020 Integrated List of Waters,* Lake Garfield is impaired for its designated use of aquatic life due to dissolved oxygen, mercury in fish tissue, and total phosphorus as well as non-native plant species Eurasian watermilfoil and Fanwort. Lake Garfield is listed as a "Category 5" body of water meaning that it is impaired requiring a TMDL.

The following reports are available:

- Housatonic River Watershed 2002 Water Quality Assessment Report

The section below summarizes the findings of any available Water Quality Assessment Report and/or TMDL that relate to water quality and water quality impairments. Select excerpts from these documents relating to the water quality in the watershed are included below (note: relevant information is included directly from these documents for informational purposes and has not been modified).

Summary Housatonic River Watershed 2002 Water Quality Assessment Report (MA21040 - Lake Garfield)

Two non-native macrophytes, *Myriophyllum spicatum* and *Potamogeton crispus*, were found in the lake in 2004 (MA, DCR 2004).

In 2003 MassDEP collected water quality data from the deep-hole station of Lake Garfield (Appendix D, Table D2). Low dissolved oxygen (DO) was found at 6m and below (approximately 50% of the lake area). There was also evidence of total phosphorus release from the sediment and moderate levels of chlorophyll a. Because of these conditions and the presence of non-native aquatic macrophytes, the Aquatic Life Use is assessed as impaired.

Friends of Lake Garfield conducted water quality monitoring at three stations on Lake Garfield (Edelstein, 2006). Despite the fact that these data do not meet minimum quality assurance/quality control (QA/QC) requirements because they are not found in a citable report, they appear to corroborate the findings of MassDEP.

Fish from Lake Garfield were sampled for toxins in fish tissue in 1993 by MassDEP. Samples were analyzed for metals and PCBs (Maietta, undated). No site-specific fish consumption advisory was issued for this waterbody, so the Fish Consumption use is not assessed.

The water at the Monterey town beach on Lake Garfield was tested weekly for *Escherichia coli* (*E. coli*) bacteria in 2002, 2003, and 2004 (n=48) (MA DPH, 2003, 2004, 2005a). The beach was never posted. Currently, there is uncertainty associated with the accurate reporting of freshwater beach closure information to the Massachusetts Department of Public Health, which is required as part of the Beaches Bill. Therefore, no Primary Contact Recreational Use assessments (either support or impairment) decisions are being made using Beaches Bill data for this waterbody.

Historical and current Technical Memoranda (TM) produced by the MassDEP Watershed Planning Program (WPP) are available here: Water Quality Technical Memoranda | Mass.gov and are organized by major watersheds in Massachusetts. Most of these TMs present the water chemistry and biological sampling results of WPP monitoring surveys. The TMs pertaining primarily to biological information (e.g., benthic macroinvertebrates, periphyton, fish populations) contain biological data and metrics that are currently not reported elsewhere. The data contained in the water quality TMs are also provided on the "Data" page (Water Quality Monitoring Program Data | Mass.gov). Many of these TMs have helped inform Clean Water Act 305(b) assessment and 303(d) listing decisions.

Literature review information:

Phosphorous Loading Assessment for Lake Garfield, Monterey, Massachusetts – 2018 Final Report: A study of phosphorous sources was performed in 2016 by Dr. Kenneth Wagner, Water Resource Services, Inc. During this study, samples were collected from April to September in 2016 throughout the lake and included in land use modeling that analyzed phosphorus levels from three potential sources: internal loading, nonpoint source runoff, and on-site waste disposal systems (septic) from lakeshore homes. Additional data was collected measuring dissolved oxygen, turbidity, specific conductivity, chlorophyll-a, pH, and temperature. Nutrient loading was estimated using the Lake Loading and Response Model (see Table A-10 for results). In addition to water quality measurements, an aquatic vegetation survey was performed to determine the extent of invasive species growth, with a particular focus on Eurasian watermilfoil (*Myriophyllum spicatum*).

Measurements were taken at a geographical spread throughout the lake for each potential phosphorus source and QA/QC was performed to ensure data accuracy. This project was performed under an approved Quality Assurance Project Plan (QAPP) developed under a MassDEP 604(b) program grant (2016-01/604).

Aquatic Invasive Surveys (2013, 2014, 2016, 2017, and 2018): Lake surveys of invasive species have been performed annually by Water Resource Services, Stockman Associates, and more recently by New England Aquatic Services. According to survey reports, invasives prevalent in Lake Garfield include Eurasian watermilfoil, water chestnut (*Trapa natans*), and various species of pondweed (*Potamogeton amplifolius, P. richardsonii*). Invasives are most prevalent around the shoreline and as deep at 10 feet into the lake. Deeper portions of the lake in the center and eastern section have less dense to no vegetation. Density is thicker in areas past the annual lake drawdown (6-8 feet in depth) but before the deeper sections (deeper than 10 feet).

Water Quality Impairments

The Clean Water Act requires states to adopt water quality standards equal to or more stringent than the Federal Water Quality Standards. These standards are delineated by different uses, for example recreation or aquatic life. The Clean Water Act also requires states to perform water quality testing and issue a report on water quality results every two years. Water quality impairments are pollutant(s) that cause the waterbody to fall below state and/or federal water quality standards.

Known water quality impairments, as documented in the *2018/2020 Massachusetts Integrated List of Waters* (MassDEP, 2022), are listed in Table A-2 below. Impairment categories from the Integrated List for Lake Garfield are presented in Table A-3.

Table A-2: 2016 MA Integrated List of Waters Categories

Integrated List Category	Description
1	Unimpaired and not threatened for all designated uses.
2	Unimpaired for some uses and not assessed for others.
3	Insufficient information to make assessments for any uses.
4	Impaired or threatened for one or more uses, but not requiring calculation of a Total Maximum Daily Load (TMDL), including: 4a: TMDL is completed 4b: Impairment controlled by alternative pollution control requirements 4c: Impairment not caused by a pollutant - TMDL not required
5	Impaired or threatened for one or more uses and requiring preparation of a TMDL.

Table A-3: Water Quality Impairments (MassDEP 2019)

Assessment Unit ID	Waterbody	Integrated List Category	Designated Use	Impairment Cause	Impairment Source
MA21040	**Lake Garfield**	**5**	Fish Consumption	Mercury in Fish Tissue	Atmospheric Deposition - Toxics
MA21040	**Lake Garfield**	**5**	Fish, other Aquatic Life and Wildlife	Dissolved Oxygen	Source Unknown
MA21040	**Lake Garfield**	**5**	Fish, other Aquatic Life and Wildlife	Eurasian Water Milfoil, *Myriophyllum spicatum*	Introduction of Non-native Organisms (Accidental or Intentional)
MA21040	**Lake Garfield**	**5**	Fish, other Aquatic Life and Wildlife	Non-Native Aquatic Plants	Introduction of Non-native Organisms (Accidental or Intentional)
MA21040	**Lake Garfield**	**5**	Fish, other Aquatic Life and Wildlife	Phosphorus, Total	Internal Nutrient Recycling

Water Quality Goals

Water quality goals are established either by the state or in some cases by the town/community most responsible for improving and maintaining the health of a body of water in order for that waterbody to meet the water quality standards. Lake Garfield's water quality goals are outlined below (Table A-5). Because many of the goals were not defined by the state in terms of water quality standards, Lake Garfield's goals are primarily established by the community.

Water quality goals may be established for a variety of purposes, including the following:

a.) For **water bodies with known impairments**, a Total Maximum Daily Load (TMDL) is established by MassDEP and the United States Environmental Protection Agency (USEPA) as the maximum amount of the target pollutant that the waterbody can receive and still safely meet water quality standards. If the waterbody has a TMDL for total phosphorus (TP) or total nitrogen (TN), or total suspended solids (TSS), that information is provided below and included as a water quality goal.

b.) For **water bodies without a TMDL for total phosphorus** (TP), a default water quality goal for TP is based on target concentrations established in the Quality Criteria for Water (USEPA, 1986) (also known as the "Gold Book"). The Gold Book states that TP should not exceed 50 ug/L in any stream at the point where it enters any lake or reservoir, nor 25 ug/L within a lake or reservoir. For the purposes of developing WBPs, MassDEP has adopted 50 ug/L as the TP target for all streams at their downstream discharge point, regardless of which type of water body the stream discharges to. Lake Garfield's water quality phosphorus goal goes beyond the standard 25 ug/L based on information provided in the 2018 Final Phosphorus Study by Water Resource Service.

c.) Massachusetts Surface Water Quality Standards (314 CMR 4.00, 2022) prescribe the minimum water quality criteria required to sustain a waterbody's designated uses. Lake Garfield is a Class 'B' waterbody (Table A-4). The water quality goal for fecal coliform bacteria is based on the Massachusetts Surface Water Quality Standards (Table A-5).

Table A-4: Surface Water Quality Classification by Assessment Unit

Assessment Unit ID	Waterbody	Class
MA21040	Lake Garfield	B

d.) **Other water quality goals set by the community** (e.g., protection of high-quality waters, in-lake phosphorus concentration goal to reduce recurrence of cyanobacteria blooms, reduction of invasive species, etc.). In addition to the water quality goals that address impairments, community goals were set for cyanobacteria and invasives aquatic plan species.

Table A-5: Water Quality Goals

Pollutant	Goal	Source
Total Phosphorus (TP)	Preliminary goal – Total phosphorus should not exceed: 25 ug/L within any lake or reservoir Secondary goal -Total phosphorus samples range between 8 ug/L – 11ug/L	Quality Criteria for Water (USEPA, 1986) 2018 Phosphorus Loading Assessment for Lake Garfield, Monterey
Bacteria	**Class B Standards** • Public Bathing Beaches: For E. coli, concentrations shall not exceed 126 colony-forming units (cfu) per 100 mL, calculated as the geometric mean of all samples collected within any 30-day or smaller interval; and no more than 10% of all such samples shall exceed 410 cfu per 100 mL (a statistical threshold value) For enterococci, concentrations shall not exceed 35 cfu per 100 mL, calculated as the geometric mean of all samples collected within any 30-day or smaller interval; and no more than 10% of all such samples shall exceed 130 cfu per 100 mL (the statistical threshold value). • Other Waters and Non-bathing Season at Bathing Beaches: For E. coli, concentrations shall not exceed 126 colony-forming units (cfu) per 100 mL, calculated as the geometric mean of all samples collected within any 90-day or smaller interval; and no more than 10% of all such samples shall exceed 410 cfu per 100 mL (a statistical threshold value). For enterococci, concentrations shall not exceed 35 cfu per 100 mL, calculated as the geometric mean of all samples collected within any 90-day or smaller interval; and no more than 10% of all such samples shall exceed 130 cfu per 100 mL (the statistical threshold value).	Massachusetts Surface Water Quality Standards (314 CMR 4.00, 2022)
Invasive aquatic species	Invasive species coverage reduced and maintained to healthy levels that do not impede recreation. Estimated at 1 acre of coverage.	Community Goal
Cyanobacteria	No algal blooms	Community Goal

Note: *There may be more than one water quality goal for bacteria due to different Massachusetts Surface Water Quality Standards Classes for different Assessment Units within the watershed.*

Land Use/Land Cover and Watershed Impervious Cover Information

Land cover describes what covers the ground including vegetation, man-made structures, water, etc. While related, land use refers to *how* the land is used, the intended use. For example, agriculture, residential, or commercial. Both land cover and land use are examined to see how surrounding landscape impacts the water resources. More impervious cover and human land uses generally increase pollutant loading in waterbodies unless properly managed.

Land use/land cover information and watershed impervious cover is presented in the tables and figures below. Land use source data is from 2005 and was obtained from MassGIS (2009b).

Watershed Land Uses and Land Cover

Land cover in the watershed surrounding Lake Garfield is mainly forest at 78%. While not a significant concern, the largest negative impact on water quality is likely residential land use as it comprises 8.2%. This is comprised of low density residential housing (6.8%), medium density (0.8%) and high density housing (0.8%). The second highest impact is likely from agriculture land use (2.4%). Those areas of development are concentrated around the lakeshore and likely contribute to pollutant loading more than development located in the upland areas of the watershed.

Table A-6: Watershed Land Uses and Land Cover

Land Use	Area (acres)	% of Watershed
Forest	1,902.96	78
Water	265.68	10.9
Low Density Residential	165.47	6.8
Agriculture	52.76	2.2
Medium Density Residential	19.47	0.8
Open Land	18.94	0.8
High Density Residential	13.91	0.6
Commercial	0.76	0
Highway	0	0
Industrial	0	0

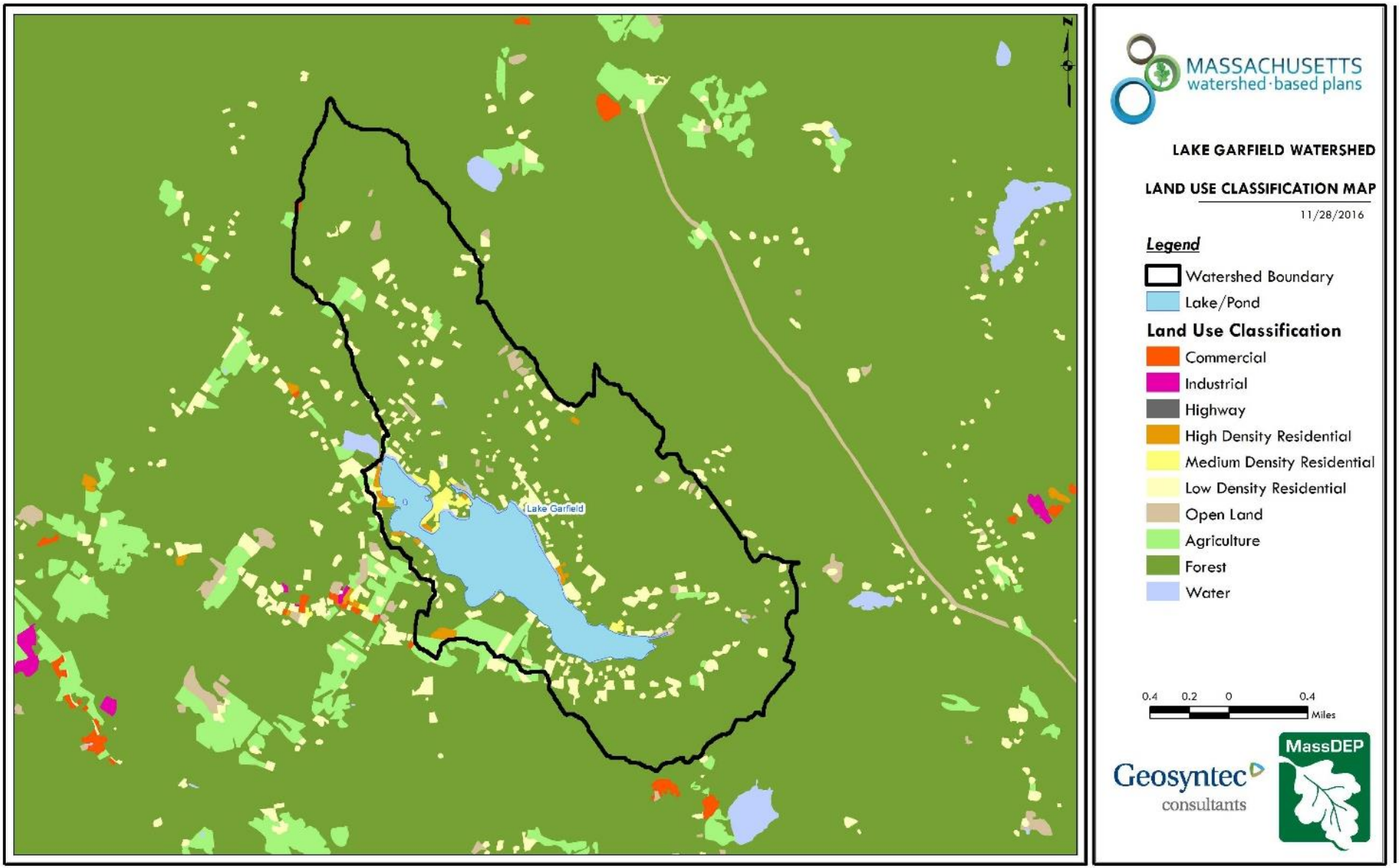

Figure A-2: Watershed Land Use Map (MassGIS, 2009b; MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Ctrl + Click on the map to view a full-sized image in your web browser

Watershed Impervious Cover

There is a strong link between impervious land cover and stream water quality. Impervious cover includes land surfaces that prevent the infiltration of water into the ground, such as paved roads and parking lots, roofs, basketball courts, etc.

Only 4% of the watershed is impervious cover, 2.8% is directly connected impervious cover. This is below the threshold of 10% at which impervious cover negatively impacts water quality and aquatic life, according to modeling done by Thomas Schueler, Lisa Fraley-McNeal and Karen Cappiella in 2000 (Schueler et al, 2009). Of larger concern is the dirt and gravel roads, which have been found to be contributing phosphorous and sediment to Lake Garfield through stormwater runoff (Water Resource Services, 2018).

Impervious areas that are directly connected (DCIA) to receiving waters (via storm sewers, gutters, or other impervious drainage pathways) produce higher runoff volumes and transport stormwater pollutants with greater efficiency than disconnected impervious cover areas which are surrounded by vegetated, pervious land. Runoff volumes from disconnected impervious cover areas are reduced as stormwater infiltrates when it flows across adjacent pervious surfaces.

An estimate of DCIA for the watershed was calculated based on the Sutherland equations. USEPA provides guidance (USEPA, 2010) on use of the Sutherland equations to predict relative levels of connection and disconnection based on the type of stormwater infrastructure within the **total impervious area (TIA)** of a watershed. For each subwatershed, the total areas of each land use were summed to calculate the percent TIA.

Table A-7: TIA and DCIA Values for the Watershed

	Estimated TIA (%)	Estimated DCIA (%)
Lake Garfield	4	2.8

The relationship between TIA and water quality can generally be categorized as shown in **Table A-8** (Schueler et al. 2009):

Table A-8: Relationship between Total Impervious Area (TIA) and water quality (Schueler et al. 2009)

% Watershed Impervious Cover	Stream Water Quality
0-10%	Typically high quality, and typified by stable channels, excellent habitat structure, good to excellent water quality, and diverse communities of both fish and aquatic insects.
11-25%	These streams show clear signs of degradation. Elevated storm flows begin to alter stream geometry, with evident erosion and channel widening. Streams banks become unstable, and physical stream habitat is degraded. Stream water quality shifts into the fair/good category during both storms and dry weather periods. Stream biodiversity declines to fair levels, with most sensitive fish and aquatic insects disappearing from the stream.
26-60%	These streams typically no longer support a diverse stream community. The stream channel becomes highly unstable, and many stream reaches experience severe widening, downcutting, and streambank erosion. Pool and riffle structure needed to sustain fish is diminished or eliminated and the substrate can no longer provide habitat for aquatic insects, or spawning areas for fish. Biological quality is typically poor, dominated by pollution tolerant insects and fish. Water quality is consistently rated as fair to poor, and water recreation is often no longer possible due to the presence of high bacteria levels.
>60%	These streams are typical of “urban drainage”, with most ecological functions greatly impaired or absent, and the stream channel primarily functioning as a conveyance for stormwater flows.

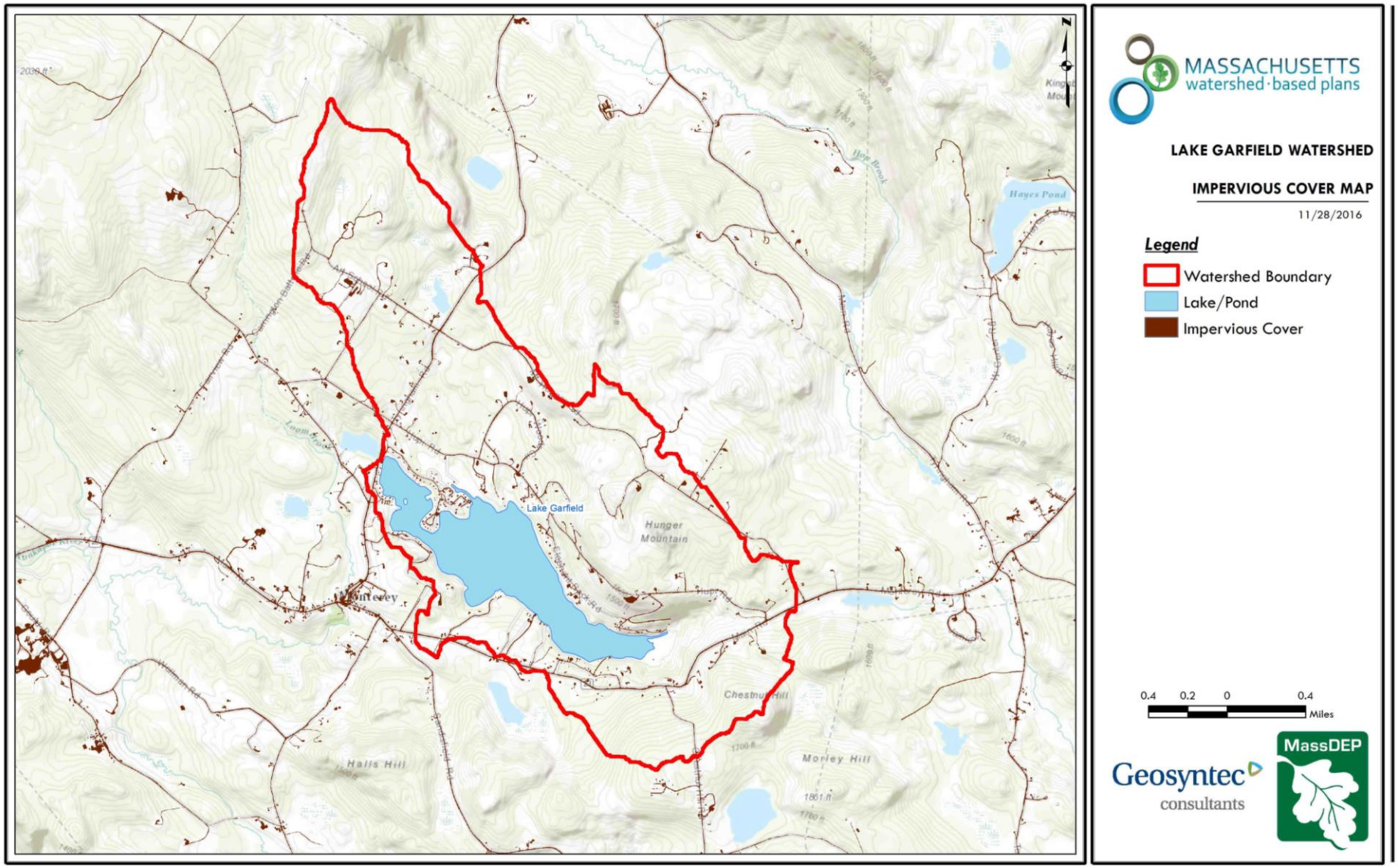

Figure A-3: Watershed Impervious Surface Map (MassGIS, 2009b; MassGIS, 1999; MassGIS, 2001; USGS, 2016)

Ctrl + Click on the map to view a full-sized image in your web browser.

Pollutant Source & Loading Assessment

Geographic Information Systems (GIS) was used for the pollutant loading analysis. The land use data (MassGIS, 2009b) was intersected with impervious cover data (MassGIS, 2009a) and United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) soils data (USDA NRCS and MassGIS, 2012) to create a combined land use/land cover grid. The grid was used to sum the total area of each unique land use/land cover type.

The amount of DCIA was estimated using the Sutherland equations as described above and any reduction in impervious area due to disconnection (i.e., the area difference between TIA and DCIA) was assigned to the pervious D soil category for that land use to simulate that some infiltration will likely occur after runoff from disconnected impervious surfaces passes over pervious surfaces.

Pollutant loading for key nonpoint source pollutants in the watershed was estimated by multiplying each land use/cover type area by its pollutant load export rate (PLER). The PLERs are an estimate of the annual total pollutant load exported via stormwater from a given unit area of a particular land cover type. The PLER values for TN, TP and TSS were obtained from USEPA (Voorhees, 2016b) (see documentation provided in Appendix A) as follows:

$$L_n = A_n * P_n$$

Where L_n = Loading of land use/cover type n (lb/yr); A_n = area of land use/cover type n (acres); P_n = pollutant load export rate of land use/cover type n (lb/acre/yr)

Table A-9: Estimated Pollutant Loading for Key Nonpoint Source Pollutants

Land Use Type	Pollutant Loading[1]		
	Total Phosphorus (TP) (lbs/yr)	Total Nitrogen (TN) (lbs/yr)	Total Suspended Solids (TSS) (tons/yr)
Forest	280	1,478	65.83
Low Density Residential	47	477	6.39
Agriculture	29	178	2.54
Open Land	4	53	0.92
Medium Density Residential	7	63	0.84
High Density Residential	7	50	0.71
Commercial	0	2	0.03
Highway	0	0	0.00
Industrial	0	0	0.00
TOTAL	373	2,301	77.25

[1]These estimates do not consider loads from point sources or septic systems.

According to the Lake Loading Response Model performed during the Phosphorous Loading Assessment for the Lake Garfield, Monterey, Massachusetts – 2018 Final Report, the greatest contributor of phosphorous is from the watershed runoff (54%) - a loading of 71.8 kg/yr. This includes stormwater runoff from developed areas and groundwater inputs. Internal nutrient cycling contributes almost 20% (26.1 kg/yr). Direct precipitation contributes to just under 15% (19.5 kg/yr). Septic systems contribute approximately 7.3% and wildlife contributes 4.5%. In summary, stormwater runoff is the largest contributor of phosphorous to Lake Garfield (See Figure A-4 for breakdown of Phosphorus Loading by Source). These results were confirmed by field sampling results performed during the 2016 study performed by Dr. Kenneth Wagner (Water Resource Services, 2018). Field data from this study found negligible phosphorus loading from septic systems, some internal loading especially at the hypolimnion depths, and the highest phosphorous levels coming from stormwater runoff (Water Resource Services, 2018).

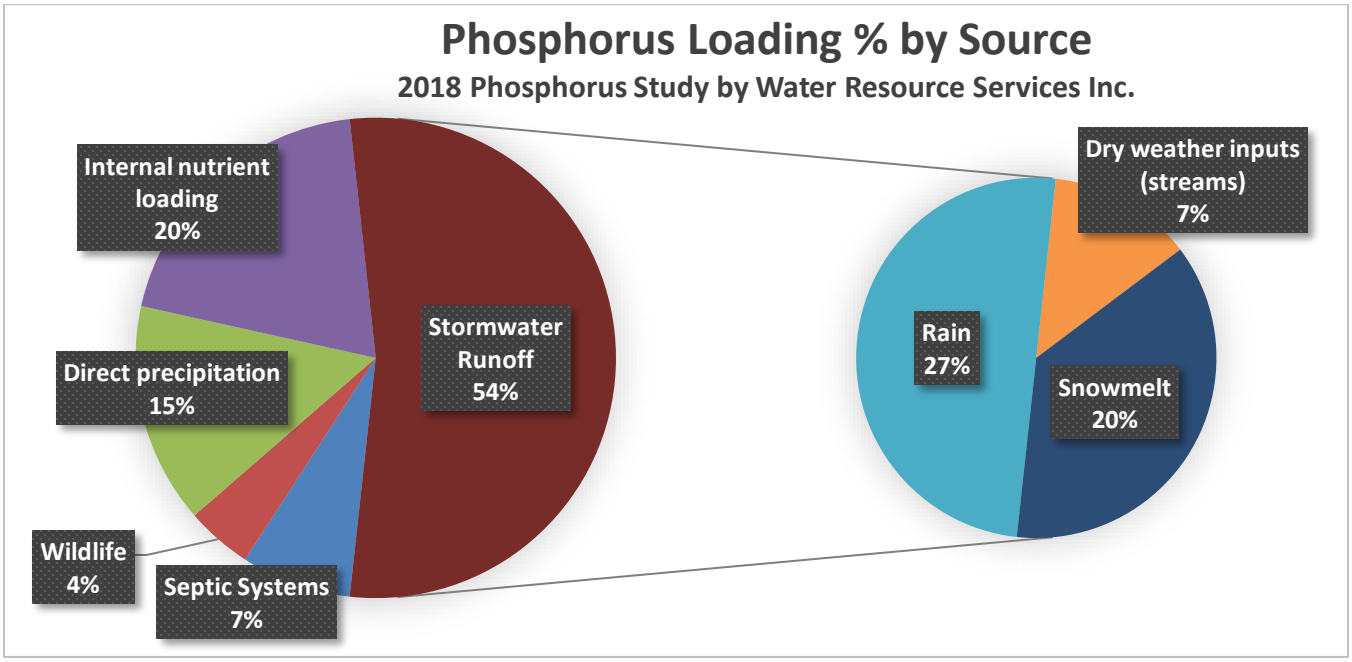

Figure A-4: Phosphorus Loading % by Source (Water Resource Services, 2018)

The Phosphorus Loading Assessment quantified phosphorus pollutant loading from runoff by subwatershed (see Figure A-5) through tributary sampling in each subwatershed. Table A-9 presents the results of that study and indicates that phosphorus loading is greatest in subwatersheds H and F+G, an area along Hupi Road on the northeast side of the lake. This area was narrowed down further by Town staff looking at parcel ownership and project feasibility. Site reconnaissance with engineering firm Foresight Land Services and Monterey Highway Department selected one section of Hupi Road as viable for structural BMPs. **For this reason, structural BMPs were prioritized and developed for this northeast Hupi Road subwatershed.** Non-structural BMPs will target the entire Lake Garfield watershed.

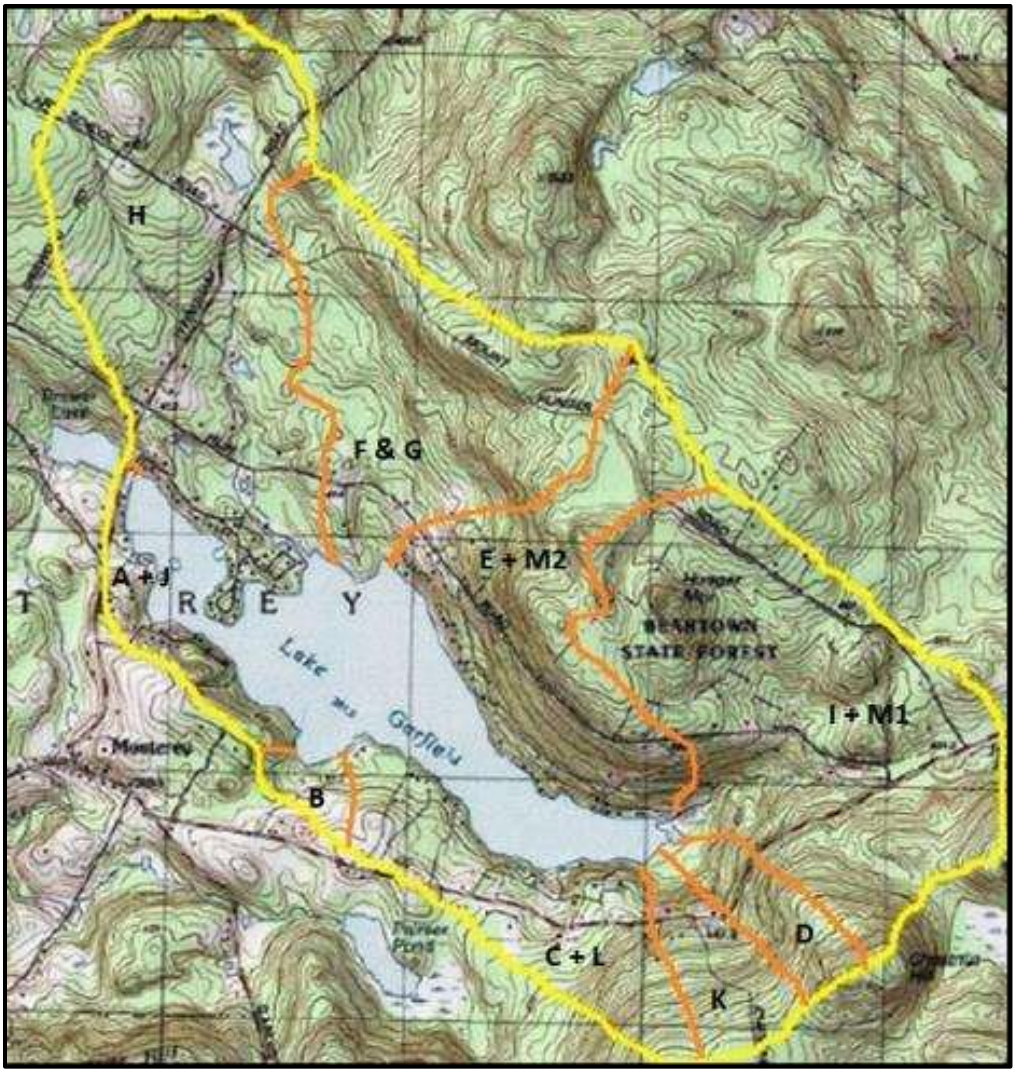

Figure A-5: Lake Garfield Subwatersheds (Water Resource Services, 2018)

Table A-10: Estimation of phosphorus loading to Lake Garfield from surface water
(Water Resource Services, 2018)

	Total P Concentration			Total Phosphorus Load			
Drainage	Snow melt	Dry	Wet	Snow melt	Dry	Wet	Total
	(mg/L)	(mg/L)	(mg/L)	(kg/yr)	(kg/yr)	(kg/yr)	(kg/yr)
A+J	0.057	0.005	0.052	2.9	0.2	2.1	5.2
B	0.015	0.005	0.015	0.2	0.1	0.2	0.5
C+L	0.038	0.013	0.077	6.0	1.4	9.9	17.3
D	0.015	0.005	0.060	0.8	0.2	2.7	3.8
E + M2	0.052	0.023	0.023	12.1	3.7	4.3	20.2
F+G	0.037	0.017	0.112	9.9	3.2	23.9	37.0
H	0.023	0.008	0.068	10.2	2.5	24.3	37.0
I + M1	0.015	0.010	0.033	6.3	2.8	10.9	20.0
K	0.016	0.005	0.247	0.9	0.2	11.2	12.3
Total				**49.4**	**14.3**	**89.5**	**153.2**

Element B: Determine Pollutant Load Reductions Needed to Achieve Water Quality Goals

Element B of your WBP should:

Determine the pollutant load reductions needed to achieve the water quality goals established in Element A. The water quality goals should incorporate Total Maximum Daily Load (TMDL) goals, when applicable. For impaired water bodies, a TMDL establishes pollutant loading limits as needed to attain water quality standards.

Estimated Pollutant Loads

Table B-1 lists estimated pollutant loads and required load reductions for the following primary nonpoint source (NPS) pollutants: total phosphorus (TP), total nitrogen (TN), and total suspended solids (TSS). These estimated loads are based on the pollutant loading analysis presented in Section 4 of Element A. Required load reductions are based on water quality targets in the Water Quality Goals section below. In most instances, the water quality targets are below current conditions. Thus reductions were estimated by evaluating the loading of pollutants into Lake Garfield prior to development using the PLER for forest by soil type. With base loading established, targets were set at a midway point between current conditions and the undeveloped state.

Water Quality Goals

Water quality goals for primary NPS pollutants are listed in **Table B-1** based on the following:

- TMDL water quality goals (if a TMDL exists for the water body).
- For all water bodies, including impaired waters that have a pathogen TMDL, the water quality goal for bacteria is based on the Massachusetts Surface Water Quality Standards (314 CMR 4.00, 2022) that apply to the Water Class of the selected water body.
- If the water body does not have a TMDL for TP, a default target TP concentrations is provided which is based on guidance provided by the USEPA in Quality Criteria for Water (1986), also known as the "Gold Book". Because there are no similar default water quality goals for TN and TSS, goals for these pollutants are provided in **Table B-1** only if a TMDL exists or alternate goal(s) have been optionally established by the WBP author.
- According to the USEPA Gold Book, total phosphorus should not exceed 50 ug/L in any stream at the point where it enters any lake or reservoir. The water quality loading goal was estimated by multiplying this target maximum phosphorus concentration (50 ug/L) by the estimated annual watershed discharge for the selected water body. To estimate the annual watershed discharge, the mean flow was used, which was estimated based on United States Geological Survey (USGS) "Runoff Depth" estimates for Massachusetts (Cohen and Randall, 1998). Cohen and Randall (1998) provide statewide estimates of annual Precipitation (P), Evapotranspiration (ET), and Runoff (R) depths for

the northeastern U.S. According to their method, Runoff Depth (R) is defined as all water reaching a discharge point (including surface and groundwater), and is calculated by:

$$P - ET = R$$

A mean Runoff Depth R was determined for the watershed by calculating the average value of R within the watershed boundary. This method includes the following assumptions/limitations:

a. For lakes and ponds, the estimate of annual TP loading is averaged across the entire watershed. However, a given lake or reservoir may have multiple tributary streams, and each stream may drain land with vastly different characteristics. For example, one tributary may drain a highly developed residential area, while a second tributary may drain primarily forested and undeveloped land. In this case, one tributary may exhibit much higher phosphorus concentrations than the average of all streams in the selected watershed.

b. The estimated existing loading value only accounts for phosphorus due to stormwater runoff. Other sources of phosphorus may be relevant, particularly phosphorus from on-site wastewater treatment (septic systems) within close proximity to receiving waters. Phosphorus does not typically travel far within an aquifer, but in watersheds that are primarily unsewered, septic systems and other similar groundwater-related sources may contribute a significant load of phosphorus that is not captured in this analysis. As such, it is important to consider the estimated TP loading as "the expected TP loading from stormwater sources."

c. If the calculated water quality goal is higher than the existing estimated total load; the water quality goal is automatically set equal to the existing estimated total load.

Table B-1: Pollutant Load Reductions Needed

Pollutant	Existing Estimated Total Load	Water Quality Loading Goal	Required Load Reduction
Total Phosphorus	337.7 lbs/yr according to Water Resource Specialist 2018 Report	304.1 lbs/yr	33.6 lbs/yr
Total Nitrogen	1,768.1 lbs/yr from groundwater (Water Resource Services, 2018)	1,492.8 lbs/yr	275.3 lbs/yr
Total Suspended Solids	77 tons/yr	76 tons/yr	1 ton/yr
Bacteria	*MSWQS for bacteria are concentration standards (e.g., colonies of fecal coliform bacteria per 100 ml), which are difficult to predict based on estimated annual loading.*	Class B. **Class B Standards** • Public Bathing Beaches: For E. coli, concentrations shall not exceed 126 colony-forming units (cfu) per 100 mL, calculated as the geometric mean of all samples collected within any 30-day or smaller interval; and no more than 10% of all such samples shall exceed 410 cfu per 100 mL (a statistical threshold value) For enterococci, concentrations shall not exceed 35 cfu per 100 mL, calculated as the geometric mean of all samples collected within any 30-day or smaller interval; and no more than 10% of all such samples shall exceed 130 cfu per 100 mL (the statistical threshold value). • Other Waters and Non-bathing Season at Bathing Beaches: For E. coli, concentrations shall not exceed 126 colony-forming units (cfu) per 100 mL, calculated as the geometric mean of all samples collected within any 90-day or smaller interval; and no more than 10% of all such samples shall exceed 410 cfu per 100 mL (a statistical threshold value). For enterococci, concentrations shall not exceed 35 cfu per 100 mL, calculated as the geometric mean of all samples collected within any 90-day or smaller interval; and no more than 10% of all such samples shall exceed 130 cfu per 100 mL (the statistical threshold value).	None
Cyanobacteria	349 cell/mL	Maintain low levels of cyanobacteria <20,000 cells/mL	None
Aquatic Invasive Species	5 acres	Reduce invasive aquatics plants enough to not impede recreation – est. 1 acre	4 acres

Element C: Describe management measures that will be implemented to achieve water quality goals

Element C: A description of the nonpoint source management measures needed to achieve the pollutant load reductions presented in Element B, and a description of the critical areas where those measures will be needed to implement this plan.

BMP Hotspot Map:

One of the key components of a watershed-based plan is to identify Best Management Practices (BMPs). BMPs fall into two categories. Structural BMPs are physical structures installed to mitigate nonpoint source pollution. These include green infrastructure solutions such as rain gardens, bioswales, or infiltration basins as well as grey infrastructure solutions such as deep sump catch basins and hydrodynamic (aka oil and grit) separators. Non-structural BMPs are practices that are more programmatic or educational. Good housekeeping, outreach campaigns around sustainable landscaping, stormwater pollution classroom curriculums, and stream clean-ups are all examples of non-structural BMPs. Successful watershed management need a mixture of both structural and non-structural BMPs.

To determine where structural BMPs would be most effective in reducing pollutant loading, GeoSyntec created a GIS based analysis called a Hotspot map. This analysis solely evaluated individual parcels for BMP implementation suitability and likelihood for the measures to perform effectively within the parcel's features. This analysis does not quantify the pollutant loading to these parcels from the parcel's upstream catchment. When further evaluating a parcel's BMP implementation suitability and cost-effectiveness of BMP implementation, the existing pollutant loading from the parcel's upstream catchment and potential pollutant load reduction from BMP implementation should be evaluated. This map identifies high priority parcels for structural BMPs (also referred to as management measure) implementation:

- Each parcel within the watershed was evaluated based on ten different criteria accounting for the parcel ownership, social value, and implementation feasibility (See **Table C-1** for more detail below);
- Each criterion was then given a score from 0 to 5 to represent the priority for BMP implementation based on a metric corresponding to the criterion (e.g., a score of 0 would represent lowest priority for BMP implementation whereas a score of 5 would represent highest priority for BMP implementation);
- A multiplier was also assigned to each criterion, which reflected the weighted importance of the criterion (e.g., a criterion with a multiplier of 3 had greater weight on the overall prioritization of the parcel than a criterion with a multiplier of 1); and
- The weighted scores for all the criteria were then summed for each parcel to calculate a total BMP priority score.

Table C-1 presents the criteria, indicator type, metrics, scores, and multipliers that were used for this analysis. Parcels with total scores above 60 are recommended for further investigation for BMP implementation suitability. **Figure C-1** presents the resulting BMP Hotspot Map for the watershed. The following link includes a Microsoft Excel file with information for all parcels that have a score above 60: hotspot spreadsheet

GIS data used for the BMP Hotspot Map analysis included: MassGIS (2015a), MassGIS (2015b), MassGIS (2017a), MassGIS (2017b), MassGIS (2020), MA Department of Revenue Division of Local Services (2016), MassGIS (2005); ArcGIS (2020), MassGIS (2009b), MassGIS (2012), and ArcGIS (2020b).

Table C-1: Matrix for BMP Hotspot Map GIS-based Analysis

Criteria	Indicator Type	METRICS																										Multiplier	Maximum Potential Score
		Yes or No?		Hydrologic Soil Group				Land Use Type									Water Table Depth				Parcel Area			Parcel Average Slope						
		Yes	No	A or A/D	B or B/D	C or C/D	D	Low and Medium Density Residential	High Density Residential	Commercial	Industrial	Highway	Agriculture	Forest	Open Land	Water	101-200 cm	62-100 cm	31-61 cm	0-30 cm	Greater than 2 acres	Between 1-2 acres	Less than 1 acre	Less than 2%	Between 2% and 15%	Greater than 15%	Less than 50%	Between 51% and 100%		
Is the parcel a school, fire station, police station, town hall or library?	Ownership	5	0																									2	10
Is the parcel's use code in the 900 series (i.e. public property or university)?	Ownership	5	0																									2	10
Is parcel fully or partially in an Environmental Justice Area?	Social	5	0																									2	10
Most favorable Hydrologic Soil Group within Parcel	Implementation Feasibility			5	3	0	0																					2	10
Most favorable Land Use in Parcel	Implementation Feasibility							1	2	4	2	4	5	1	4	X[1]												3	15
Most favorable Water Table Depth (deepest in Parcel)	Implementation Feasibility																5	4	3	0								2	10
Parcel Area	Implementation Feasibility																				5	4	1					3	15
Parcel Average Slope	Implementation Feasibility																							3	5	1		1	5
Percent Impervious Area in Parcel	Implementation Feasibility																										5	2.5	1	5
Within 100 ft buffer of receiving water (stream or lake/pond)?	Implementation Feasibility	5	2																									2	10

Note 1: **X** denotes that parcel is excluded

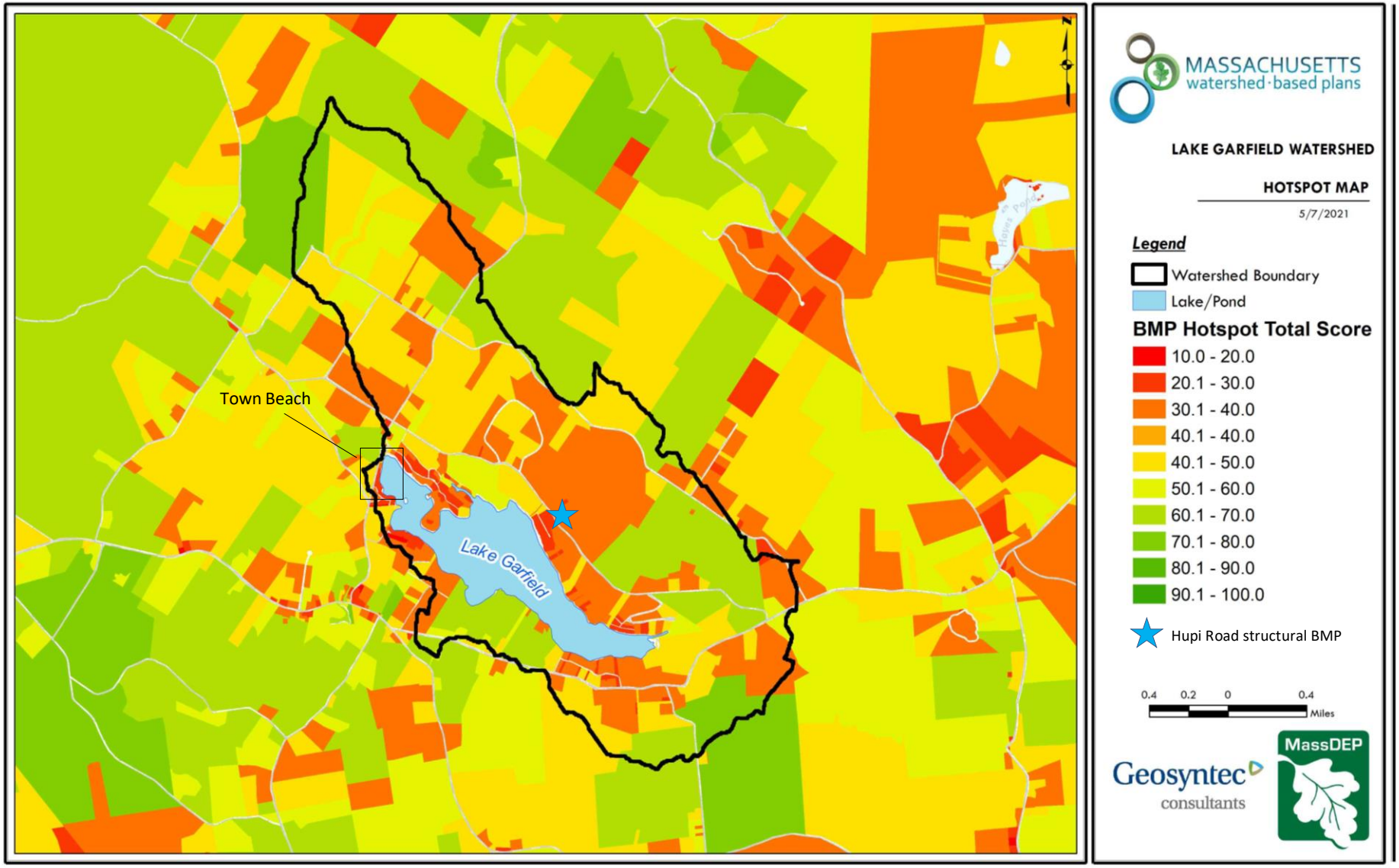

Figure C-1: BMP Hotspot Map (MassGIS (2015a), MassGIS (2015b), MassGIS (2017a), MassGIS (2017b), MassGIS (2020), MA Department of Revenue Division of Local Services (2016), MassGIS (2005), ArcGIS (2020), MassGIS (2009b), MassGIS (2012), ArcGIS (2020b))

Ctrl + Click on the map to view a full-sized image in your web browser.

Based on the hotspot map and the Phosphorous Loading Assessment for Lake Garfield, Monterey, Massachusetts – 2018 Final Report, it was determined that phosphorus loading was primarily the result of sediment runoff (i.e., phosphorus attached to particulate matter) from four subwatersheds in the north area of Lake Garfield watershed (subwatersheds labeled H, F&G, E&M2, and I&M1 in Figure A-5) as well as some loading from subwatershed in the southeast labeled as subwatershed C&L in Table A-4 (Water Resource Services, 2018). Those areas roughly correspond to darker red hotspot areas in the northeast area of the Hotspot Map (Figure C-1) with the exception of the area around the Town Beach which scored higher for BMPs due to the public land ownership.

Preliminary field reconnaissance of subwatersheds by engineering consultants Foresight Land Services and the Town of Monterey Highway Department determined that **the area most feasible for structural BMP installation is a drainage area of Hupi Road from Peppermint Brook, a seasonal, intermittent stream to Elephant Rock Road.** This area is located in subwatershed F&G in Figure A-5, indicated by the blue star in the BMP Hotspot Map (Figure C-1). According to field reconnaissance, a significant amount of sediment was coming from this drainage area, which in turn is contributing to the phosphorus loading as sediment is a carrier for phosphorus. Figure C-2 shows the highlighted land use of this drainage area and Figure C-3 illustrates the area soils. Surrounding subwatersheds E&M2 was explored during Field Reconnaissance and found to be too steep within the publicly owned right of way for a structural BMP installation. Similarly, subwatershed C&L also known as Chestnut Hill in the southeast section of Lake Garfield watershed has a significant slope that would make structural BMP installation difficult. Subwatershed E&M2 just north of Chestnut Hill indicated elevated phosphorus loading, however this is likely a result of the great amount of area drained. The land use of subwatershed E&M2 is dominated by forest and thus site suitability is difficult to determine. Finally, subwatershed H, indicates some of the highest loading according to the 2018 Phosphorus Loading Report, and has some of the greatest potential for structural BMPs. With all these subwatersheds, Friends of Lake Garfield, Lake Garfield Working Group, and the Town of Monterey would like to complete follow-up site studies to identify what structural BMPs, if any, could be implemented to effectively lessen phosphorus loading.

Besides the Hupi Road area described above, the other greatest potential to address phosphorus loading from stormwater is in the residential area located on a small peninsula which juts into the lake (Figure A-5 subwatershed H). This area is almost entirely private property, thus structural BMPs would need to be implemented by or on resident's land. To accomplish this, Friends of Lake Garfield and Lake Garfield Working Group would like to create a collective group of residents willing to have stormwater BMPs installed on their property. Residents would sign an agreement to have their property surveyed for site suitability and provide permission for installation when funding is secured. Stakeholders are interested in exploring this and other areas further in order to more appropriately site BMPs.

Figure C-2: Hupi Road Selected BMP Drainage Area

Figure C-3 Soils Map of Hupi Road BMP Selected Area

Proposed Management Measures:

Structural BMPs

While specific BMPs have been identified below in the Hupi Road BMP Treatment Train, there are several pretreatment and treatment BMPs that effectively prevent and/or remove phosphorus. Pretreatment can be especially helpful when phosphorus pollution is a result of sedimentation. Pretreatment BMPs can include deep sump catch basins, vegetative filter strips, oil/grit separators, and sediment forebays. These pretreatment BMPs function by slowing flow, holding back sediments and solids thereby allowing them settle out before stormwater goes into a treatment BMP.

Volume 2 of the Massachusetts Stormwater Handbook provides a wealth of information on structural BMPs both pretreatment, treatment, and conveyance. Outlined here are a few of the most effective BMPs for removing phosphorus.

Vegetated Stream Buffers

An excellent BMP for lake or streamside homeowners is to install a vegetative buffer along their shoreline. Vegetative buffers can be anywhere between 10 ft. and 100 ft. wide and typically are a mix of upload trees and shrubs down to riparian herbaceous plant species.

Rain Gardens – Rain gardens are depressions in the ground filled with sand, soil media, and mulch intended to filter runoff that's directed into it. Rain gardens can remove up to 90% of phosphorus when designed large enough and/or paired with pretreatment systems. These structures can be lined and piped to prevent infiltration in high pollutant areas or left unlined to allow for exfiltration and groundwater recharge (MassDEP, 2016b). Co-benefits of rain gardens is the opportunity to install pollinator friendly plant species and provide native habitat. These systems are especially effective at treating the "first flush" aka initial runoff of stormwater, which contains the most amount of nutrient pollution (Zeng, 2019).

Infiltration Basins – Infiltration basins are impounded sections that catch stormwater runoff, usually by way of a pretreatment basin. As the name suggests, these systems allow stormwater to infiltrate and are sometimes constructed with more than one chamber to catch varying amounts of volume. Infiltration basins are estimated to remove 60%-70% of phosphorus if constructed properly. It should be noted that infiltration basins should be sited some distance away from steep gradients (15% or more) in order to properly capture and retain stormwater.

Bioswales aka Water Quality Swales - Bioswales are shallow linear depressions that collect, slow down, and absorb stormwater from nearby areas. Bioswales can be landscaped with native plants, or simply seeded with grass to reduce maintenance need. At times, rock veins or rip rap are installed along the bioswale to reduce stormwater velocity, allowing more of the water to infiltrate and alleviate flashy flow conditions. Bioswales can be one of the most effective ways to remove phosphorus with an estimated removal rate similar to rain gardens and bioretention basins (20% - 90%). They are excellent ways to capture water along roadsides and driveways with curb cutting or sheet flow directed into them.

Infiltration Trenches – In situations where space is limited, an infiltration trench can remove significant phosphorus (40% - 70%). Infiltration trenches are typically linear rectangular trenches filled with sand, gravel, and stone substrate that runoff is directed into and allowed to exfiltrate through the bottom into the subsoil.

Media Filters (Sand, Organic or Proprietary Media Mix) – For a less visible BMP, media filters provide filtration of stormwater underground in a two-chamber concrete system filled with media tailored to remove phosphorous. This media could be a mix of sand, loam, peat, mulch or other removal material such as steel wool (James,

1992). The Massachusetts Stormwater Handbook estimates that Sand & Organic Media Filters remove 10% - 50% of phosphorus (MassDEP, 2016b).

Hupi Road BMP Treatment Train

The structural BMPs described below will address phosphorus loading in subwatershed F&G (Hupi Road) and subwatershed H (Lake Smart Program).Funding is being sought to examine structural BMPs in areas with high pollutant loading including subwatersheds H, E&M2, I&M1, and C&L aka Chestnut Hill.

The location for the Hupi Road Structural BMPs were selected based on the phosphorus source study that considered the entire Lake Garfield watershed (Phosphorous Loading Assessment for Lake Garfield, WRS, 2018) as well as site reconnaissance as described above. Based on this, the drainage area indicated by the blue star on Figure C-1 and outlined in Figures C-2 and C-3 was identified as the highest priority for structural BMPs. Using 604(b) funding awarded by MassDEP (20-01/604), the Town of Monterey hired Foresight Land Services to determine BMPs needed to address runoff and create conceptual design plans. Figure C-4 illustrates the design plans created. For the full design package see Appendix B.

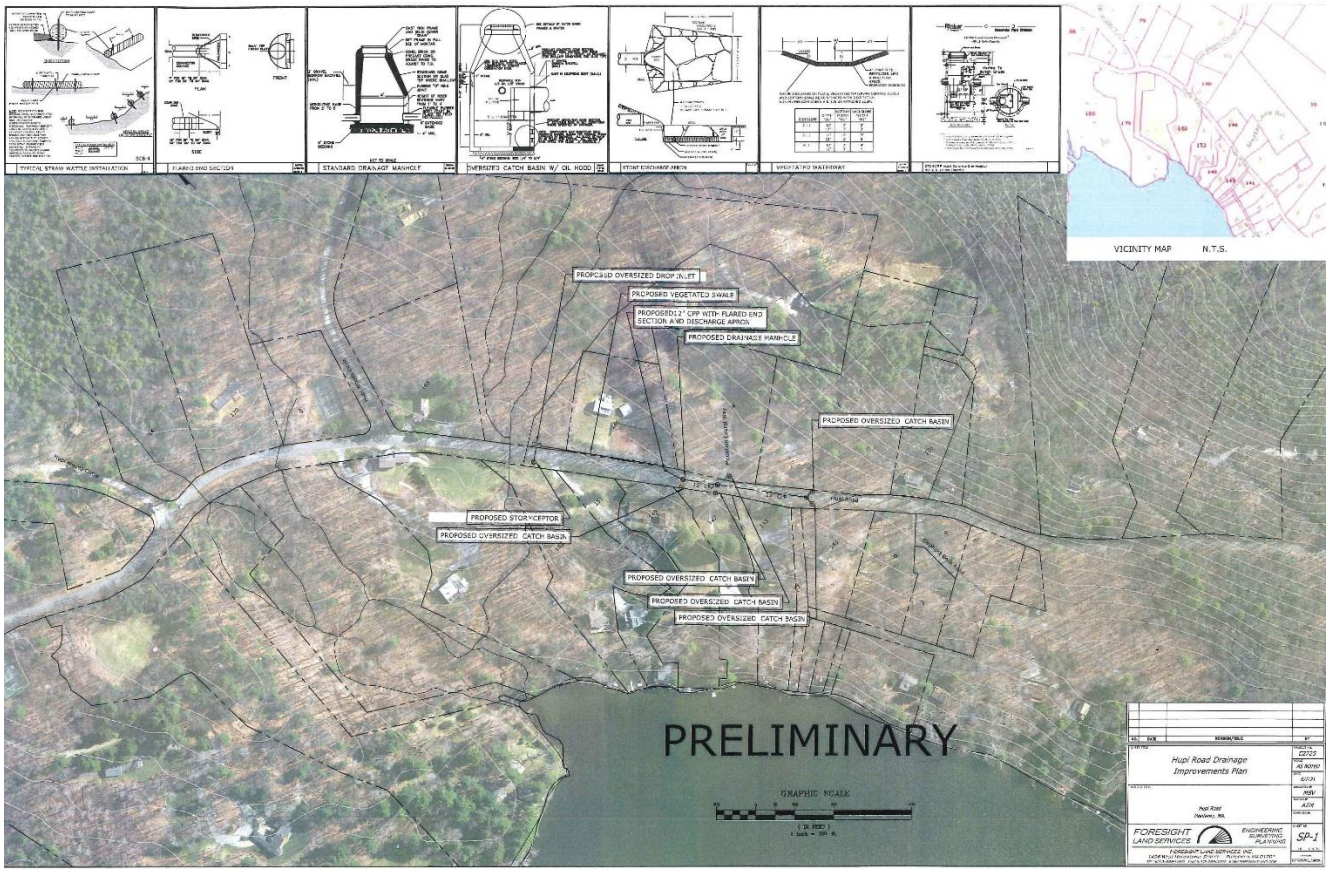

Figure C-4 BMP Conceptual Designs for Hupi Road Drainage Area

Preliminary designs shown in Figure C-4 outline a "treatment train" of BMPs that capture sediment carried by stormwater from the road and nearby property, treat, and infiltrate runoff before it reaches Lake Garfield. The treatment train contains the following elements:

- Linear bioswale along the northeast edge of Hupi Road to catch runoff from hills northeast of the drainage area;

- Deep sump catch basins connected by a closed pipe system along both sides of the road, at driveway locations, and at Mountain Laurel Way. This stormwater system will transport stormwater along the road down gradient, allowing sediments and solids to settle out for catch basin cleanings regularly performed by the Town of Monterey;
- Hydrodynamic separator or Stormceptor that separates out oil and additional pollutants;
- Rain garden or swale to capture post-treatment near the seasonal stream, allowing for further infiltration.

The estimated cost of all BMPs when installed together is $221,000, including final engineering design, permitting and construction. For a breakdown of costs and more details on designs see Appendix B.

The collection of BMPs installed will result in an 95% reduction in estimated pollutant load of total suspended solids (TSS), which in turn reduces phosphorus loading to Lake Garfield (Table C-2). Estimated load reductions were calculated using the MassDEP TSS Removal Calculation Worksheet.

Table C-2 TSS Pollutant Load Reduction

TSS Removal Calculation Worksheet

Location: Hupi Road, Monterey

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	0.25	1.00	0.25	0.75
Water Quality Swale - Dry	0.70	0.75	0.53	0.23
Oil Grit Separator	0.25	0.23	0.06	0.17
Water Quality Swale - Dry	0.70	0.17	0.12	0.05
	0.00	0.05	0.00	0.05

Total TSS Removal = 95%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: Hupi Road BMPs, Monterey
Prepared By: CEI
Date: 6/25/2021

*Equals remaining load from previous BMP (E) which enters the BMP

Monterey Town Beach Rain Garden

To demonstrate the value of stormwater BMPs, a rain garden could be installed at the Town Beach to accompany the Rain Garden Diaroma proposed. The Town beach includes two parcels on either side of Sylvan Road, on the East end of Lake Garfield, just off Tyringham Road. The southern parcel includes a picnic area, parking lot, kayak stand, and a sandy beach with a swimming area. The northern parcel is currently a grassy area with a small Verizon utility shed on it. Both the northern and southern parcel have space for a small 500 – 1,000 sq. ft. rain garden that would capture runoff from surrounding grassy areas and impervious surfaces from nearby roads and in the case of the southern option, a dirt parking lot (see Figure C-5 - Land Cover). The soil at both these locations is Pilsbury fine sandy loam (hydrologic soil group C/D) with a slight slope (0-5%) toward the Lake. Despite it being sandy, this soil has is classified as "poorly drained" (see Figure C-6), thus soil amendments will need to be part of the project installation.

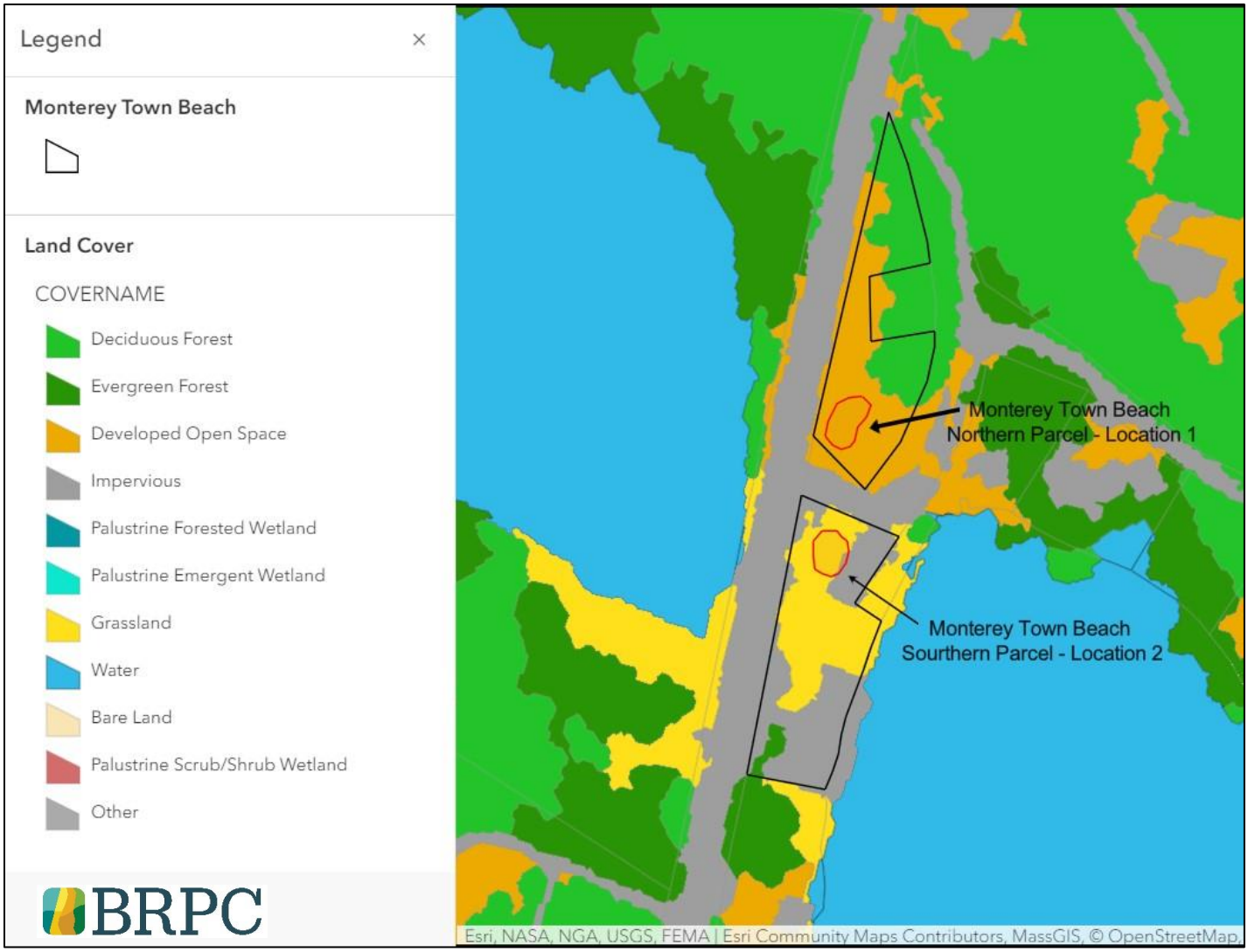

Figure C-5: Land Cover of Monterey Town Beach
(BRPC, 2022 using MassGIS Layers)

Figure C-6: Hydrologic Soils of Monterey Town Beach
(BRPC, 2022 using MassGIS Layers)

A conceptual design has not been completed for this BMP, however sketches in Figure C-7 and C-8 outline the two possible locations on the northern and southern parcel. It was estimated that in either option a rain garden of 500 square feet could be created capturing around half an acre. The surrounding land use is roughly 50% pervious open space, mainly grassy field, and 50% impervious roads, some of which are dirt roads. Given these inputs, the Mass DEP Watershed-Based Planning Tool estimated 2.3 lbs/yr total nitrogen load reduction, 0.3 lbs/yr total phosphorus reduction, and 168 lbs/yr TSS load reduction (see Figure C-9).

The Rain Gardens will be designed in collaboration with Monterey Parks Commission to ensure full use of the park and consider best design elements given how the Town Beach is currently used. The Friends of Lake Garfield, and the Lake Garfield Working Group will spearhead the education elements regarding signage and the planned rain garden diorama. These groups will also help with project management. The Monterey Native Plants Working Group will provide valuable advice on landscaping design and plant selection including riparian pollinator species appropriate for the rain garden as well as help organize volunteers to help with planting once constructed. An estimated cost for this project is $20,000, $16,500 for design and construction and an additional $3,500 for project management.

The hope is that this project will serve as an exemple BMP and encourage residents as well as visitors to install similar small BMP projects on their property throughout the watershed.

Figure C-7: Town Beach Rain Garden Option 1 – Northern Location

Figure C-8: Town Beach Rain Garden Option 2 – Southern Location

BMP TYPE (edit)		**LAND USE/COVER TYPE** (in drainage area)	**% OF DRAINAGE AREA**
BIORETENTION AND RAIN GARDENS		OPEN LAND, Impervious	50
BMP SIZE (design storm depth; inches)	**DRAINAGE AREA** (acres)	OPEN LAND, Pervious	50
1.00	0.50	+ land use/cover	
BMP LOCATION			
Monterey Town Beach			

ESTIMATED POLLUTANT LOAD REDUCTIONS (lbs/yr)			ESTIMATED FOOTPRINT (sf)	ESTIMATED COST ($)
TN: 2.32699	TP: 0.30495	TSS: 168.03999	579.8	16,496

Figure C-9: Town Beach Rain Garden Potential Load Reductions

Lake Garfield Lake Smart Program

Many areas where structural BMPs would be most effective are located on private residential property. Friends of Lake Garfield have mapped which properties have streams, both buried and above ground, that feed into the lake by walking the lakeshore during the drawdown winter season. Outfalls and stream flow will help identify which properties should be prioritized. This is especially true in subwatershed H (Figure A-5) located on the peninsula in the neighborhood off Sylvan Road. Friends of Lake Garfield and the Lake Garfield Working Group will work with residents to sign a "Lake Smart Pledge" commitment in which homeowners agree to be included in a joint siting study that looks at where structural stormwater BMPs should go to maximize phosphorus reduction. Once sited, homeowners within the program will commit to allowing BMP implementation on their property and assist with long-term, ongoing maintenance.

Figure C-10: Example BMPs for Homeowners
(BRPC, 2022)

This model is similar to the RainWise Rebate Program implemented in Seattle. The RainWise program allows contractors to site and install rain gardens and rain cisterns on residential property. This way phosphorus reductions are accomplished through mitigation at many, smaller BMP sites. Residents pay the up-front costs that are then rebated back to them covering the cost of installation. In Lake Garfield's Lake Smart Program, costs will be covered up-front through a combination of grants and funding provided through the Town, Friends of the Lake, and Lake Garfield Working Group. To implement this program, the Town will seek Clean Water Act 319 and the State's Municipal Vulnerability Preparedness Action Grant to develop the program, perform necessary outreach, and site small BMP projects.

Nonstructural BMPs

In addition to the structural BMPs outlined above, the following non-structural BMPs were identified and developed by stakeholders (including members of the Friends of Lake Garfield, Lake Garfield Working Group, and Monterey residents) during information and feedback sessions. Table C-2 gives a summary of these nonstructural BMPs.

Table C-3 Nonstructural BMPs

BMP TYPE	Diver Assisted Suction Harvesting (DASH)
BMP LOCATION	Locations are determined by an annual invasives aquatic survey
DESCRIPTION	The Town of Monterey supports the Lake Garfield Working Group in funding annual removal of milfoil and other invasives via Diver Assisted Suction Harvesting (DASH).
ESTIMATED POLLUTANT LOAD REDUCTIONS	Reduction of estimated 900 gallons of invasives per year
ESTIMATED COST ($)	$30,000/year

BMP TYPE	Boat Wash Station
BMP LOCATION	Lake Garfield Boat Launch
DESCRIPTION	Invasives are commonly spread from lake system to lake system through boats as invasives aquatics, zebra mussels, and other plant pieces get taken into the ballasts or caught up in the motor. A boat wash station and accompanying boat launch monitor would inform boaters and allow them to clean their boats of invasives either before or after recreating at Lake Garfield, thereby reducing spread.
ESTIMATED POLLUTANT LOAD REDUCTIONS	200 lbs of invasives
ESTIMATED COST ($)	$70,000

BMP TYPE	Lake Drawdown
BMP LOCATION	Lake Garfield
DESCRIPTION	The Town of Monterey draws down the lake 5 - 8 feet annually between October 15 and February 15th. While not intended to control invasive aquatics, annual invasive species surveys have shown that drawdowns significantly reduce Eurasian milfoil around the shallower, shoreline areas where the water was absent for a portion of the year.
ESTIMATED POLLUTANT LOAD REDUCTIONS	Invasive thinning ~30 feet from shoreline around the perimeter
ESTIMATED COST ($)	No additional cost, incorporated into dam maintenance budget

BMP TYPE	Outreach – Monterey News Articles
BMP LOCATION	Monterey
DESCRIPTION	Friends of Lake Garfield, Lake Garfield Working Group, and other contributing guests write a semi-regular monthly article in the Monterey News about the updates regarding watershed health, best practices to reduce stormwater pollution, and progress on implementation of the Watershed Based Plan
ESTIMATED POLLUTANT LOAD REDUCTIONS	N/A
ESTIMATED COST ($)	$675/year

BMP TYPE	Outreach – Website Updates
BMP LOCATION	Publicly available
DESCRIPTION	Friends of Lake Garfield and Town website updated with relevant progress and information on implementation of the watershed-based plan.
ESTIMATED POLLUTANT LOAD REDUCTIONS	N/A
ESTIMATED COST ($)	$5,300

BMP TYPE	Outreach – Road Signage
BMP LOCATION	Town Boat Launch, Tyringham Road, Hupi Road, Route 23
DESCRIPTION	Signage at boat launches will inform visitors who pass by or recreate at the lake of the risk of invasives and how to prevent spread. Additional signage along roads around the lake will inform drivers when they are entering and exiting the watershed with a reminder to care of this natural resource. At present, some signs exist to this effect, with the plan to install more in highly trafficked locations
ESTIMATED POLLUTANT LOAD REDUCTIONS	N/A
ESTIMATED COST ($)	$5,000

BMP TYPE	Outreach – BMP Diorama
BMP LOCATION	Town Beach
DESCRIPTION	Friends of Lake Garfield will create and install a BMP diorama of a rain garden. This will be a 3-D model of a stormwater BMP showing the layers of construction and information on how each contributes to capturing and removing pollutants from Lake Garfield.
ESTIMATED POLLUTANT LOAD REDUCTIONS	N/A
ESTIMATED COST ($)	$7,000

BMP TYPE	Capacity Building
BMP LOCATION	Lake Garfield Watershed
DESCRIPTION	Coordinate partners to implement the watershed plan, evaluate implementation effectiveness, and revise every 5 years as needed.
ESTIMATED POLLUTANT LOAD REDUCTIONS	N/A
ESTIMATED COST ($)	$5,200/year

BMP TYPE	Review and Update Municipal Good Housekeeping Practices
BMP LOCATION	Roads within Lake Garfield Watershed
DESCRIPTION	Work with Monterey Highway Dept. to review road maintenance including road sweeping, catch basin cleaning, stormwater outfall inspection and maintenance as well as other road maintenance. Where appropriate, make improvements to housekeeping practices that reduce TSS and phosphorous
ESTIMATED POLLUTANT LOAD REDUCTIONS	5%-10% reduction in phosphorus (dependent on current housekeeping practices)
ESTIMATED COST ($)	$3,500

BMP TYPE	Monitor & Evaluate Lake Health
BMP LOCATION	Lake Garfield
DESCRIPTION	Hire LAPA West, HVA or consultants to periodically monitor phosphorus, Cyanobacteria, nitrogen, dissolved oxygen, invasive aquatic plant species, and other pollutants of concern on a regular basis.
ESTIMATED POLLUTANT LOAD REDUCTIONS	N/A
ESTIMATED COST ($)	$24,060 startup and ongoing costs inclusive

BMP TYPE	Outreach – Stormwater Classroom Education
BMP LOCATION	Southern Berkshire School District 5th Grade
DESCRIPTION	Hire HVA to deliver their stormwater lesson plans during the water unit of 5th grade classrooms that Monterey students attend.
ESTIMATED POLLUTANT LOAD REDUCTIONS	N/A
ESTIMATED COST ($)	$5,000/year

Element D: Identify Technical and Financial Assistance Needed to Implement Plan

Element D: Estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon to implement this plan.

Successful implementation of the Lake Garfield Watershed-Based Plan is reliant on the partners' ability to access available financial and technical assistance. Table D-1 presents the funding needed to implement the management measures presented in this watershed plan. The table includes costs for structural and non-structural BMPs, operation and maintenance activities, information/education measures, and monitoring/evaluation activities.

While there are a number of funding sources available, a few sources have the ability to cover a variety of activities, namely, the MassDEP Clean Water Act Section 319 Nonpoint Source Program, and the Executive Office of Energy and Environmental Affairs (EOEEA) Municipal Vulnerability Preparedness Action Grant Program (MVP). Each year the US EPA provides designated funds to state and tribal agencies under Clean Water Act Section 319 to implement their approved nonpoint source management programs. State and tribal nonpoint source programs include a variety of components, including technical assistance, financial assistance, education, training, technology transfer, demonstration projects, and regulatory programs. In Massachusetts, 319 funds are dedicated to the implementation projects. Successful application for 319 funds should include conceptual design (for structural implementation projects), and estimated pollutant load reductions that address the impairment for the targeted waterbody. Many of the education and outreach projects outlined in this watershed-based plan can be incorporated into the grants targeting the structural BMP implementation as each 319 grant must include a "Outreach-Technology Transfer" component.

The EOEEA MVP Program endeavors to prepare Massachusetts municipalities for the impacts of climate change. Many of the solutions that address the impact of climate change on water resources overlap or are the same as those that address water quality. MVP allocates their implementation funds through "Action Grants." MVP emphasizes community engagement, thus many of the outreach and education projects in this plan can be funded in part by this program. To be eligible for MVP Action Grants, communities must complete an MVP Plan for which EOEEA has separate funding available.

Table D-1: Summary of Funding Needed to Implement the Watershed Plan.

	Location	Capital Costs	Operation & Maintenance Costs	Relevant Authorities	Technical Assistance Needed	Funding Needed	Possible Funding Sources
Structural and Non-Structural BMPs (from Element C)							
Hupi Road Treatment Train	Hupi Rd. 1000' above Elephant Rock Rd.	$221,000	$500/year – Highway Dept. budget	Monterey Highway Department	Engineering and construction firms selected.	$221,000	• DEP 319 • NFWF LISFF • CWRLF
Town Beach Rain Garden	Tyringham Rd. & Sylvan Rd – Monterey Town Beach	$16,5000	$250	Monterey Parks Commission	Engineering, Landscaping, Construction	$20,000	• DEP 319 • DEP 604b • EOEEA MVP
Lake Smart Program	Particular focus on Sylvan Rd. neighborhood (subwatershed H)	$25,000 for conceptual development $250,000 for implementation	$500/year for landscape maintenance split among all resident households	Lake Garfield Working Group, Friends of Lake Garfield	Engineering firm. Construction contractors or landscape firms.	$275,000	• EOEEA MVP • DEP 319 • NFWF LISFF • FoLG & LGWG
Diver Assisted Suction Harvesting (DASH)	Determined by annual aquatic vegetation survey	$30,000	N/A	Lake Garfield Working Group, Friends of Lake Garfield	Hired entities such as New England Aquatic Services	$30,000	• LGWG • FoLG
Boat Wash Station	Lake Garfield Boat Launch	$70,000	$10,000	Monterey Parks and Recreation	Trained staff to monitor the boat wash and assist in cleaning. Could be same as boat launch monitor	$80,000	• FoLG • LGWG • MA-BIG
Lake Drawdown	Lake Garfield	N/A	N/A	Monterey, Highway Department			• Town

	Location	Capital Costs	Operation & Maintenance Costs	Relevant Authorities	Technical Assistance Needed	Funding Needed	Possible Funding Sources
Information/Education (see Element E)							
Hire Boat Monitor Program	Lake Garfield Public Boat Launch	N/A	$10,000	Town of Monterey	Training to identify invasive species and proper boat washing	$10,000	• Town • LGWG • Volunteers
Monterey News Articles	Monterey News (town-wide)	N/A	N/A	Lake Garfield Working Group	BRPC, Lake Garfield Working Group, Guest Contributors	$625/yr	• DEP 319 • NFWF LISFF • EOEEA MVP
Rain garden/buffer program	Private properties along Lake Garfield shoreline.	$5,000	$15,000	Friends of Lake Garfield, Lake Garfield Working Group, Monterey	HVA and BRPC can provide educational workshops in rain garden and buffer	$20,000	• EOEEA MVP • NFWF LISFF • DEP 319
Signage	Along roads at entrance to the watershed	$200/sign	N/A	Monterey Highway/Dept. of Public Works	Sign designer	$5,000	• Town Highway • LGWG • FoLG
Website outreach	Online	$5,000	$300	Friends of Lake Garfield	Website manager or web designer	$5,300	• FoLG • Town
BMP Diorama	Monterey Town Beach	$7,000	N/A	Friends of Lake Garfield	Display designer	$7,000	• DEP 319 • EOEEA MVP
Stormwater Handbook for Homeowners	Watershed Residents	$10,051	N/A	Berkshire Regional Planning Agency	Graphic designer	$10,015	• DEP 319 • EOEEA MVP
HVA Stormwater Education	Southern Berkshire Regional School District 5th Grade Classrooms	N/A	$1,500 per classroom	Housatonic Valley Assoc.	N/A	$7,500/yr	• EPA NRD • DEP 319 • EOEEA MVP

	Location	Capital Costs	Operation & Maintenance Costs	Relevant Authorities	Technical Assistance Needed	Funding Needed	Possible Funding Sources
Monitoring and Evaluation (see Element H/I)							
Cyanobacteria/Algal Bloom Monitoring	Lake Garfield (deep hole and beach section)	N/A	$250/cell count	Lakes Association of Western Massachusetts	Volunteer run with assistance from lake specialist Dr. Kenneth Wagner	$500/yr	• LAPA West • Town • LGWG • FoLG
E. coli	Lake Garfield Town Beach	N/A	$40/sample	Monterey Parks and Recreation and Dept. of Health	Local laboratory needed to analyze water samples and get a bacteria count.	$560/yr	• DEP WQM • Town of Monterey
Invasive Plant Survey	Lake Garfield	N/A	$8,000	Lake Garfield Working Group	Invasive plant expert, trained volunteers, or other entities with identification and mapping capabilities	$8,000/yr	• FoLG • LGWG
Other parameters such as DO, temperature, and turbidity	Lake Garfield	$3,000	$5,000	Lake Garfield Working Group, Lakes Association of Western Massachusetts	Trained volunteers and need of equipment	$8,000	• DEP WQM • LAPA West Members • Town
Phosphorus	Lake Garfield	$2,000	$5,000	Lake Garfield Working Group, Lakes Association of Western Massachusetts	Trained volunteers and need of equipment	$7,000	• DEP WQM • LAPA West • FoLG • LGWG
						Total Funding Needed:	**$715,500**

Funding Source: Abbreviations

- DEP 319: Massachusetts Department of Environmental Protection Clean Water Act Section 319 Grant Program
- DEP 604b: Massachusetts Department of Environmental Protection Clean Water Act Section 604(b) Grant Program
- DEP WQM: Massachusetts Department of Environmental Protection Water Quality Monitoring Grant Program
- CWRLF: Massachusetts Department of Environmental Protection Clean Water Revolving Loan Fund
- EOEEA MVP: Executive Office of Energy & Environmental Affairs Municipal Vulnerability Program (MVP) Action Grant
- EPA NRD: United States Environmental Protection Agency Natural Resource Damages Fund
- FoLG: Friends of Lake Garfield Fundraising from Members
- MA-BIG: Massachusetts Boating Infrastructure Grant Program
- LAPA West: Western Massachusetts Lakes and Ponds Association
- LGWG: Town of Monterey funds allocated to Lake Garfield Working Group
- Town: Town of Monterey funds

Element E: Public Information and Education

Element E: Information and Education (I/E) component of the watershed plan used to:

1. Enhance public understanding of the project; and
2. Encourage early and continued public participation in selecting, designing, and implementing the NPS management measures that will be implemented.

Public information and outreach will be managed by the Lake Garfield Working Group, a combination of Town representatives, Lake Garfield residents, and Friends of Lake Garfield members. With the help of BRPC, this group established the outreach strategy outlined in this section. The Lake Garfield Working Group will remain the main steering committee responsible for outreach implementation and monitoring during the implementation of this plan.

Step 1: Goals and Objectives

The goals and objectives for the watershed information and education program.

- Promote the reduced use of fertilizers and pesticides
- Mitigate, manage, and reduce the prevalence and spread of aquatic invasive plant species through non-chemical means
- Reduce the impact of septic leaching on phosphorus and nitrogen loading
- Manage runoff to prevent erosion and transport of sediment into waterways
- Manage pet/livestock waste

Step 2: Target Audience

Target audiences that need to be reached to meet the goals and objectives identified above.

The primary audience we hope to target are residents and seasonal homeowners in the Lake Garfield watershed, especially those located nearest to the Lake. Outlined below are specific groups, organizations, and memberships that reach that audience along with additional audiences targeted through education efforts:

- Friends of Lake Garfield Members
- Western Massachusetts Lakes and Ponds Association Members
- Housatonic Valley Watershed - Berkshire Members
- Visiting and local boaters and fishermen
- Second homeowners/Seasonal residents
- Lakeside Homeowner's Associations namely Elephant Rock and Lads Beach
- Property owners with private beaches along the northern shore

Step 3: Outreach Products and Distribution

The outreach product(s) and distribution form(s) that will be used for each.

Watershed and water quality related issues have been a source of outreach for many years. Many of the activities listed below describe ongoing efforts to educate Lake Garfield residents and visitors as well as the wider Monterey community. Where noted, some activities are planned as part of the watershed-based plan implementation efforts.

- Create a **Stormwater Management Handbook for Homeowners** to distribute to watershed residents. The Handbook will include practicable suggestions and designs for small stormwater BMPs they can implement on their property as well as climate resilient solutions.

- Every quarter, Friends of Lake Garfield, the Town of Monterey, Lake Garfield Working Group, and other entities will write an **article in the Monterey News**. This article will include topics that range from water quality health, ways residents can help improve water quality, progress on the watershed-based plan and implementation projects, and green infrastructure installments aimed toward reducing pollutants.

- **Websites** have and will continue to serve as a staging area for a variety of topics. Information regarding the watershed-plan and water quality improvement efforts will be posted and linked to websites hosted by Friends of Lake Garfield, Lake and Pond Association of Western Massachusetts, Housatonic Valley Association, and the Town of Monterey website when appropriate.

- **Signage** at boat launches will inform visitors who pass by or recreate at the lake of the risk of invasives and how to prevent spread. Additional signage along roads around the lake will inform drivers when they are entering and exiting the watershed with a reminder to care for this natural resource. At present, some signs exist to this effect, with the plan to install more in highly trafficked locations.

- At the Town boat ramp, a boat wash station will be constructed, and a seasonal boat launch monitor will be hired so that boats will be washed and dried properly to prevent the spread of Eurasian milfoil and other aquatic invasives. As part of this effort the **boat launch monitor will distribute flyers** on how to reduce aquatic invasive dispersal via boat management.

- The Conservation Commission plans to revive an outreach campaign in which residents applying for permits from the Conservation Commission also **receive information about rain gardens and natural buffers**.

- Friends of Lake Garfield will create and install a **BMP diorama** of a rain garden. This will be a 3-D model of a stormwater BMP showing the layers of construction and information on how each contributes to capturing and removing pollutants from Lake Garfield located at Monterey Town Beach next to a demonstration rain garden

- Create outreach **materials supporting structural BMPs** outlined in Element C. This would include many of the above outreach methods and additionally include: flyer mailings to neighbors of structural BMPs and the larger Monterey community; information sessions open to the public providing updates to BMP

project implementation; announcements through major forums like the Select Board, Conservation Commission, Planning Board meetings as well as Facebook groups and Monterey News.

- HVA will work with the Southern Berkshire Regional School District to reach Monterey students through **classroom education** curriculum developed for 5th graders during their water unit. This series of lessons teach students about stormwater runoff, nonpoint source pollution and green infrastructure solutions through stormwater modeling, with an opportunity to visit a BMP such as the one to be installed on Hupi Rd., one of the rain gardens created on private property, or the BMP proposed at the Town Beach.

Step 4: Evaluate Information/Education Program

Information and education efforts and how they will be evaluated.

The above outreach methods will be measured by the following metrics:

- Monterey news: # and frequency of Monterey articles written
- Websites: # of website visitors to water quality specific pages and information
- Signage: number of watershed signs installed, number that already exist
- Boat launch monitors: # of boaters engaged, # of flyers distributed
- Boat wash station: # of uses
- Conservation Commission: # of residents reached
- BMP Diorama: # of visitors reached
- Stormwater Management Handbook for Homeowner: # of handbooks distributed
- Outreach Materials Supporting Structural BMPs: # of flyers, # of people reached
- Classroom Education: # Classrooms reached, # of students educated

Elements F & G: Implementation Schedule and Measurable Milestones

Element F: Schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.

Element G: A description of interim measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.

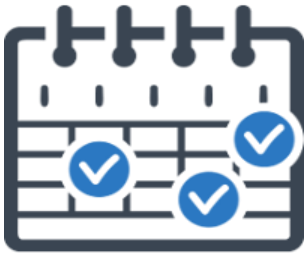

Table FG-1: Implementation Schedule and Interim Measurable Milestones

Structural & Non-Structural BMPs					
BMP	Interim Milestone #1	Interim Milestone #2	Interim Milestone #3	Interim Milestone #4	Interim Milestone #5
Diver Assisted Suction Harvesting (DASH) *Locations determined by an annual invasive plant aquatic survey*	Annual removal of 900 gallons of Eurasian milfoil				
	Annually during summer - ongoing				
Boat Wash Station *Lake Garfield Boat Launch*	Boat wash station installed	120 boats washed in year 1	Cumulative 350 boats washed in 3 years	Total of 500 lbs of plants removed over 5 years	500 lbs of plant materials removed annually
	Within 10 years	Within 11 years	Within 15 years	Within 20 years	Ongoing
Lake Drawdown *Lake Garfield*	Annual drawdown				
	Annually during winter - ongoing				
Hupi Road Treatment Train	Apply for funding	Final Engineering and Permitting Complete	Conduct outreach and project feedback	Complete construction	Monitoring and maintenance
	Within 1 year	Within 3 years	Started within 3 years	Within 6 years	Ongoing
Town Beach Rain Garden	Apply for funding and gather project team	Conceptual Designs	Final Engineering and Permitting	Construction & Install Plants	Monitoring and maintenance
	Within 2 years	Withing 4 years	Within 6 years	Within 10 years	Ongoing

Public Education & Outreach					
BMP	Interim Milestone #1	Interim Milestone #2	Interim Milestone #3	Interim Milestone #4	Interim Milestone #5
Boat monitor program	Boat monitor hired and trained	600 Boaters reached in year 1	700 boaters reached in year 2	750 boaters reached in year 4	Total of 3000 boaters reached by year 5
	Within 5 years	Within 6 years	Within 7 years	Within 10 years	Annually - ongoing
Monterey Newsletter Articles	4 articles published				
	Annually - ongoing				
Rain garden & buffer program	Pamphlets & outreach materials created	Native plant sale established	500 plants sold	500 linear feet of vegetative buffer installed	10 rain gardens installed
	Within 1 year	Within 3 years	Within 3 years	Within 5 years	Within 10 years
Signage	Additional signage installed at boat launch	Install "Entering watershed" signs at 2 locations			
	Within 5 years	Withing 10 years			
Website outreach	Friends of Lake Garfield updated	Town website updated with projects detailed	Cumulative 800 unique visitors reached	Cumulative 300 repeat visitors	
	Within 2 years	Within 2 years	Within 5 years	Ongoing	
BMP Diorama	Friends of Lake secure funding	Diorama design complete	Diorama installed		
	Within 2 years	Within 3 years	Within 5 years		
Stormwater Classroom Education	Secure funding to hire HVA	Hire HVA to give lesson plans in 5th grade classes			
	Within 2 years	Within 4 years			

Monitoring					
BMP	Interim Milestone #1	Interim Milestone #2	Interim Milestone #3	Interim Milestone #4	Interim Milestone #5
Cyanobacteria/Algal Bloom Monitoring	Continue to implement cell count monitoring				
	Annually during summer - ongoing				
E. coli monitoring	Continue E. coli and bacteria monitoring				
	Annually during summer - ongoing				
Invasive Plant Survey	Continue invasive plant mapping				
	Annually during spring ongoing				
Other water quality parameters	Continue monitoring temp., turbidity, and DO	Secure equipment for additional parameters as needed (Ex. nitrogen, ammonia, salinity, conductivity, chloride, etc.)	Monitor Lake health with new parameters equipment		
	Annually during summer – ongoing	Within 3 years	Withing 5 years and ongoing		
Phosphorus monitoring	Secure funding for equipment	Develop monitoring plan & Approved QAPP	Implement monitoring plan		
	Within 2 years	Within 3 years	Annually/ongoing		

Elements H & I: Progress Evaluation Criteria and Monitoring

Element H: A set of criteria used to determine (1) if loading reductions are being achieved over time and (2) if progress is being made toward attaining water quality goals. Element H asks "**how will you know if you are making progress towards water quality goals?**" The criteria established to track progress can be direct measurements (e.g., E. coli bacteria concentrations) or indirect indicators of load reduction (e.g., number of beach closings related to bacteria).

Element I: A monitoring component to evaluate the effectiveness of implementation efforts over time, as measured against the Element H criteria. Element I asks "**how, when, and where will you conduct monitoring?**"

The Lake Garfield Watershed-based plan is an iterative process and will be implemented using adaptative management. As such, success is determined through regular water quality monitoring and evaluation of the measures taken to implement this plan. The team most responsible for implementing the plan and keeping an eye on monitoring and evaluation results is the Lake Garfield Working Group. This group is a mix of town representatives and Friends of Lake Garfield members. The monitoring itself is conducted by various organizations and individuals depending on the parameter in question. For example, *E. coli* is monitored weekly during the summer by Monterey's Board of Health, aquatic invasive plants are monitored annually by a consultant hired by Friends of Lake Garfield, and cyanobacteria is monitored twice a year through cell counts conducted by LAPA West.

Successful implementation of the watershed-based plan includes the periodic review of management measures that have been completed. The Lake Garfield Working Group will review results from water quality monitoring and compare the results against the progress made in implementing this plan. If progress toward the desired outcome is not being made, the measure should be re-evaluated, adjusted, re-implemented and re-evaluated until water quality goals are met.

Below outlines the adaptative management approach that will be used during plan implementation. Also in this section is a description of the water quality parameters targeted by this plan including who will be responsible for monitoring, where and a brief overview of the methods. Finally, there is a section describing project specific evaluation efforts which includes number of BMPs installed, how pollutant load reduction will be determined, and how outreach will be measured. Notably, outreach and education evaluation are not covered in this section. Those criteria can be found in Element E.

Adaptive Management

Adaptive management is an iterative resource management technique in which decision makers utilize ongoing data collection to determine the best next steps on an ongoing basis. In the case of watershed planning, this is the first step in which an implementation plan is proposed to achieve the water quality goals outlined in Element A. Ongoing water quality monitoring will help determine the effectiveness of efforts implemented and inform changes to this plan. This process is completed iteratively until the water quality goals are attained.

Phosphorus will be assessed annually post-BMP implementation. If water quality measurements fall short of state water quality goals 5 years after installation, the Town of Monterey along with partnership organizations such as Friends of Lake Garfield and the Lake Garfield Working Group will inspect the installed BMPs to determine if they are functioning as designed and make adjustments or repairs as necessary. In addition, the Lake Garfield Working Group will evaluate outreach and education to determine if the correct audiences are being targeted in an effective manner. Lake Garfield Working Group will work with water partners to outreach to ensure that recommended practices are being adopted. Finally, the Town of Monterey will explore additional locations for BMP installations on public and private properties until water quality goals are achieved.

Water Quality Monitoring

Evaluation Criteria

The water quality target concentration(s) for phosphorus, bacteria, cyanobacteria, and aquatic invasive plants is presented under Element A of this plan.

To achieve these target concentrations, the annual loading must be reduced to the amount described in Element B. Element C of this plan describes the various management measures that will be implemented to achieve this targeted load reduction. The evaluation criteria and monitoring program described below will be used to measure the effectiveness of the proposed management measures (described in Element C) in improving the water quality of Lake Garfield.

Water Quality	Target Concentration
Total phosphorus	8-11 ug/L
Bacteria	Less than 126 colonies/100 mL
Aquatic Invasives Species	Low enough to not impede recreation – 1 acre
Cyanobacteria	No algal blooms

Bacteria: *Escherichia coli (E. coli)* bacteria testing is performed by the Town of Monterey Public Health Board at the Lake Garfield Public Beach. Grab samples are collected once a week between Memorial Day and Labor Day, (~15 samples annually) at the public beach and analyzed by either Housatonic Basin Sampling and Testing or MicroBac Laboratories. This testing will continue for as long as the Public Town Beach is open to the public as part of their health and safety requirements.

Cyanobacteria/Algal Blooms: Cyanobacteria monitoring for Berkshire lakes and ponds started at Lake Garfield in 2019. Since then, the organization that conducts the testing, LAPA West has continued testing in Lake Garfield and have expanded to other lakes throughout the region. Volunteers use the EPA Citizen Science protocol for cyanobacteria cell counts and have been trained in genus identification. Training and ongoing support for this program is provided by Dr. Kenneth Wagner, Certified Lake Manager. Samples are collected at various depth in the deepest part of Lake Garfield, called Big Bowl or Deep Hole. Cell counts are the average of multiple one

milliliter samples collected during one sampling event to produce the "# of cells/1 milliliter" metric. If samples counts are particularly high an additional sample is taken at the Public Town Beach. Samples are collected every other week during June and July, and weekly starting August and ending in mid-September. While Lake Garfield has never been closed due to cyanobacteria, cell counts throughout the region have increased and blooms have occurred earlier in the year (June and July as opposed to August and September). As such, this program will continue in its current capacity as much as possible and apply for funding to increase capacity for testing of cyanobacteria as well as other parameters.[1]

Phosphorus: Total phosphorous monitoring was conducted in 2016 to determine pollutant sources. LAPA West has committed to purchasing phosphorous testing equipment either through EPA grant funding or their own funds. With this equipment secured, annual testing will be performed, and phosphorus levels will be recorded along with cyanobacteria testing every other week in June and July and weekly in August - mid-September at the Big Bowl and Public Beach locations.

Other Parameters: Temperature, dissolved oxygen, and turbidity is measured at the time of cyanobacteria sampling. LAPA West uses test kits, a thermometer, and a Secchi disk to do so and monitors at Big Bowl and the Public Beach, every other week June - July, and every week August - mid-September.

Invasive Plant Surveys: Plant surveys of Eurasian watermilfoil, pondweed, water chestnut along with other aquatic invasives will continue to be performed annually usually around the time of DASH. Surveys identify invasive species present, map the location and extent as well as the density of plant patches.

Project-Specific Evaluation Criteria

Lake Smart Program: The Lake Garfield Working Group (LGWG) is implementing a homeowners good housekeeping project to encourage residents to install rain gardens and riparian buffers and implement sustainable landscaping practices on private property especially nearest the Lake. In addition to outreach efforts, materials (handbooks, brochures, flyers, workshops, etc.). This program will provide native plants appropriate for rain gardens, and helping landowners plan and plant rain gardens, riparian buffers, rain barrels, and other small BMPs. The LGWG will record outreach efforts including number of handbooks, brochures, and other materials distributed as well as number workshops given and total number of attendees at events. Moreover, this group will keep track of the number of rain gardens and riparian buffers installed, square feet planted, number of rain barrels distributed, and gallons of water conserved.

Diver Assisted Suction Harvesting (DASH): Eurasian milfoil is removed annually via DASH. Impact is measured annually through an invasive survey in May- early June prior to suction. Eurasian milfoil patch size and density are identified and mapped along with other common aquatic invasives.

Boat Launch Monitors and Washes: Implementation of this program will be measured through the number of boats serviced and number of boat owners engaged. This will be documented daily by the boat launch monitor.

Hupi Road Treatment Train: Project success will be initially measured through the progress made on and completion of milestones outlined in Table FG-1 as well as the number of structures installed. Once complete,

[1] Cyanobacteria information collected during interview with LAPA West volunteer, Shannon Poulin

the BMPs will be evaluated based on their effectives in removing TSS and phosphorus. This will in part be determined by the land use modeling using as-built drawings. Effectiveness will be partially evaluated based on lbs. or volume of sediment removed by Monterey Highway from the vegetated swale, deep sump catch basins, and the oil/grit separator. Additional data from monitoring of nearby Peppermint Brook, where the treatment train drains to will determine the effectiveness of removal. Outreach efforts in concert with this project will be evaluated by number of outreach materials distributed, attendance numbers at outreach events, and number of people who provide feedback when solicited.

Town Beach Rain Garden: Like the Hupi Road Treatment Train, progress will be determined based on whether and when milestones are reached according to Table FG-1. Land use modeling using as-built drawings will determine estimated phosphorus and TSS load reductions. Plantings should be monitored to ensure a healthy garden especially during the first 5 years while plants are getting established. After this point evaluations should measure the amount of sediment that collects when maintenance is needed. Outreach for this project will be measured by how many people view the project and the accompanying diorama each year while visiting the Town Beach.

Municipal Good Housekeeping: One important way for Monterey to reduce sediments in Lake Garfield is through good housekeeping. These efforts are typically done by the Highway department but are occasionally hired out. To evaluate good housekeeping efforts the Monterey Highway Dept. will record miles of road swept annually, the number of catch basins cleans, volume of debris removed, number and frequency of stormwater outfalls inspections, and linear square feet of erosion stabilized.

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Appendices

Appendix A – Pollutant Load Export Rates (PLERs)

Land Use & Cover[1]	PLERs (lb/acre/year)		
	(TP)	(TSS)	(TN)
AGRICULTURE, HSG A	0.45	7.14	2.59
AGRICULTURE, HSG B	0.45	29.4	2.59
AGRICULTURE, HSG C	0.45	59.8	2.59
AGRICULTURE, HSG D	0.45	91.0	2.59
AGRICULTURE, IMPERVIOUS	1.52	650	11.3
COMMERCIAL, HSG A	0.03	7.14	0.27
COMMERCIAL, HSG B	0.12	29.4	1.16
COMMERCIAL, HSG C	0.21	59.8	2.41
COMMERCIAL, HSG D	0.37	91.0	3.66
COMMERCIAL, IMPERVIOUS	1.78	377	15.1
FOREST, HSG A	0.12	7.14	0.54
FOREST, HSG B	0.12	29.4	0.54
FOREST, HSG C	0.12	59.8	0.54
FOREST, HSG D	0.12	91.0	0.54
FOREST, HSG IMPERVIOUS	1.52	650	11.3
HIGH DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.27
HIGH DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.16
HIGH DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.41
HIGH DENSITY RESIDENTIAL, HSG D	0.37	91.0	3.66
HIGH DENSITY RESIDENTIAL, IMPERVIOUS	2.32	439	14.1
HIGHWAY, HSG A	0.03	7.14	0.27
HIGHWAY, HSG B	0.12	29.4	1.16
HIGHWAY, HSG C	0.21	59.8	2.41
HIGHWAY, HSG D	0.37	91.0	3.66
HIGHWAY, IMPERVIOUS	1.34	1,480	10.2
INDUSTRIAL, HSG A	0.03	7.14	0.27
INDUSTRIAL, HSG B	0.12	29.4	1.16

INDUSTRIAL, HSG C	0.21	59.8	2.41
INDUSTRIAL, HSG D	0.37	91.0	3.66
INDUSTRIAL, IMPERVIOUS	1.78	377	15.1
LOW DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.27
LOW DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.16
LOW DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.41
LOW DENSITY RESIDENTIAL, HSG D	0.37	91.0	3.66
LOW DENSITY RESIDENTIAL, IMPERVIOUS	1.52	439	14.1
MEDIUM DENSITY RESIDENTIAL, HSG A	0.03	7.14	0.27
MEDIUM DENSITY RESIDENTIAL, HSG B	0.12	29.4	1.16
MEDIUM DENSITY RESIDENTIAL, HSG C	0.21	59.8	2.41
MEDIUM DENSITY RESIDENTIAL, HSG D	0.37	91.0	3.66
MEDIUM DENSITY RESIDENTIAL, IMPERVIOUS	1.96	439	14.1
OPEN LAND, HSG A	0.12	7.14	0.27
OPEN LAND, HSG B	0.12	29.4	1.16
OPEN LAND, HSG C	0.12	59.8	2.41
OPEN LAND, HSG D	0.12	91.0	3.66
OPEN LAND, IMPERVIOUS	1.52	650	11.3
[1]HSG = Hydrologic Soil Group			