LAKE HAYWARD
WATERSHED MANAGEMENT PLAN

January 2021

Prepared by the Lake Quality Improvement Committee of Lake Hayward
With Technical Contributions from SLR International Corporation (formerly Milone & MacBroom, Inc.)

This document has been prepared over approximately six years by the Lake Hayward Lake Quality Improvement Committee (LQIC), a volunteer group made up of residents of the Lake Hayward Community in East Haddam, Connecticut. The membership of the Committee has changed over time and this group would like to recognize the contributions of all members, past and present, as well as the support we have received from the Property Owners' Association of Lake Hayward (POAHL), which has lent financial support to LQIC throughout this time. The following individuals and organizations have been instrumental to the completion of this Plan through their individual contributions, education of Committee and watershed resident members, and technical support in analyzing the lake and preparing this document.

Individual Contributors (in alphabetical order)

Ed Bader
Jan DePratti
Cari Eckert
Jeanine Armstrong Gouin
Corinne Halliday
Gary Johnson
Wolf Koste
Gail Miers
Randy Miller
Marlee Mooney
Rachel Mosier
Steve Nelson
Tim Pelton
Dennis Pilarczyk
Rick Reed
Felicia Tencza

Technical Resources (in alphabetical order)

Aquatic Control Technology
Rick Canavan (formerly of CME Associates)
Connecticut Federation of Lakes
Eight Mile River Watershed Association
SLR International Corporation (formerly Milone & MacBroom, Inc.)
Northeast Aquatic Research, LLC

Financial Supporters (in alphabetical order)

Property Owners' Association of Lake Hayward
Town of East Haddam

EXECUTIVE SUMMARY

Lake Hayward is a man-made waterbody, formed by a dam located just north of Haywardville Road. The lake is fed by a small unnamed stream that drains a watershed of approximately 2.35 square miles (approximately 1,500 acres). The watercourse downstream of Lake Hayward is known as Lake Hayward Brook. It is a tributary to the federally designated Wild & Scenic Eightmile River. Lake Hayward is approximately 1.5 miles long and 0.5 mile-wide at its widest point and covers approximately 178 acres. Its maximum depth is 37 feet, with an average depth of 11 feet.

Like many lakes in Connecticut, Lake Hayward has been impacted by surrounding development, unmitigated stormwater discharges, erosion of soil and subsequent deposition into the lake, failed and underperforming septic systems, algae blooms, and the colonization of invasive species. Despite these impacts, Lake Hayward is not designated a Connecticut impaired waterbody. In fact, it is a highly valued recreational resource that is extensively used for swimming, boating, and fishing, both by area residents and visitors.

The subject document presents the first ever Lake Hayward Watershed Management Plan (WMP). Its primary purpose is to guide residents, watershed coordinators, resource managers, policy makers, and community organizations in their efforts to restore and protect the quality of Lake Hayward and its tributary streams and wetlands in the contributing watershed. The analysis contained herein is consistent with the elements specified by the Environmental Protection Agency's nine element approach.

Priority threats to Lake Hayward include the following:

1. <u>Stormwater Runoff</u> – Dense development, including residential, livestock farming, and agricultural uses, along with steep slopes and lack of stormwater management measures result in water quality degradation and erosion in the Lake Hayward watershed, with subsequent deposition of sediment into the lake, particularly near concentrated stormwater or tributary outlets. The highest priority for implementation in the Lake Hayward watershed is the identification of high-impact stormwater management improvement projects, procurement of design services, regulatory permitting, and construction. These improvements will be informed by stormwater sampling and analysis, coupled with a visual watershed inspection.

2. <u>Erosion</u> – The steep slopes in the western portion of the watershed and steep tributary pathways to the east and west of Lake Hayward result in repeated and ongoing erosion issues, with notable sediment deposition in the lake. Working collaboratively with property owners in the watershed, identification of individual improvement projects and low-cost solutions is a high priority.

3. <u>Failing and Underperforming Septic Systems</u> – Anecdotal evidence suggests that inadequate, under-performing, and in some cases failing septic systems occur within the watershed. Additionally, not all property owners are diligent about septic system maintenance. These issues are often documented during real estate transactions, as it is common to observe septic system renovations occurring just prior to or just following transaction of a property. However, not all property owners are willing to participate in a voluntary program to evaluate or rectify septic system issues. Assistance from the Chatham Health District will be needed to inventory septic systems within the watershed, with emphasis on those located closest to the lake, to identify and correct ongoing deficiencies. This effort will also require a robust education and outreach effort.

4. Algae Blooms – The occurrence of algae blooms has been trending up in the past several years, with several instances of blue-green algae blooms. A combination of excess nutrients in the water and sediment, shallowing water in areas of sediment deposition, and warm temperatures provide the ideal conditions for these blooms to occur.

5. Activities in the Watershed – Despite efforts to educate watershed residents, tree clearing, driveway pavement, application of fertilizers, and leaf disposal among other activities continue to occur within the largely residential watershed. Additionally, portions of two active livestock and agricultural farms lie within the watershed, with the resultant untreated stormwater runoff that comes in contact with chicken and horse manure and other contaminants that subsequently drain to the lake.

6. Invasive Species – Invasive species are a continual threat to Lake Hayward. These are being actively managed through annual application of herbicides; however, infestation of invasive species remains a serious threat to the quality and functionality of Lake Hayward.

7. Aging Dam Infrastructure – The earthen dam that creates Lake Hayward is aging and in need of repairs. While not a contributor of pollution to the lake, the loss of the dam would likely result in downstream ecological impacts, including sediment impacts, a loss of the Lake Hayward fishery and amphibian population, and a devastating loss of a recreational resource and related property values. Lake Hayward is located in the headwaters of the federally designated Wild and Scenic Eightmile River. Damage to downstream stream reaches as a result of dam failure are of great concern.

The primary goal of this WMP is to restore, maintain, and improve the water quality and ecological value of Lake Hayward. The environmental quality of the lake and its watershed is recognized as an important resource for the lake community, the towns within the watershed, and the larger Eightmile River watershed. The water quality of Lake Hayward affects its aesthetic, ecological, recreational, and financial value. The decision was made to pursue a specific management plan for Lake Hayward and its watershed in order to help meet these goals. Implementation of this WMP will seek to:

- Maximize the value of existing data from previous and ongoing studies and monitoring
- Identify areas for additional monitoring, investigation or long-term planning
- Coordinate and prioritize actions in the lake and watershed to best use limited resources
- Help leverage funding and collaborative opportunities

The WMP will be an integral component towards:

- Protection and maintenance of good water quality
- Prioritization of resources
- Engagement with non-resident and resident stakeholders
- Coordination of ongoing efforts
- Documentation of actions
- Supporting funding requests

Fifteen priority action items have been identified for the Lake Hayward watershed as follows:

Priority Area #1 – Expand Community Outreach and Education

- Implement a multi-tiered outreach and education program to engage watershed residents, visitors, and municipal partners with the goal of gaining support for watershed management implementation efforts.
- Develop annual topics for public education/outreach.
- Engage municipal stakeholders on an annual basis.
- Undertake annual outreach efforts relative to residential landscaping, residential septic system maintenance, pet waste management, low impact and sustainable development, stormwater management, agricultural practices, and erosion control.

Priority Area #2 – Secure Future Project Funding

- Identify appropriate funding sources that are well-matched and with high likelihood of success to fund watershed management initiatives.
- Continue to work with the Town of East Haddam to receive an annual allocation of funding towards watershed management.
- Continue to work with the Property Owners' Association of Lake Hayward (POALH) and others to continue to fund quality treatment and watershed best management practice (BMP) measures.

Priority #3 – Undertake Dam Repairs

- Undertake dam safety improvements as recommended following the most recent inspection.
- Conduct regular dam safety inspections as required by law.
- Maintain the integrity of the dam through maintenance and required repair/replacement as needed.

Priority Area #4 – Institute Stormwater Management Measures

- Identify, design, fund, and construct stormwater improvement projects in the watershed to mitigate impervious surfaces and erosion, including a bio-detention basin behind the tennis courts along Lake Shore Drive.
- Install a hydrodynamic separator demonstration project.
- Disconnect runoff paths on the west shore hillside, upgradient from Lake Shore Drive.
- Work with the towns of East Haddam and Colchester to undertake regular street sweeping and catch basin clean-out and petition them to minimize road sanding and salt application.
- Work with the Town of East Haddam to correct chronic erosion problems along East Shore Drive.
- Develop and fund an annual maintenance program for stormwater piping throughout the watershed to eliminate chronic clogging.
- Encourage the towns of East Haddam and Colchester to replace existing shallow catch basins with deep sump catch basins to increase the amount of sediment captured by these structures.
- Work with property owners to construct rain gardens, install erosion control measures, and plant riparian buffers.
- Educate and encourage a low impact and sustainable development approach to stormwater management on individual properties.

Priority Area #5 – Stabilize Erosion Sources

- Identify, design, fund, and construct bank erosion stabilization projects in the watershed.
- Install in-stream velocity dissipation in the tributaries that discharge into Lake Hayward to reduce the transport of suspended solids and subsequent deposition in the lake.
- Working with property owners, identify ongoing erosion issues on individual properties and formulate solutions to correct them.

Priority Area #6 – Reduce Nutrient Input

- Through community outreach and education, raise the awareness of the impacts of phosphorus on lake water quality and strive to significantly reduce use of phosphorus within the watershed.
- Encourage the cessation of fertilizer or the use of no phosphorus fertilizer.
- Correct erosion problems.
- Correct failing and underperforming septic systems.
- Employ measures to control the Canada Goose population.

Priority Area #7 – Correct Failing and Underperforming Septic Systems

- Undertake a grass roots effort to educate and mobilize property owners to investigate, repair, and maintain their septic systems.
- Conduct annual pump-out drives.
- Request a septic system monitoring survey by Chatham Health District within the watershed.

Priority Area #8 – Manage Nuisance and Invasive Aquatic Vegetation

- Conduct annual professional monitoring for invasive species within the lake.
- Continually educate visitors, particularly at the public boat launch. Post signage.
- Monitor boat launch activities to control introduction of invasive species.
- Continue to engage professional services as necessary for invasive species control.

Priority Area #9 – Monitor and Attempt to Avoid Algae Blooms

- Continue the annual monitoring program for lake water quality.
- Visually monitor, document, and conduct laboratory analysis of samples of algae blooms.

Priority #10 – Monitor Water Quality

- Continue the rigorous water quality monitoring program as described in Section 3 of this WMP.
- Engage project partners and technical service providers as sources of water quality data.
- Expand the library of previous studies.

Priority Area #11 – Maintain the Tranquil Quality of Lake Hayward

- Adopt a speed limit for powered watercraft.
- Conduct a voluntary monitoring program.
- Post speed limit at public boat launch.

Priority Area #12 – Maximize Open Space in the Watershed

- Work with municipal officials and staff within the towns of East Haddam, Colchester, and Salem to maximize undeveloped open space areas within the watershed.
- Ensure protections are incorporated into any new development within the watershed.
- Educate landowners in currently developed areas, both within and outside of the immediate lake proper.
- Work with the towns of East Haddam and Colchester to adopt protective overlay zones.

Priority #13 – Manage the Canada Goose Population

- Educate property owners about low-cost measures to discourage geese from grazing on grass areas.
- Where possible and on publicly owned or POALH owned land, plant vegetation that discourages geese.
- Identify, fund, and execute additional measures to reduce the goose population.

Priority #14 – Undertake Localized Sediment Removal

- Identify funding sources and undertake sediment removal projects in areas with chronic deposition, primarily near stormwater and tributary outlets.

Priority #15 – Protect Existing Natural Habitat

- Monitor and maintain upland areas for invasive plant species and maintain healthy upland vegetation in the watershed.
- Periodically monitor wetlands adjacent to the lake.

Table ES-1 summarizes anticipated implementation costs for the capital improvement costs associated with this WMP. These do not include costs that would be incurred by individual landowners in addressing issues on their properties, such as failing septic systems or localized erosion.

TABLE ES-1
Implementation Costs

Action	Anticipated Planning/Design Cost	Anticipated Implementation Cost
1. Implement public outreach and education program (annual)	N/A	$5,000
2. Secure future project funding (annual)	$3,000	N/A
3. Undertake dam reconstruction	$15,000	$230,000
4. Conduct periodic dam inspections (each)[1]	N/A	$3,000
5. Construct a bio-detention basin behind tennis courts	$8,000	$40,885
6. Undertake a hydrodynamic separator demonstration project	$10,000	$50,000
7. Disconnect stormwater runoff paths (each)	$3,000	$21,000
8. Conduct regular street sweeping and catch basin maintenance	*	*
9. Arrest erosion problems along East Shore Drive (each)	$5,000	$25,000
10. Replace existing shallow catch basins	*	*
11. Stabilize eroding banks (each)	$5,000	$15,000
12. Periodically treat the lake for invasive species control (annually)	N/A	$20,000
13. Take action to discourage goose population	$2,000	$50,000
14. Manage invasive aquatic vegetation (annual)	$1,500	$25,000
15. Continue to monitor water quality in the lake and tributaries (annual)	N/A	$10,000
16. Adopt a speed limit for powered watercraft	N/A	N/A
17. Undertake localized sediment removal/dredging (each project)	$15,000	$100,000

[1]Every 2 years by POALA engineer; State DEEP inspection every 7 years.
*Work to be undertaken by the municipality

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1.0 INTRODUCTION

1.1 Background

Lake Hayward is situated just north of Devil's Hopyard State Park in the northeastern corner of East Haddam, Connecticut. The lake is located near the municipal boundaries of the Towns of East Haddam, Colchester, and Salem. Lake Hayward is a man-made waterbody, formed by a dam located just north of Haywardville Road. The lake is fed by a small unnamed stream that drains a watershed of approximately 2.35 square miles (approximately 1,500 acres). The watercourse downstream of Lake Hayward is known as Lake Hayward Brook. It is a tributary to the Eight Mile River. Lake Hayward is approximately 1.5 miles long and 0.5 mile-wide at its widest point and covers approximately 178 acres. Its maximum depth is 37 feet, with an average depth of 11 feet. Figure 1-1 is a location plan that depicts Lake Hayward and the surrounding roadway network and topography.

Like many lakes in Connecticut, Lake Hayward has been impacted by surrounding development, unmitigated stormwater discharges, erosion of soil and subsequent deposition into the lake, failed and underperforming septic systems, algae blooms, and the colonization of invasive species. Despite these impacts, Lake Hayward is not designated as Connecticut impaired waterbody. In fact, it is a highly valued recreational resource that is extensively used for swimming, boating, and fishing, both by area residents and visitors.

The subject document presents the first ever Lake Hayward Watershed Management Plan (WMP). Its primary purpose is to guide residents, watershed coordinators, resource managers, policy makers, and community organizations in their efforts to restore and protect the quality of Lake Hayward and its tributary streams and wetlands in the contributing watershed. The plan is intended to be a practical tool with specific recommendations aimed at improving and sustaining lake water quality and the ecosystem within it. This is a "living document," meaning that as conditions change over time in the lake and in the watershed, the plan will be reexamined and revised to reflect current conditions and goals.

This WMP identifies and analyzes issues that are most critical to Lake Hayward and develops priority recommendations moving forward. The analysis is consistent with the elements specified by the Environmental Protection Agency's nine element approach, as a precursor to obtaining certain funding. Table 1-1 presents the nine EPA elements and the location within this document where they can be found.

TABLE 1-1
EPA Nine Elements

Element	Description	Location in the Plan
A	Identify causes and sources of pollution	Sections 1.6 and 4.0
B	Estimate pollutant loading and expected load reductions	Sections 1.7 and 9.2
C	Describe management measures and targeted critical areas	Section 9.0
D	Estimate technical and financial assistance needed	Section 10.6
E	Develop an information and education component	Section 8.0
F	Develop a project schedule	Section 10.7
G	Describe interim, measurable milestones	Section 10.1
H	Identify indicators to measure progress	Section 10.2
I	Develop a monitoring component	Section 10.3

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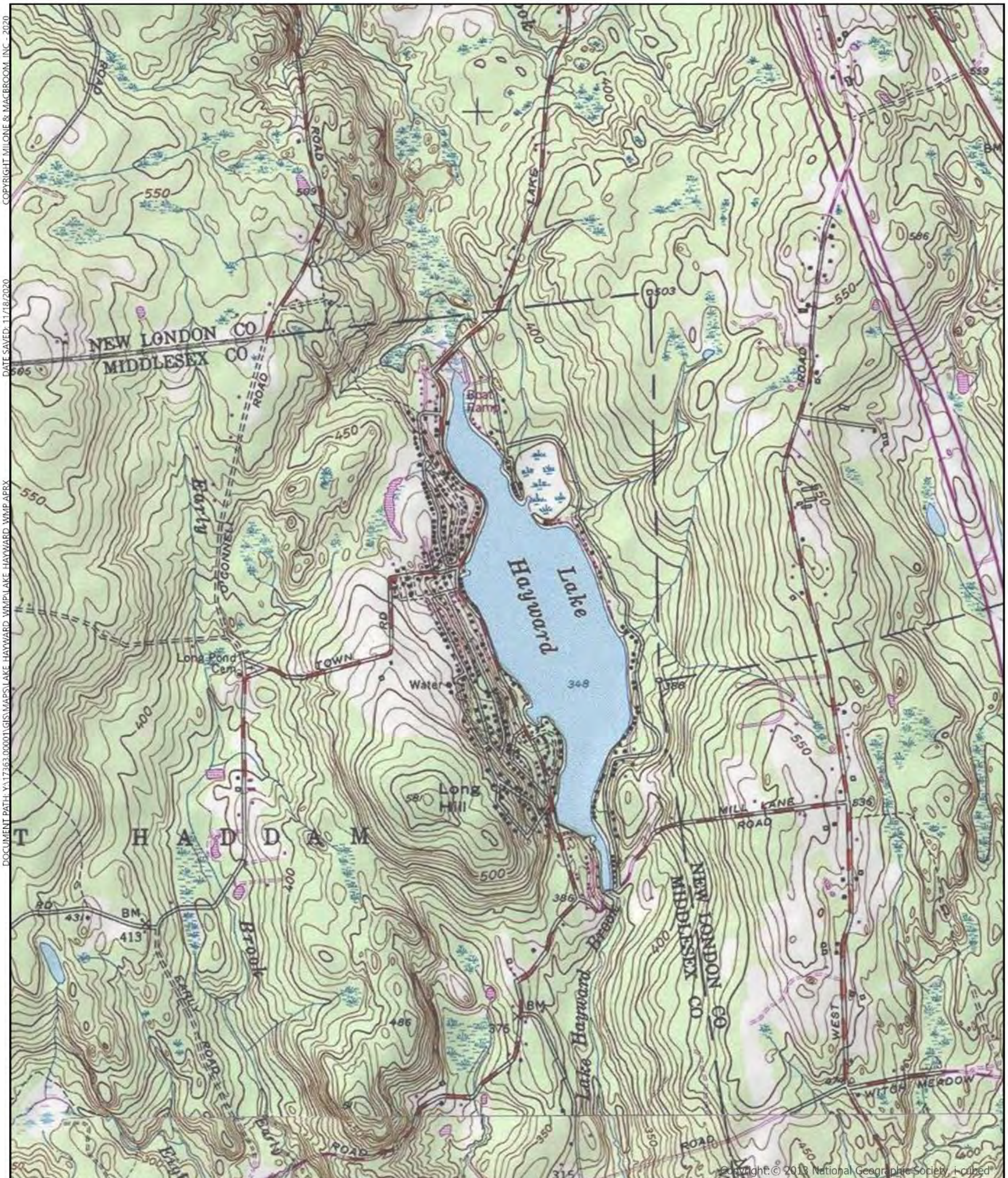

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99 REALTY DRIVE
CHESHIRE, CT 06410
203.271.1773
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Location Plan

Lake Hayward Watershed Management Plan
Lake Quality Improvement Committee of Lake Hayward
Lake Hayward
East Haddam, CT

N

0 1,000
Feet

SCALE	1 in = 2,000 ft
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FIG. 1-1	

This document was prepared by the Lake Quality Improvement Committee (LQIC), a volunteer group of lake residents in the Lake Hayward watershed. LQIC was originally established in 2014. Its members, both current and past, have included residents from the western side of the lake, belonging to the Property Owners' Association of Lake Hayward (POALH) as well as residents from the eastern side of the lake. Planning began specific to the LWMP in January 2015, with a kickoff meeting for stakeholders. The LQIC has received funding from POALH for various components of its work, including funding to retain the services of Milone & MacBroom, Inc. to prepare GIS mapping and undertake analysis of various aspects of the lake and contributing watershed.

1.2 History of Lake Hayward

The following history of Lake Hayward is taken in large part from the POALH website[1].

Lake Hayward was once known as Long Pond by the native American tribes who inhabited its shores and was subsequently named Shaw Lake. In 1838, Charles Goodyear, of the Goodyear Tire and Rubber Company, and Nathaniel Hayward were partners in a rubber mill that operated in Massachusetts. In 1847, after breaking away from Goodyear's company, Hayward established a factory in Colchester, Connecticut to manufacture shoes. Hayward remained in Colchester until his death in the 1860s.

During the time Nathaniel Hayward was residing in Colchester, he purchased land for hunting along Shaw's Pond on the north east edge of East Haddam, where a grist mill was operating. After Hayward's death, Shaw's Pond was renamed Lake Hayward in his honor, as was Hayward Avenue in Colchester. In the late 1930s and early 1940s, the land surrounding the lake was developed into seasonal cottages. An advertisement from the time when the Lake Hayward was being developed by the Jas. J. Smith Company read:

"Every man or woman should own some real estate – they should have a place to call their own, where they can spend their summers and pass the days of their vacation to suit themselves, where the children can be taken early and brought back late, brown as berries, and with the robust health that only life in the open can give. No one knows what the future may bring forth. It is such a short drive from your home that you need not go away for an expensive vacation. Stay at home – take day trips to the Lake. Real Estate is an imperishable asset ever increasing in value. It is the most solid security that human integrity has devised. In fact, it is the basis of all wealth."

Today, the land area immediately surrounding Lake Hayward is home to approximately 474 seasonal and year-round residences, 394 of which are located on the western side of the lake and 80 on the eastern side. The west side of Lake Hayward is known for its beautiful sunrises and exceptional lake views. It hosts four private beaches, accessible only to POALH members and their guests. POALH is a chartered body democratically governed by the property owners. Annual dues are assessed each year, with the town assessment is used as a base. Through mandatory membership, members receive the benefits of beach access, tennis courts, volleyball, basketball and baseball fields, areas to store boats, a children's playground, trash collection, portalets at the beaches, and a pavilion area that accommodates both POALH-sponsored and private functions.

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[1] http://www.lakehaywardct.com/history/

The east side of Lake Hayward boasts beautiful sunsets and an unpaved road that has been designated as a scenic route. East side residents are not part of the lake association. Property owners have waterfront frontage or a right-of-way for lake access. A state-owned boat launch is located at the northern section of the east side of Lake Hayward. State-owned facilities include a small paved ramp, parking for approximately five cars, and seasonal (chemical) toilets. The boat ramp is used for launching of small watercraft. Public access is restricted to the launch area.

Only non-combustion engine-powered boats are allowed on Lake Hayward. Water-based uses include swimming, fishing, kayaking, canoeing, paddle boarding, paddle boating, row boating, and sailing. During the winter months the lake supports ice fishing and ice skating. Surrounding the lake is a blend of year-round and summer residences.

1.3 Key Prior Studies

Numerous studies have been undertaken to assess the quality of Lake Hayward. The following reports have been evaluated as part of the subject WMP:

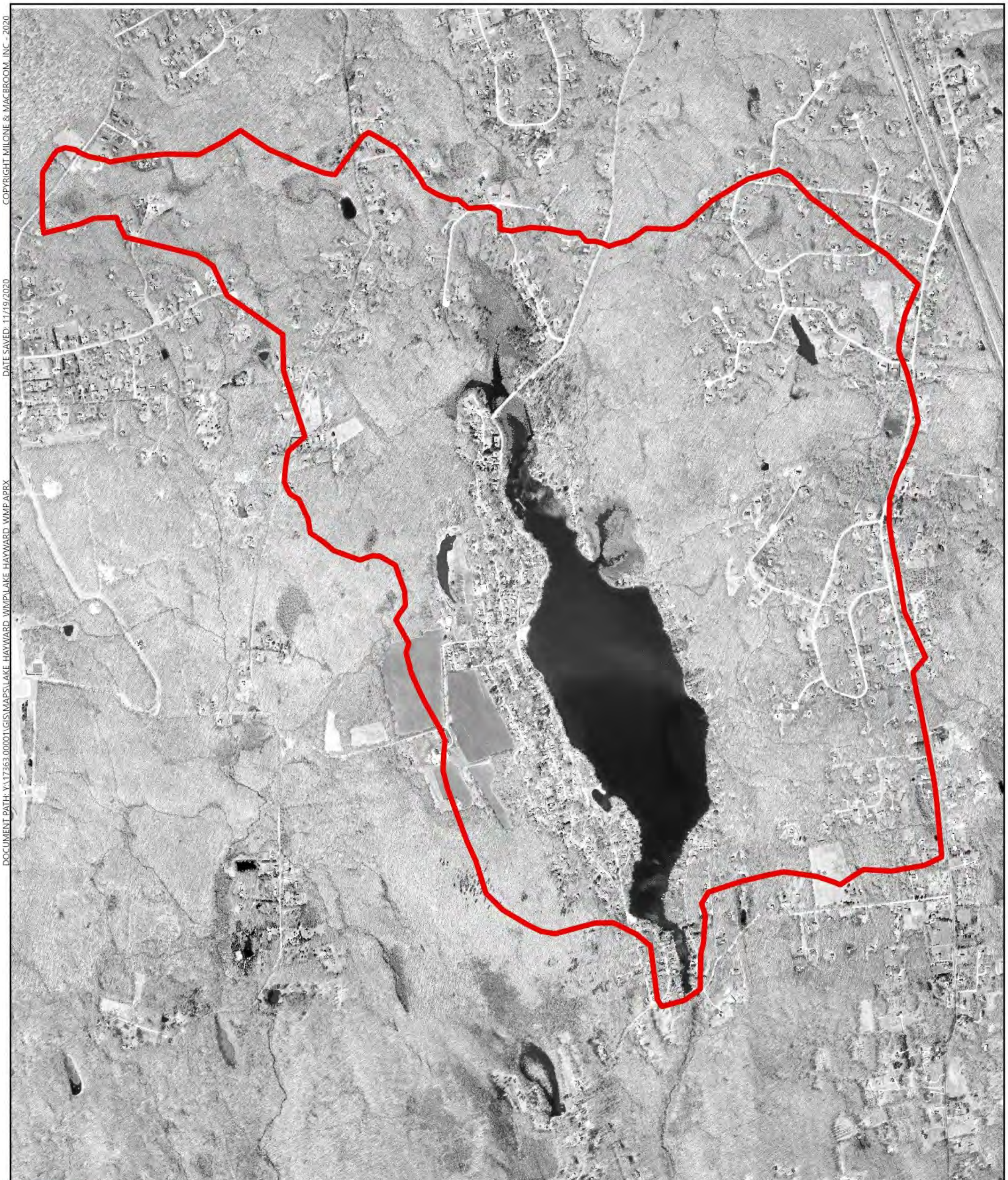
- *Stormwater Management Priorities: Roadmap for Rural Towns Study*; Prepared by Nathan L. Jacobson & Associates, Inc.; February 2012 – This study evaluated numerous watersheds, including the Lake Hayward watershed. Stormwater outfalls were sampled and analyzed for pollutants.

- *Diagnostic/Feasibility Study of Lake Hayward; East Haddam, Connecticut*; Prepared by Northeast Aquatic Research, LLC; May 2003 – This study evaluated lake drainage and basin characteristics; undertook lake and drainage water quality sampling; and evaluated management options for weed control, stormwater and nonpoint source control. This study was funded jointly by the then Connecticut Department of Environmental Protection and POALH.

- *Eightmile River Wild & Scenic Study* – In 2006, the National Park Service completed its draft Report & Environmental Assessment of the Eightmile River. The Wild and Scenic River Study concluded that the entire mainstem and East Branch congressionally authorized study area plus additional tributary areas of the watershed were eligible for designation into the National Wild and Scenic Rivers System. The river was subsequently formally designated, effective July 1, 2011. Lake Hayward and its contributing watershed comprise the headwaters of Lake Hayward Brook, which is a tributary of the Eightmile River.

1.4 Introduction to Watershed Management

A lake watershed is the physical boundary where the land surface slopes toward the lake, such that if a drop of water could roll uninhibited, it would eventually reach the lake. Everything that happens within the watershed boundary will either directly or indirectly affect the lake. Figure 1-2 depicts the Lake Hayward watershed. It encompasses approximately 2.35 square miles (approximately 1,500 acres) within the towns of East Haddam, Colchester, and Salem. The outermost line is reflective of the entire watershed whereby all land drains to the lake. The smaller sub-basins delineate the areas that flow towards a single discharge point to the lake.



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Contributing Watershed

Lake Hayward Watershed Management Plan
Lake Quality Improvement Committee
Lake Hayward
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N

0 1,000
Feet

SCALE 1 in = 1,800 ft
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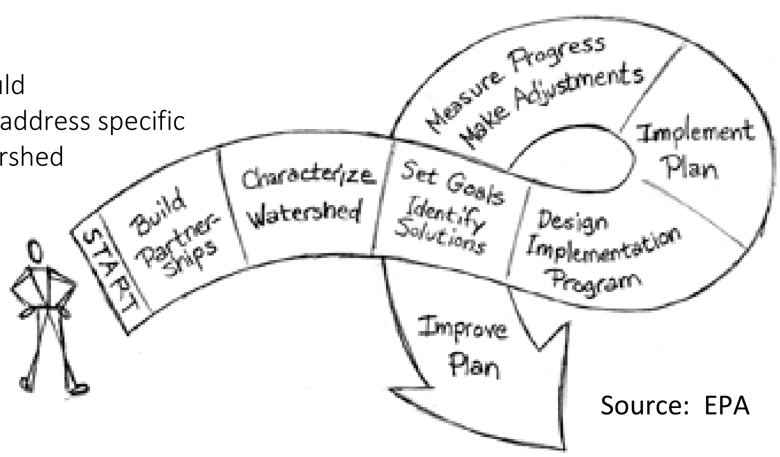
PROJ. NO. 17363.00001

FIG. 1-2

Watershed management is a holistic approach to guiding what happens on the land and in the water to promote a healthy aquatic environment and sustainability of a healthy lake. The primary objective of watershed management planning is to identify significant issues and risks and then formulate a strategy and plan to address them. Figure 1-3 summarizes many of the components of watershed management planning.

FIGURE 1-3
Components of Watershed Management Planning

Watershed management plans should be different for every watershed to address specific issues facing that waterbody. Watershed management planning is not a discrete process with a beginning and an endpoint; rather, it is an ongoing progression of collecting data, identifying issues, setting goals, working the plan, evaluating its effectiveness, and then circling back to revisit the issues.



Source: EPA

The benefits of successful watershed management are clear. They include preservation of the long-term health of the late, a cleaner healthier environment, a thriving ecological habitat, and preservation of recreational resources.

1.5 Identified Threats in the Watershed

Some of the most common issues in Connecticut's lakes are caused by one or more of the following issues:

- Failing or underperforming septic systems
- Erosion and sedimentation
- Stormwater quantity and quality
- Invasive aquatic species
- Eutrophication
- Pollution

In Lake Hayward, the priority threats include the following:

- Impervious surfaces / stormwater runoff / non-point sources of pollution
- Erosion within the watershed and sedimentation surrounding stormwater outfalls
- Manure runoff from agricultural land uses in the watershed
- Poor stormwater management / catch basin failure
- Insufficient riparian buffers
- Inadequate septic systems and maintenance / lack of monitoring and enforcement
- Lack of watershed management education of property owners within the watershed
- Baseline levels of invasive aquatic plants
- Insufficient boating regulation enforcement and State boat launch monitoring

1.6 Causes and Sources of Pollution (EPA Element A)

1. Stormwater Runoff – Dense development, including residential, livestock farming, and agricultural uses, along with steep slopes and lack of stormwater management measures result in water quality degradation and erosion in the Lake Hayward watershed, with subsequent deposition of sediment into the lake, particularly near concentrated stormwater or tributary outlets. The highest priority for implementation in the Lake Hayward watershed is the identification of high-impact stormwater management improvement projects, procurement of design services, regulatory permitting, and construction. These improvements will be informed by stormwater sampling and analysis, coupled with a visual watershed inspection.

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1.7 Existing Conditions Pollutant Load Modeling (EPA Element B)

According to the Environmental Protection Agency's (EPA's) watershed management guidelines, there are two general types of techniques for estimating pollutant loads: (1) techniques that use actual monitoring data or literature values; and (2) techniques that use models to predict the estimated pollutant loads. Since historic monitoring of Lake Hayward are not sufficient to support the first technique, modeling was undertaken and is presented herein.

Pollutant load modeling was conducted for the Lake Hayward watershed using the Environmental Protection Agency's (EPA's) *Spreadsheet Tool for the Estimation of Pollutant Load* (STEPL) Version 4.4b. STEPL employs algorithms to calculate nutrient and sediment loads from different land uses and the load reductions. It computes surface runoff; nutrient loads, including nitrogen, phosphorus, and 5-day biochemical oxygen demand; and sediment delivery based on various land uses and management practices. Land use categories include urban land, cropland, pastureland, feedlot, forest, and a user-defined land use. Annual nutrient loading is then calculated based on the runoff volume and the pollutant concentrations in the runoff water. The annual sediment load from sheet and rill erosion is calculated based on the Universal Soil Loss Equation (USLE) and the sediment delivery ratio.

Pollutant modeling requires numerous model inputs, including the delineation and size of sub-watersheds, land use type, hydrologic soil classifications, method of wastewater disposal, and annual rainfall data. Each is described below.

<u>Sub-Watershed Delineation</u>

The Lake Hayward watershed was apportioned into 22 sub-watersheds based on topography and drainage features. The sub-watersheds are presented in Figure 4-1 in Section 4 of this Plan.

<u>Land Use Classification</u>

Each sub-watershed was analyzed using ArcMap Geographic Information System (GIS) software. The percentage of land use types within each sub-watershed was composited using multiple publicly available geospatial data datasets. Land use data from the Center for Land Use Education and Research (CLEAR, 2020) was compiled with data from the towns of East Haddam, Salem, and Colchester parcel and zoning data. Land use data was classified into eight distinct categories, which were then further distilled into the following four categories in order to be compatible with the STEPL model, as shown below:

Land Use Conversion to STEPL:

Current Land Use:	**STEPL Input:**
Agriculture	Pastureland *Feedlot
Medium Density Residential Low Density Residential Rural Residential Vacant Residential (< 1 ac) Utility	Urban
Open Space Vacant Forested (> 1 ac)	Forest

A portion of Cold Spring Farm is located within the Lake Hayward watershed, primarily occupied by hay fields and small patches of crop/vegetables. These were modeled as cropland, with an assumption that manure is applied two months of the year. Additionally, small livestock grazing pastures, estimated at 0.5 acres are located on Cold Spring. These were modeled as feedlots. Allegra Farm has approximately 16 horse paddocks averaging 5,000 square feet each, covering approximately 2 acres. These which were modeled as feedlots. Urban Land was modeled as single family residential. The complete database of land use inputs can be found in Appendix 1, Table A.

Hydrologic Soil Classifications

Hydrologic Soil Classifications describing the permeability of soils were derived from the Natural Resources Conservation Service (NRCS, 2017) datasets and were characterized for each sub-watershed accordingly. The soil classification with the largest percentage of coverage in each sub-watershed was utilized as the dominant soil type. A full breakdown of the hydrologic soil classifications in each sub-watershed can be found in Appendix 1, Table B.

Wastewater Disposal

No public sewer is available within the Lake Hayward watershed; therefore, all residential properties were assumed to have septic systems. Aerial imagery from 2018 was used to estimate the number of dwellings within each sub-watershed. The STEPL model estimates that 2% of all septic systems are currently failing. This may be understated for the Lake Hayward watershed, given the age of construction and small lot sizes. A complete estimated tally of existing septic systems located in each sub-watershed can be found in Appendix 1, Table C.

Rainfall

Annual rainfall was estimated based on the Middlesex County, Connecticut, weather station near Shuttle Meadow Reservoir. All other optional data input values were left as default values per the recommended EPA guidance in the program user guidance.

Results

Table 1-2 presents the total estimated pollutant loading within the Lake Hayward watershed. The tables in Appendix 1 break down the allocation by sub-watershed. The largest input is total suspended solids, followed by biochemical oxygen demand (BOD), nitrogen, and phosphorus. Biochemical oxygen demand is the amount of dissolved oxygen that must be present in water in order for microorganisms, such as that found in wastewater or stormwater runoff, to decompose the organic matter in the water. BOD is used as a measure of the degree of pollution.

TABLE 1-2
Effective Watershed Pollutant Load per STEPL

Pollutant	Loading
Nitrogen (N)	6,893 pounds/year
Phosphorous (P)	1,470 pounds/year
Biochemical Oxygen Demand (BOD)	22,459 pounds/year
Total Suspended Solids (TSS)	565,600 pounds/year

The above data was used as a baseline against which to measure improvements from proposed best management practices in the watershed. Proposed conditions are presented in Section 9 of this Plan.

1.8 Watershed Management Plan Goals & Objectives

The primary goal of this WMP is to restore, maintain, and improve the water quality and ecological value of Lake Hayward. The environmental quality of the lake and its watershed is recognized as an important resource for the lake community, the towns within the watershed, and the larger Eightmile River watershed. The water quality of Lake Hayward affects its aesthetic, ecological, recreational, and financial value. The decision was made to pursue a specific management plan for Lake Hayward and its watershed in order to help meet these goals. Implementation of this WMP will seek to:

- Maximize the value of existing data by maintaining a database of previous and ongoing studies and monitoring
- Identify areas for additional monitoring, investigation or long-term planning
- Coordinate and prioritize actions in the lake and watershed to best use limited resources
- Help leverage funding and collaborative opportunities

The WMP will be an integral component towards:

- Protection and maintenance of good water quality
- Prioritization of resources
- Engagement with non-resident and resident stakeholders
- Coordination of ongoing efforts
- Documentation of actions
- Supporting funding requests

1.9 Stakeholders

A host of watershed stakeholders and stakeholder organizations have been identified and engaged throughout the development of this WMP. A brief summary of each, their role, and resources follows:

Lake Quality Improvement Committee – The LQIC is the entity created to oversee the efforts to improve water quality in Lake Hayward and to spearhead the WMP. The Committee was initially developed to address the management of invasive species, namely fanwort, in the lake. Its charge has expanded through time to include public outreach and education, water quality data collection, field investigations, and watershed management planning.

Property Owners' Association of Lake Hayward – POALH operates under Special Act No. 87 – An Act Incorporating the Property Owners' Association of Lake Hayward as amended by Special Act 75-25 approved May 8, 1975 as amended. The POALH board includes its elected President, Vice President, Secretary-Clerk, and Treasurer. The association may levy taxes, assessments and charge user fees; buy, sell, lease, mortgage, hold or own real or personal property; enact, amend or repeal bylaws; and take any and all other actions necessary or desirable in furtherance of its purposes. POALH has representation on and provides financial support for the LQIC.

Municipal Representatives – Representatives of East Haddam, Colchester, and Salem provide regulatory oversight of the lands within the contributing watershed to Lake Hayward.

Watershed Residents – The residents within the Lake Hayward watershed are the critical front line relative to land use practices and stewardship of the lake itself.

Chatham Health District – The Chatham Health District is a non-profit organization that serves the towns of Colchester, East Hampton, East Haddam, Hebron, Marlborough and Portland, Connecticut. The Director of Health and staff of the CHD work to promote health and wellness among the residents they serve. By enforcing the Connecticut Public Health Code, conducting health education programs, monitoring disease outbreaks and nurturing the environment, the CHD is focused on promoting healthy communities. The CHD provides oversight on private drinking water wells and septic systems in the Lake Hayward watershed.

East Haddam Lakes Association (EHLA) – EHLA is comprised of members from Bashan Lake, Lake Hayward, and Moodus Reservoir, all located in East Haddam. The organization requests annual funding from the Town of East Haddam, primarily for invasive week treatment/removal, lake monitoring/weed mapping, and public education.

Eight Mile River Wild and Scenic Coordinating Committee (WSCC) – The WSCC was established following completion of the Eightmile River Study to provide oversight and guidance in the implementation of the Eightmile Watershed Management Plan. Lake Hayward is located within the Eightmile River watershed.

State Representatives – LQIC regularly communicates and coordinates with state representatives to provide awareness of the importance of lake water quality and the initiatives.

Connecticut Department of Energy & Environmental Protection (CT DEEP) – CT DEEP regulates water quality in Connecticut's waterbodies. They also own and manage the public boat launch at Lake Hayward.

2.0 WATERSHED COMPOSITION

The following narrative provides background on the general composition of the watershed.

2.1 Contributing Watershed

The contributing watershed of Lake Hayward (i.e. the land area that drains to the lake) is approximately 2.35 square miles in size and includes land area within the towns of East Haddam, Colchester, and Salem. Figure 1-2 depicts the watershed boundaries. Table 2-1 presents the distribution of land area within each member town.

TABLE 2-1
Watershed Land Area by Town

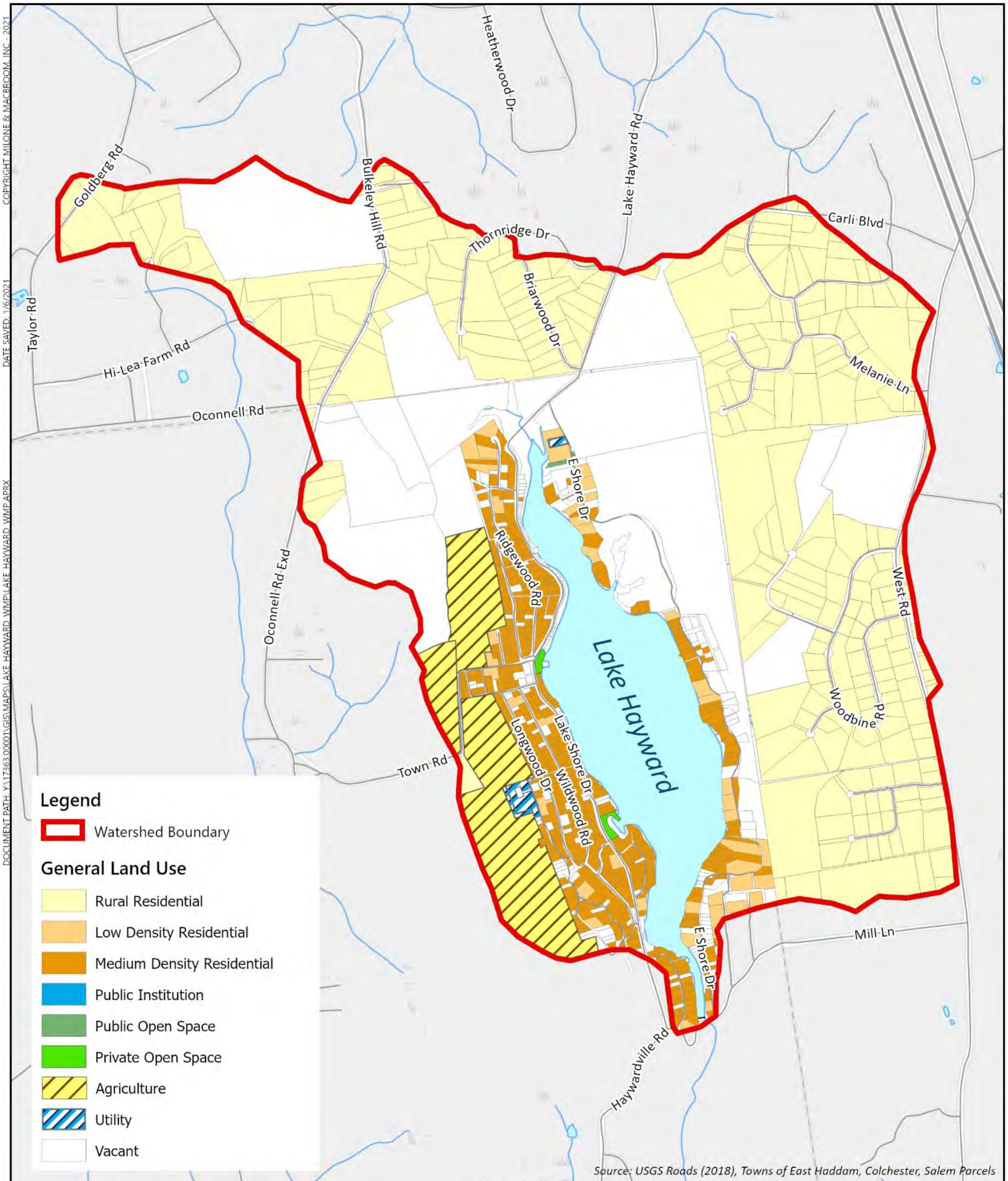
Town	Percentage of Watershed
East Haddam	49%
Colchester	45%
Salem	6%

2.2 Land Uses

Table 2-2 presents major land use categories within the Lake Hayward watershed. Figure 2-1 graphically presents this information. Note that the total watershed acreage is slightly greater than other references, with variations due to the source of the delineation. The largest land use type within the watershed is residential development, comprising 52.8% of the contributing watershed. The most concentrated (medium density) residential development occurs immediately adjacent to and surrounding the lake, shown in burnt orange in Figure 2-1. The majority of this smaller lot residential development is located on the western side of the lake along Lake Shore Drive, Ridgewood Road, Wildwood Road, and Longwood Road, as well as several smaller connecting roadways as well as along portions of East Shore Drive on the eastern side of the lake.

TABLE 2-2
Major Land Uses within the Watershed

Land Use Category	Acres	% Total Area
Residential	*878.36*	*52.8%*
Rural Residential	724.67	43.6%
Low Density Residential	36.64	2.2%
Medium Density Residential	117.04	7.0%
Open Space	*79.70*	*4.8%*
Public Open Space	78.05	4.7%
Private Open Space/Agricultural	1.65	0.1%
Municipal	*4.14*	*0.2%*
Public Institution	0.02	0.0%
Utility	4.13	0.2%
Undeveloped/Unprotected Land	*700.22*	*42.1%*
Vacant	514.82	31.0%
Water	185.40	11.2%
Total	1662.43	100.0%



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Land Uses within the Watershed

Lake Hayward Watershed Management Plan
Lake Quality Improvement Committee
Lake Hayward
East Haddam, CT

N
0 1,000
Feet

SCALE 1 in = 1,800 ft
DATE 1/6/2021
PROJ. NO. 17363.00001

FIG. 2-1

Low density residential and rural residential lands make up the remainder of the residential land use category, shown in light orange and yellow in Figure 2-1, with larger lot (rural residential) land concentrated to the east and northern portions of the watershed (shown in yellow in Figure 2-1).

The next most abundant land use within the watershed is undeveloped and unprotected land, which comprises a full 42.1% of the watershed. Much of this land area, shown in white on Figure 2-1 is primarily located in the northern half of the watershed and includes numerous large tracts of land. This undeveloped land provides a significant buffer from the developed outskirts of the watershed and the headwaters of the watershed.

The remaining land within the watershed, approximately 5 percent is comprised of farmland, open space, and public lands, including the Allegra Horse Farm and Cold Spring Farm, both located at the western extent of the watershed.

2.3 Regional Hydrology

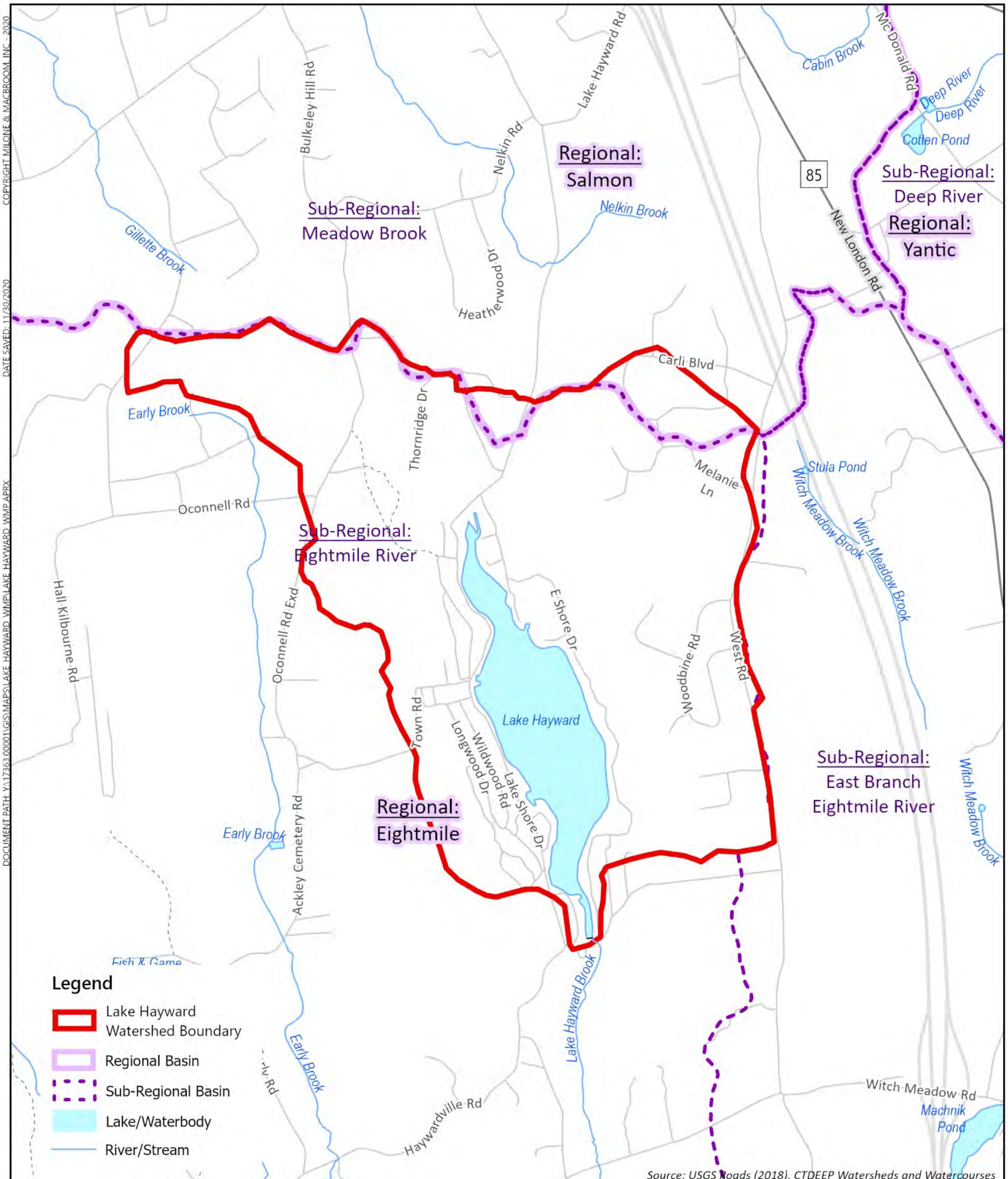
Lake Hayward is located within the Eightmile River Regional basin and the Eightmile River Sub-Regional basin. In fact, it is located within the headwaters of that watershed. Portions of the Eightmile River has been federally designated as a Wild and Scenic River, reflective of its exceptional ecological value. Figure 2-2 graphically presents the regional and sub-regional hydrology, including nearby streams. Note that the discharge of water over the Lake Hayward dam in the lower-most extent of the lake is the headwaters of Lake Hayward Brook, which flows south to the Eightmile River just north of Devil's Hopyard State Park.

2.4 Topography and Geology

Figure 2-3 depicts topography within the Lake Hayward watershed, which ranges in elevation from a high of about 550 feet, with the lake being the low point within the watershed at approximate elevation 348, representing approximately 200 feet of elevation change. As shown in Figure 2-3, contours (i.e. equal lines of elevation) are depicted in white. The closer together the contour lines, the steeper the slopes are. High points are located on the outskirts of the watershed, with notable steep slopes to the northwest of the lake and along the western shore.

Figure 2-4 depicts surficial geology within the watershed. As shown in light green, the majority of surficial materials are comprised of till, which is defined as unsorted material that was deposited directly by glacial ice, with no stratification. Till is derived from the erosion and entrainment of material by the moving ice of a glacier. It is generally comprised of rocks and boulders of varying sizes. Several notable areas of sand and gravel overlying sand are depicted on Figure 2-4 in light yellow. These are concentrated to the north and east of Lake Hayward.

Finally, two distinct areas of "swamp" (shown in pink in Figure 2-4) are notable adjacent to Lake Hayward. These are located immediately adjacent to and east of the lake between East Shore Drive and Lake Hayward, and immediately to the north of the northern point of the lake. These areas are highly visible natural wetlands, with a variety of aquatic and plant species. These areas are discussed in greater detail in Section 6.0.



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Regional and Sub-Regional Hydrology

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Lake Quality Improvement Committee
Lake Hayward
East Haddam, CT

N
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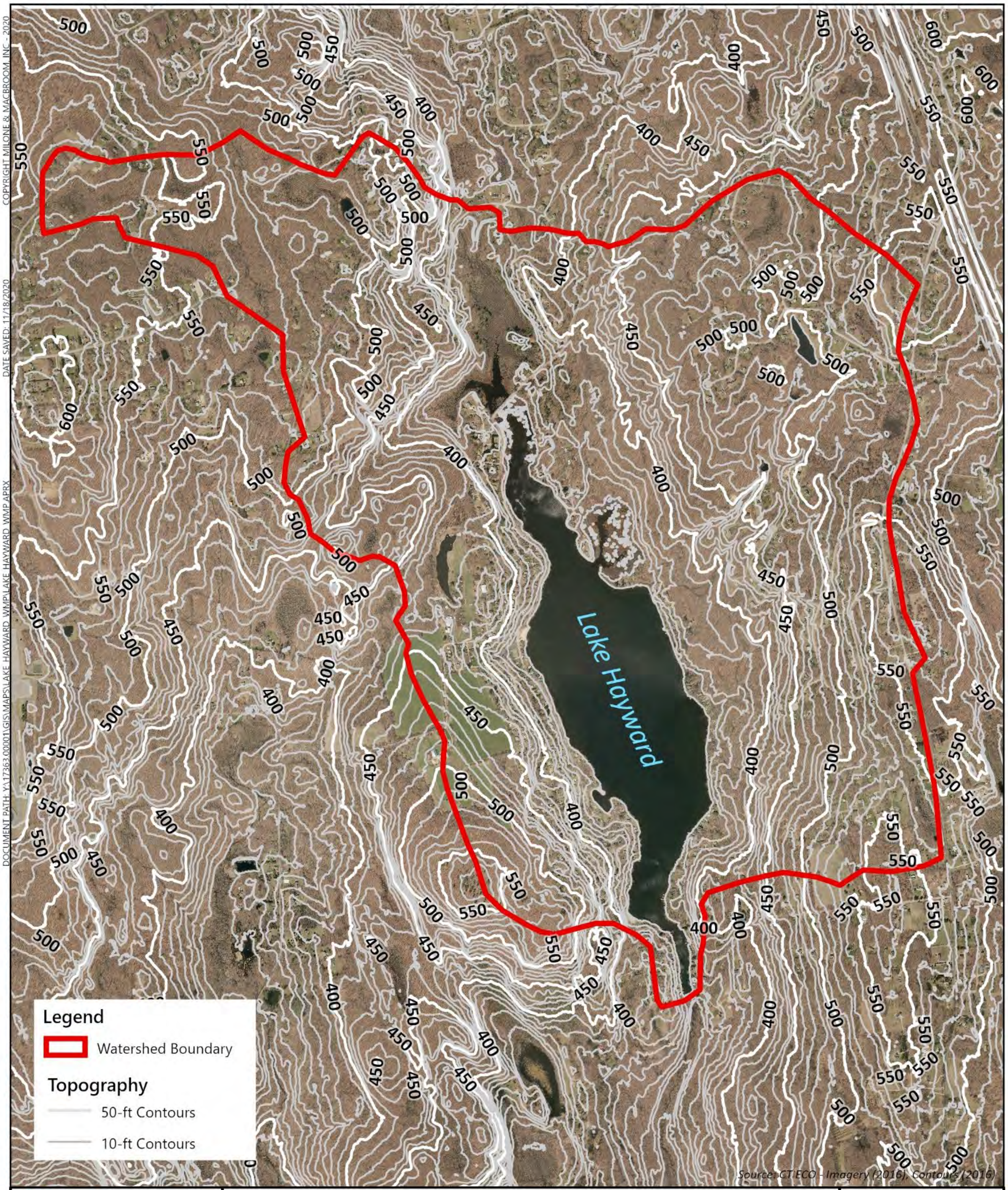
Feet

SCALE	1 in = 2,500 ft
DATE	11/30/2020
PROJ. NO.	17363.00001

FIG. 2-2



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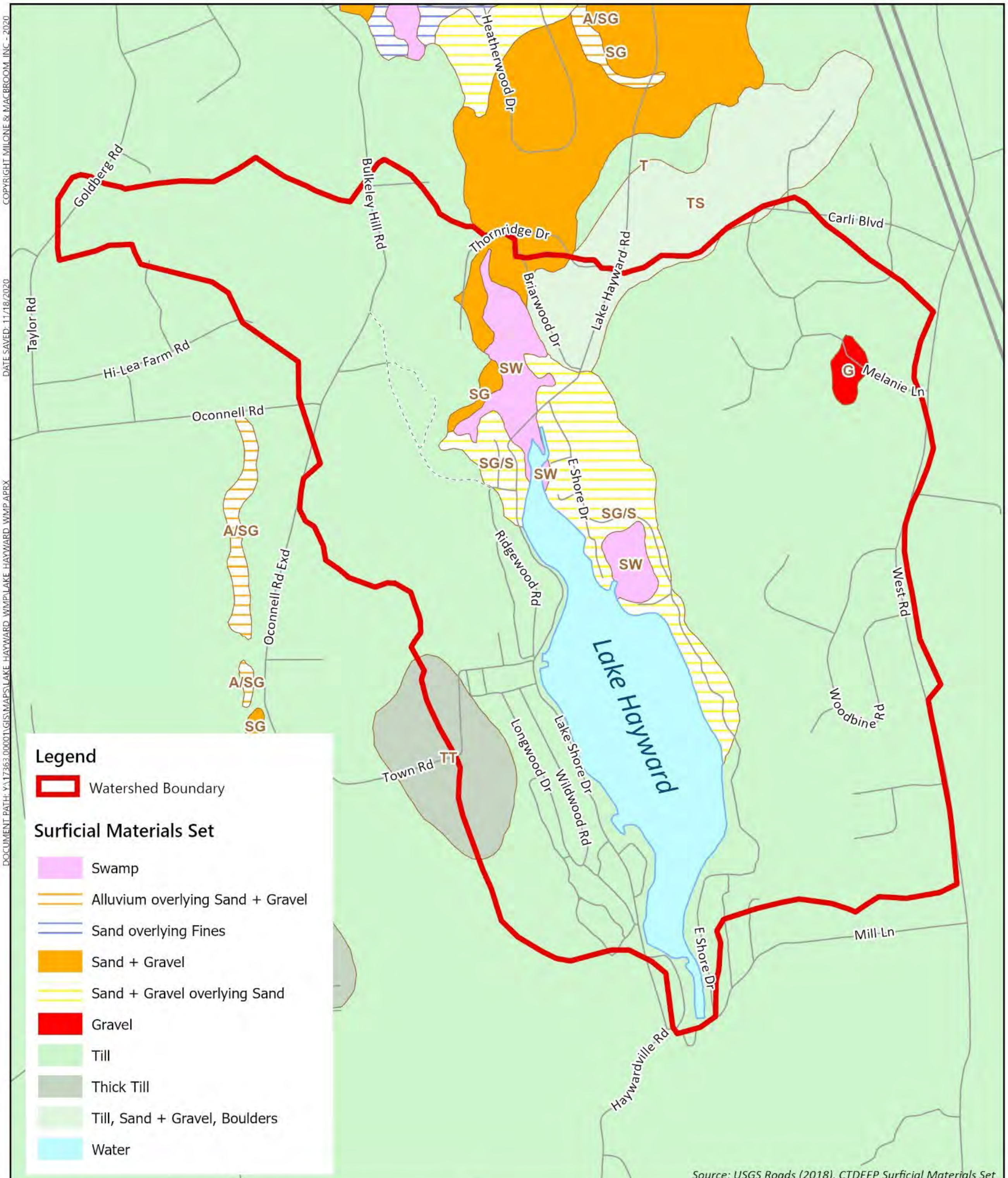
Topography over Aerial Imagery
Lake Hayward Watershed Management Plan
Lake Quality Improvement Committee
Lake Hayward
East Haddam, CT

SCALE 1 in = 1,800 ft
DATE 11/18/2020
PROJ. NO. 17363.00001

FIG. 2-3



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Surficial Geology

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Lake Quality Improvement Committee
Lake Hayward
East Haddam, CT

SCALE 1 in = 1,800 ft
DATE 11/19/2020
PROJ. NO. 17363.00001

FIG. 2-4

2.5 Recreation

Recreation is a critical function of Lake Hayward. Active recreation includes swimming, fishing, canoeing kayaking, sailing, electric power-driven boating, and passive recreation along the perimeter of the lake.

A state-owned public boat ramp and asphalt parking lot is located on the eastern side of the lake on East Shore Drive. This facility is heavily used by visitors, particularly on the weekends. Bass fishing boats and fishing kayaks are commonly observed on the lake, as well as visiting kayakers. No internal combustion motors are permitted on Lake Hayward.

Three bathing beaches are maintained by POALH, all on the west side of the lake. From north to south, they are known as First Beach, Second Beach, and Third Beach. All support sandy areas for sunbathing, boat storage for Association members, and cordoned swimming areas. None of the beaches are supervised by lifeguards. First Beach has a covered pavilion where community and recreational events take place, including POALH meetings, private functions, and music concerts. All three beaches have portable bathroom facilities. Two tennis courts are located directly across the street from First Beach on Lake Shore Drive as well as a basketball court.

Beach monitoring for bacteria as required by health regulation for swimming use during May through September. The State guidance on cyanobacteria provides information about exposure to cyanobacteria (blue green algae). Guidelines for public beaches for additional information can be found here: http://www.ct.gov/deep/lib/deep/water/beach_monitoring/beachguide.pdf

3.0 WATER QUALITY

The water quality of Lake Hayward is a critical indicator for conditions in the watershed and is the central focus of this Plan. Water quality is affected by historical and current activities, both natural and human, within the watershed.

3.1 Historical Lake Water Quality

Many water quality studies of Lake Hayward have been undertaken over the years since 1940. A listing of past studies is included in Appendix B. As part of the WMP initiation, LQIC gathered available data from these studies into central electronic storage as a single spreadsheet file to facilitate analysis. While data from previous studies is available, there are also gaps. Additionally, comparisons of results between studies should include an understanding of the different methods and frequency of sample collection and analysis.

3.2 Water Quality Trends

At present, the greatest water quality concern within Lake Hayward is the recent trend of annual algae blooms that have occurred since 2018. A significant contributor to algae blooms is cultural eutrophication, with increased nutrient loading and biological production resulting from human activities in the watershed. With that background, this section focuses on 'trophic parameters' including Secchi transparency, total phosphorus (TP) and chlorophyll-a. Total nitrogen (TN) is typically not a limiting nutrient for biological production but is included in the discussion of trophic status. Another significant contributor may be internal loading (i.e. nutrients that are released from the lake bottom).

In 2015, LQIC began a volunteer program to monitor trophic parameters to identify seasonal, annual, and long term trends. After the first major algae bloom in 2018, LQIC hired Northeast Aquatic Research (NEAR) to mentor and support a more comprehensive water sampling program. This program has added temperature/dissolved oxygen measurements and direct algae counts in addition to the Secchi transparency, TN and TP sampling. Bottom sediment samples were also taken by NEAR in late 2020. NEAR had also been hired in 2000/2001 to complete a comprehensive lake study. That study provides a good baseline to the more recent volunteer program.

Note that some of the charts in this section include averages that may contain only one or two data points-especially in the earlier years. This adds to the potential error. Mid-summer is considered to be July through August and Spring/Summer is considered to be April through August. 2020 consists of raw data that has not yet been analyzed by NEAR.

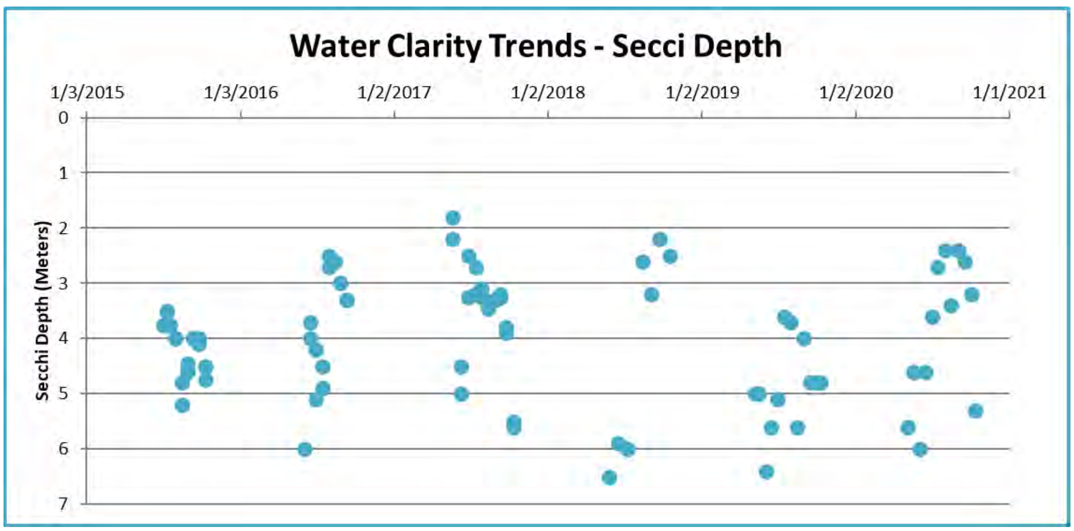
3.2.1 Water Clarity (Secchi Transparency)

Water clarity is measured with a Secchi disk, a weighted 8" disc, with alternating black and white quadrants. The disk is lowered into the water until it can no longer be seen. The Secchi depth is determined by noting depth markings on the rope. A deep Secchi depth indicates clearer water and a shallow depth indicates more turbid or cloudy water. It is a simple test that has remained unchanged for many decades.

The Secchi depth is affected by suspended particles such as soil or algae growth. By its nature, Secchi measurements in Lake Hayward must be taken in deeper water away from any outfalls, so it is primarily affected by algae. Algae, in turn, are affected by the amount of nutrients in the water.

LQIC has collected a large amount of historical Secchi data, though much of it is one or two readings taken in a particular year. Figure 3-1 shows historical Secchi depths over the last six years. There is no apparent overall trend in increasing or decreasing transparency. Less transparency may be associated with algae blooms.

FIGURE 3-1



3.2.2 Total Phosphorus

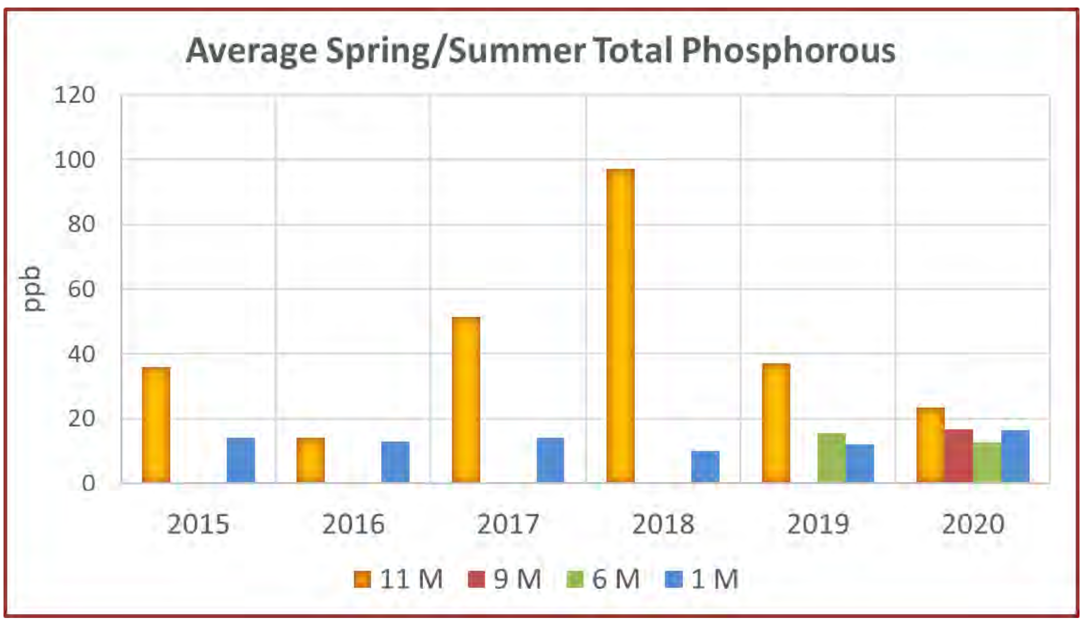
Phosphorus comes from many sources and is typically the limiting nutrient for the growth of plants and algae in a lake. Excessive concentrations of phosphorus can result in algae blooms that detract from the recreational uses of the lake and, in the case of blue-green algae (cyanobacteria), may even be toxic. When plants and algae die, the bacteria that consume them use up dissolved oxygen in the water. This may lead to fish kills and can remobilize phosphorus from the sediment. Phosphorus is more soluble in water containing low levels of dissolved oxygen. Sources of phosphorus include the following:

- Septic system effluent is an important source and speaks to the need for lake residents to correctly maintain their systems.
- Fertilizers may contain phosphorus. It is not very mobile in the soil but can enter the lake through runoff resulting from erosion or excessive use of fertilizer containing phosphates.
- It is present in animal waste, including horse, chicken, geese, and pet waste.

- Phosphorus is present in soil and can be moved to streams and lakes by erosion and sediment transport.
- Detergents are less of a source than they used to be due to efforts to limit phosphates in detergents in the early 1970s.
- Phosphorus is also present in the lake bottom sediments and may be released through biological or physical processes.

Phosphorus can be present as dissolved or particulate and organic or inorganic-bound forms. Studies in this region have focused on total phosphorus (TP) rather than individual fractions. This is in part to simplify sampling and analysis but also because phosphorus has been shown to transition between phases. In 2015, LQIC began monitoring surface and bottom water samples for TP collecting samples with a van Dorn sampler and delivering to an analytical lab for analysis. This was expanded in 2019 to increase the frequency of sampling and to add intermediate depth samples. Figure 3-2 shows sample results for these years. The surface phosphorus has not changed significantly, but the bottom samples are highly variable.

FIGURE 3-2

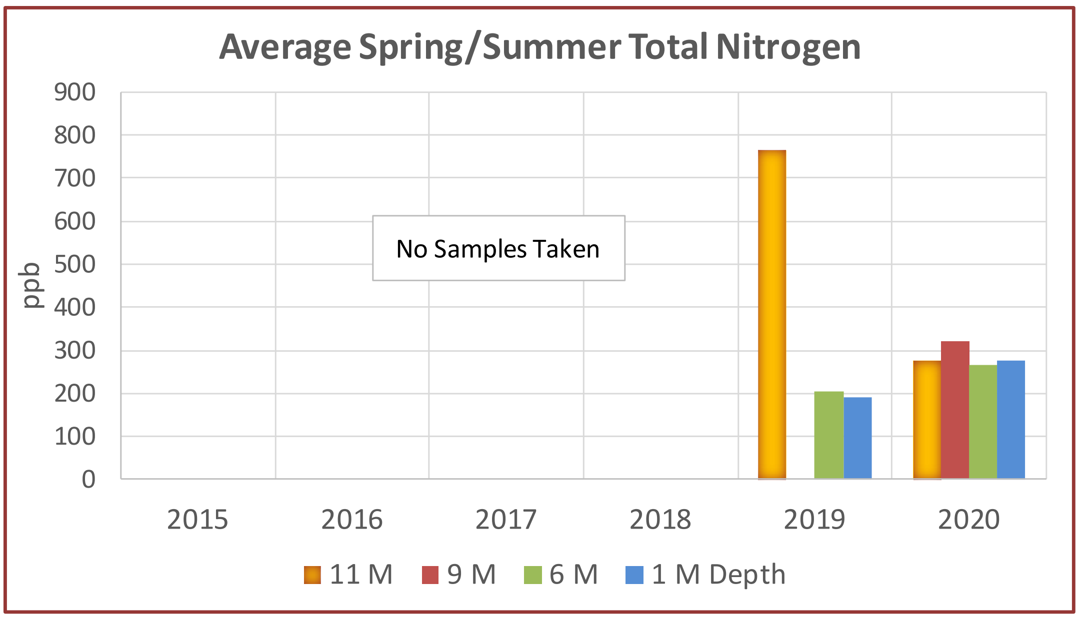


The higher phosphorus concentration from water sampled at 11 meters is due to accumulated phosphorus in anoxic water. In the summer, the development of density differences due to temperature stratification keeps the bottom water separate from the surface waters and is no longer in contact with the air. Decomposition in the sediment consumes oxygen that can eventually create anoxic waters in the hypolimnion. Since phosphorus is soluble in anoxic water, any phosphorus that comes out of the sediments or is precipitated from the water column above will generally remain in solution. Together, these two processes account for the higher accumulation of phosphorus in the bottom layers. Herbicide treatment also may increase oxygen demand due to increased decomposition, which increases the chance for loss of phosphorus from sediment.

3.2.3 Total Nitrogen (TN) and Ammonia (NH_3)

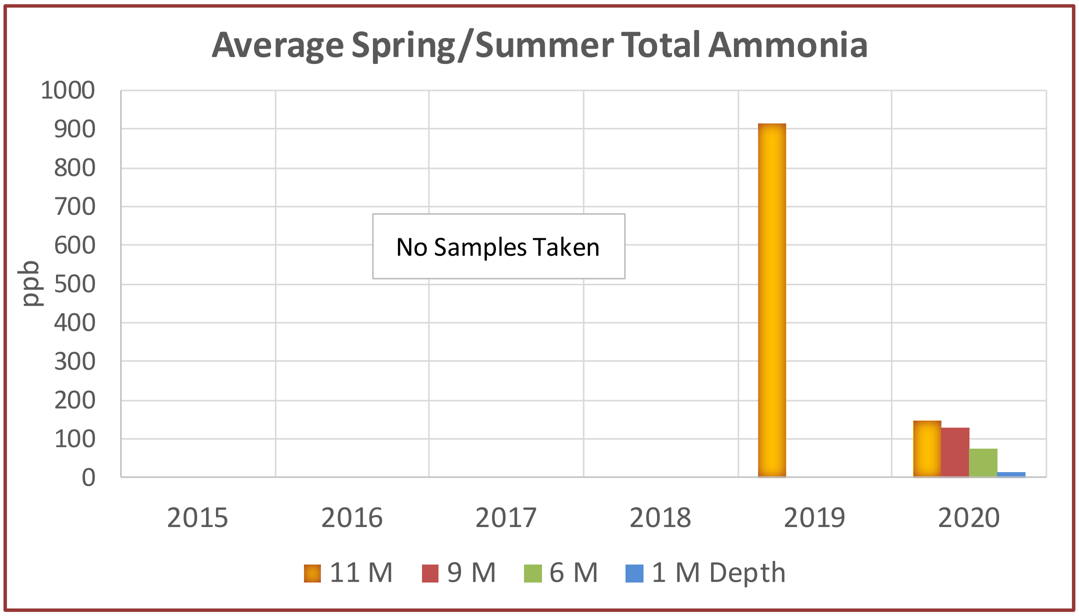
Nitrogen is another important nutrient, even though phosphorus is typically the limiting nutrient. The 1995 study "CT Lakes, A Study of the Chemical and Physical Properties of Fifty-Six CT Lakes" by Canavan & Siver addresses how the TN to TP ratio tends to determine which nutrient is most limiting. Plants need both nitrogen and phosphorus. If TN/TP is greater than about 17, then it matters little how much nitrogen is present because there is not enough phosphorus to stimulate further growth. A review of available data shows that Lake Hayward has historically had TN/TP well above 17, except for one sample in 1974 when it was 18. Figure 3-3 shows the average spring/summer TN sample results for 2019 and 2020.

FIGURE 3-3



Ammonia is the part of TN that is preferred by microcystis cyanobacteria, which dominated the algae in the lake in 2019. Figure 3-4 shows the average Spring/Summer NH3 sample results for 2019 and 2020. Much of the TN is in the form of NH3. Nitrogen and ammonia were not sampled in recent years prior to 2019.

FIGURE 3-4



3.2.4 Chlorophyll-a and Algae Cell Counts

Chlorophyll is the green pigment in plants that allows them to create energy from sunlight through the process of photosynthesis. Measuring chlorophyll in lake water is an indirect measure of the amount of photosynthesizing plants, such as algae. Chlorophyll-a is a pigment that is common across all types of algae and is a measure of algal biomass. Other pigments can be used to determine the presence and importance of different types of algae.

Samples are usually taken near the surface because that is where living, photosynthesizing algae cells are. The earliest available sample was taken in 1938, per the historical record. Figure 3-5 on the following page presents historic testing. The data does not include many chlorophyll-a samples. The latest samples have some of the lowest concentrations of all samples in the record.

Starting in 2019, chlorophyll-a sampling ceased. Algae cells are now counted directly using an algae straw to collect a core sample from the top 10 feet of the lake. Lake Hayward had a moderate algae bloom starting September 21, 2019 that continued on and off in windswept locations through mid-October. Figure 3-6 shows algae counts peaking around that time. The dominant type of algae was blue green algae all year, and most of that was a type called microcystis. Microcystis can produce toxins. 2020 cell counts are not yet available.

FIGURE 3-5

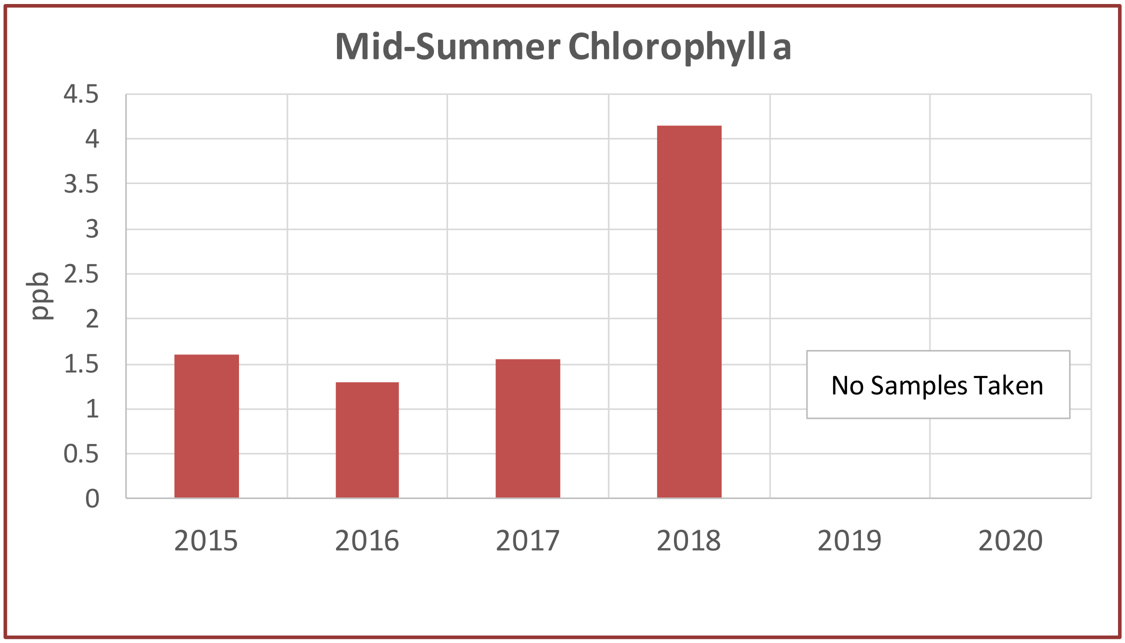
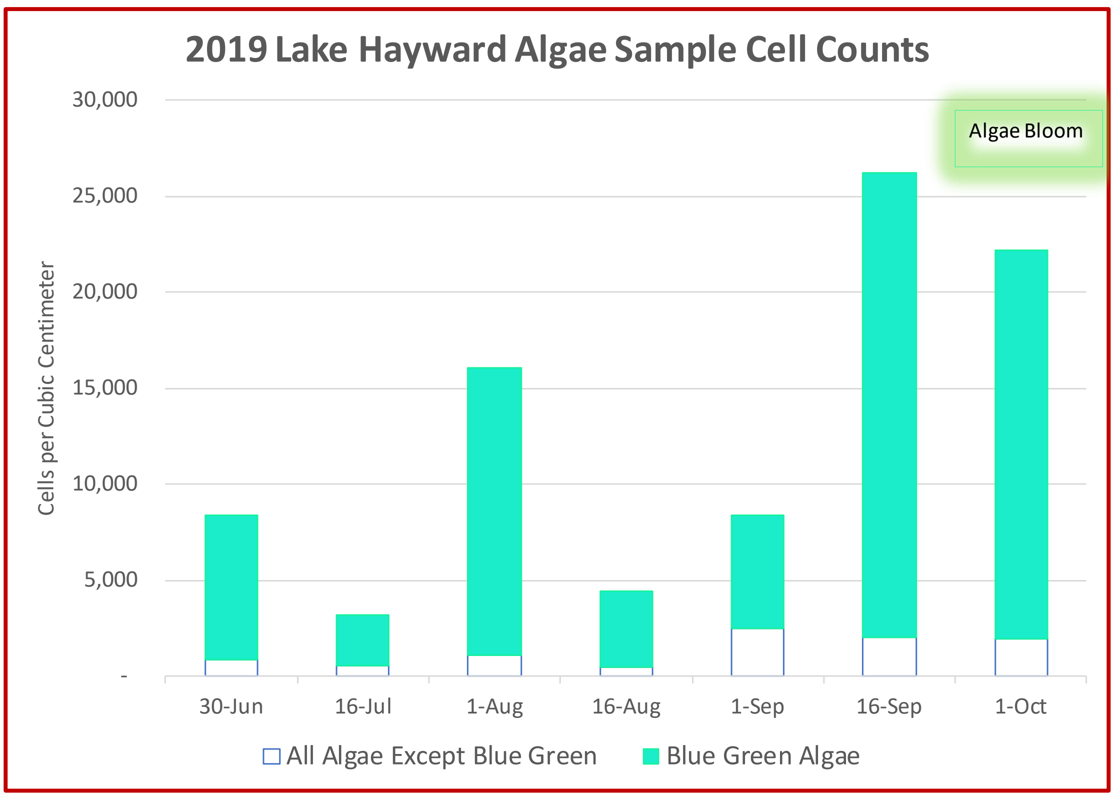


FIGURE 3-6



3.3 Trophic State of Lake Hayward

A trophic classification system is used to characterize lakes based on the above sample results. Lakes naturally transition from an oligotrophic state (low levels of nutrients required for plant growth) through a mesotrophic state to a eutrophic state and finally to a highly eutrophic state (extremely high levels of nutrients) over many centuries. Human activity can significantly accelerate, and human intervention can significantly reverse, that process of eutrophication. A highly eutrophic lake is characterized by algae blooms and fish kills and has less recreational value. Lake Hayward is currently considered mesotrophic using Table 3-1, but recent algae blooms may be a worrisome indicator that eutrophication has increased.

TABLE 3-1
Connecticut DEEP Lake Classification Guide

	Oligotrophic	Mesotrophic	Eutrophic	Highly Eutrophic
ppb Total Phosphorus (spring & summer)	0-10	10-30	30-50	50+
ppb Total Nitrogen (spring & summer)	0-200	200-600	600-1000	1000+
ppb Chlorophyll-a (mid-summer)	0-2	2-15	15-30	30+
Feet Secchi Depth (mid-summer)	19.7 +	6.7-19.7	3.3-6.7	0-3.3

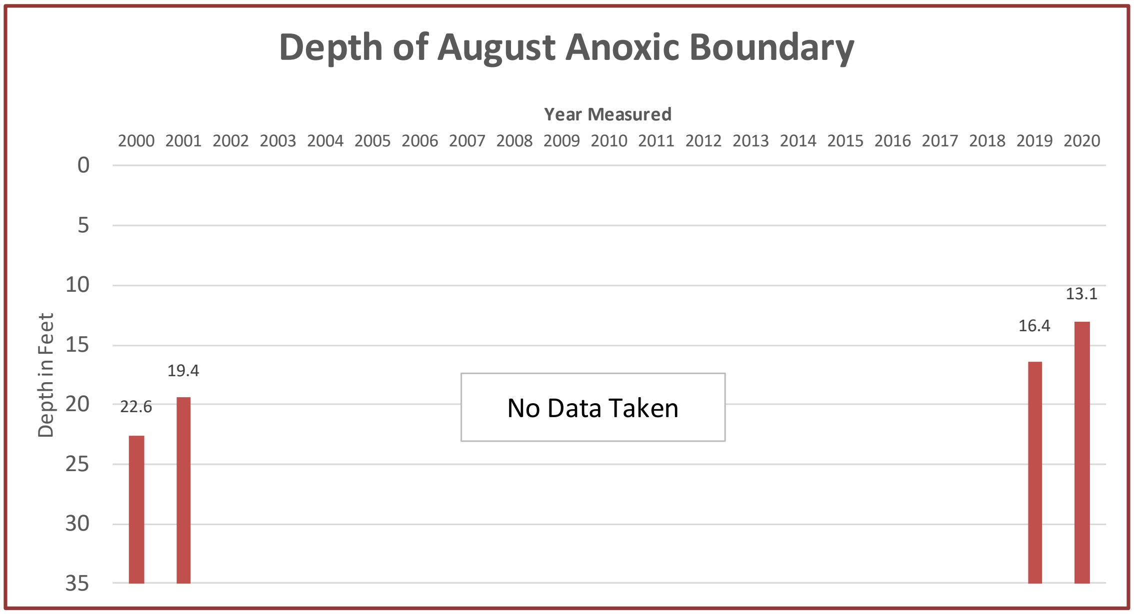
3.4 Dissolved Oxygen

Beginning in 2019, dissolved oxygen and temperature vs. depth profiles have been measured at the deepest point in the lake. These measurements confirm that a thermocline (a region where temperature changes rapidly with depth) forms in the Spring as the surface water heats up and disappears in the Fall when temperatures equalize. Water density differences due to the thermocline resist mixing between surface and deep waters.

The surface waters of the lake are saturated with dissolved oxygen due to mixing with air. The bottom waters are deficient in dissolved oxygen due to bacterial decomposition of dead leaves and other organic matter. When the dissolved oxygen is essentially zero near the bottom, the water is said to be Anoxic. The depth where water begins to be anoxic is called the anoxic boundary. The height (inverse of depth) of the anoxic boundary varies over the year, but typically peaks in August.

Figure 3-7 compares the height of the August anoxic boundary in 2019 and 2020 with prior sampling done in 2000 and 2001. The height of the anoxic boundary is clearly higher now than it was in 2000/2001. Anoxic water promotes a number of chemical reactions in the bottom sediments that release nutrients including nitrogen, phosphorous and ammonia from the lake bottom. The higher the anoxic boundary, the more severe anoxic conditions can be expected lake-wide.

FIGURE 3-7



3.5 Sediment Testing

Recent sediment tests were conducted to help quantify the nutrient contribution from internal loading. The results are in, but the internal loading calculation has not yet been completed. It is expected in early 2021.

3.6 Trends and Possible Causes

Lake Hayward water quality remains mesotrophic at this time. There are signs that nutrient levels have been increasing since the turn of the century. There also is a troubling trend of annual algae blooms since 2018. The causes of these trends are being actively investigated by LQIC and NEAR.

3.7 Connections to Other Plan Elements

Water quality is connected to all other elements of this watershed management plan. Increased human watershed land use can reduce the ability to filter nutrients by creating impervious surfaces and adding to the nutrient load from septic systems. Storm water runoff transports silt and nutrients into the lake. Invasive aquatic plant treatment affects the chemistry and ecological balance of life in the lake. As such, the implementation plan includes continued monitoring to assess the success of projects.

3.8 Potential Threats

The following potential threats to water quality in Lake Hayward have been identified:

- Annual algae blooms
- Continued land development
- Discharge of untreated stormwater runoff
- Active erosion sites
- Failing and underperforming septic systems
- Use of fertilizers and other yard chemicals
- Poor landscaping/maintenance practices (i.e. putting fall leaves in the lake)

3.9 Implementation Actions

The following actions are recommended for Lake Hayward:

1. Engage Project Partners – Continue to draw upon technical service providers as sources of water quality data, including Secchi transparency and algae counts. Regional partners with volunteer monitoring programs include the CT Federation of Lakes and the CT River Coastal Conservation District.

2. Continued Monitoring – Continue the existing water quality monitoring at beaches for bacteria, and throughout the lake for other parameters. Consistent sampling techniques and analysis by the same laboratory are important. Monitoring physical features can provide useful data for a more complete assessment of water quality data. Monitoring to consider includes:

   - Weather data with a local weather station
   - Lake level monitoring with a staff gage

3. Expand Library – Continue to develop the library of previous studies as volunteer time allows. Additional studies are mentioned in the Diagnostic/Feasibility Study that may still be in the files of POALH.

4.0 STORMWATER MANAGEMENT

4.1 Introduction

Stormwater runoff is comprised of excess precipitation that flows over the ground surface and impervious areas and discharges to storm drains or watercourses. The quality of stormwater runoff reflects the land uses and surfaces with which it comes in contact. It is well documented that land development and activities within a watershed can alter hydrologic conditions by modifying the way water moves over, through and from the land, as well as quality of the stormwater runoff that comes in contact with the land, buildings, roadways, and impervious surfaces.

Impervious surfaces and stormwater infrastructure alter watershed hydrology and impact water quality. Roads, bridges, and culverts are all important infrastructure. According to the UConn Center for Land Use Education and Research (CLEAR), the greater the amount of total impervious surface in a watershed, the greater the concern regarding the quality of stormwater runoff. When the percentage of total impervious surface in a watershed is greater than 10%, water quality is impacted. When the percentage of total impervious surface in a watershed is greater than 25%, the water quality is degraded[2].

The contributing watershed to Lake Hayward is approximately 1,500 acres, primarily within the Town of East Haddam, with portions of the watershed extending into the towns of Colchester and Salem. The land use composition in the contributing watershed includes single family residential dwellings and large expanses of woodland, wetland, and open space. The near-lake land use is dominated by seasonal cottages, with a number of year-round homes interspersed.

The most impactful land areas relative to stormwater quality are those that immediately surround the lake, including land uses and activities along East Shore Drive on the east side and the densely developed residential area on the west side, including Lake Shore Drive, Ridgewood Road, Lookout Drive, Sunset Road, East Lane, Town Road, Hay Field Road, Wildwood Road, Longwood Drive, Briarcliffe Road, Laurel Lane, Forest Way, Cragmere Road, and Glimmer Glen.

Anything with which stormwater comes in contact (roadways, rooftops, driveways, grass, dirt, etc.) has the potential to affect the quality of the runoff, including those substances that may dissolve and those that can become suspended and then be carried with the stormwater runoff, eventually reaching the lake. Constituents of concern include bacteria from failing or under-functioning septic systems, animal droppings, or unprotected garbage; oil and grease that may have been deposited on driveways or travelways; fertilizers that are applied to lawns and gardens; sand and salt that is applied to roadways; and soil that is eroded along steep slopes or within under-sized streams and tributaries.

Stormwater runoff conditions on the west side of Lake Hayward are influenced by the higher density of development and naturally occurring steep slopes. The western side of the lake is also characterized by steep slopes that are more prone to erosion as compared to the eastern and outer extents of the watershed. Three lake association beaches are located on the western shore

[2] http://clear.uconn.edu/projects/landscape/v1/analysis/calcap/images/threshold.pdf

(from north to south they are: First Beach, Second Beach, and Third Beach). Limited testing of stormwater runoff and tributary flow confirm that the quality of water discharging from the west contains significantly higher concentrations of pollutants as compared to the east.

The lawns of numerous lakeside properties along both shores of the lake appear to be well maintained. This may indicate the use of chemical fertilizers that contain high concentrations of nitrogen and phosphorus. These nutrients can be carried into the lake with stormwater runoff, thus increasing the ability of aquatic plant life (including nuisance algae) to flourish.

Sand and sediment that occur in high concentrations can cause accelerated shallowing in the lake and vegetated deltas that form at the location of concentrated stormwater outfalls. Such filling shortens the life of the lake, can interfere with swimming and boating, and can become an aesthetic deterrent.

Numerous studies have been performed at Lake Hayward through the years, including most recently a 2012 study entitled "*Stormwater Management Priorities: Roadmap for Rural Towns Study*" funded by the Long Island Sound Futures Fund and coordinated by the Eightmile River Wild & Scenic Coordinating Committee in partnership with Eastern Connecticut Resource Conservation and Development, Inc. and the Towns of East Haddam, Lyme and Salem, prepared by Nathan L. Jacobson & Associates, Inc. Three of the stormwater outfalls that discharge to Lake Hayward were identified among the worst within the Town of East Haddam. This underscores the importance of vigilant stormwater management.

Stormwater is regulated in Connecticut only in certain instances, including in high density urban areas, at certain commercial and industrial operations, and at construction sites that cover an area greater than one acre. Stormwater runoff in developed residential areas, such as those that surround Lake Hayward, is not specifically regulated by the municipality or the state.

Septic system construction, modification, and operation are regulated through the Chatham Area Health District. New septic systems must be constructed in accordance with standards and must be maintained as required in the regulations. Septic systems should be pumped out at least once every five years and a permit to discharge obtained from the Health District. Unfortunately, these requirements are not strictly enforced, and on-site inspections rarely occur. As such, under-performing or even failing systems can go undetected and pollutants, including bacteria, nitrogen, and phosphorus, can be carried overland with leachate and intermixed with stormwater runoff, eventually discharging into the lake.

The maintenance of the roadways and catch basins where they exist surrounding Lake Hayward is undertaken by the Town of East Haddam. Discussions with town representatives indicate that roads are swept and catch basins cleaned annually.

Because stormwater runoff is largely unregulated, the voluntary efforts of watershed residents are vitally important towards maintaining healthy lake water quality.

4.2 Stormwater Collection System

4.2.1 Overview

Fourteen major outlets, including culverted discharges and small tributaries, discharge to Lake Hayward, along with a number of smaller discharge pipes that direct stormwater directly to the lake. The remaining stormwater discharges to Lake Hayward occur as overland flow.

For analysis purposes, the contributing watershed to Lake Hayward was subdivided into 14 sub-basins correlating to the primary direct outfalls. An additional 9 sub-basins drain directly to the lake via sheet flow. In some cases, the natural direction of overland flow has been altered by curbing and stormwater collection system piping that redirect the stormwater flow.

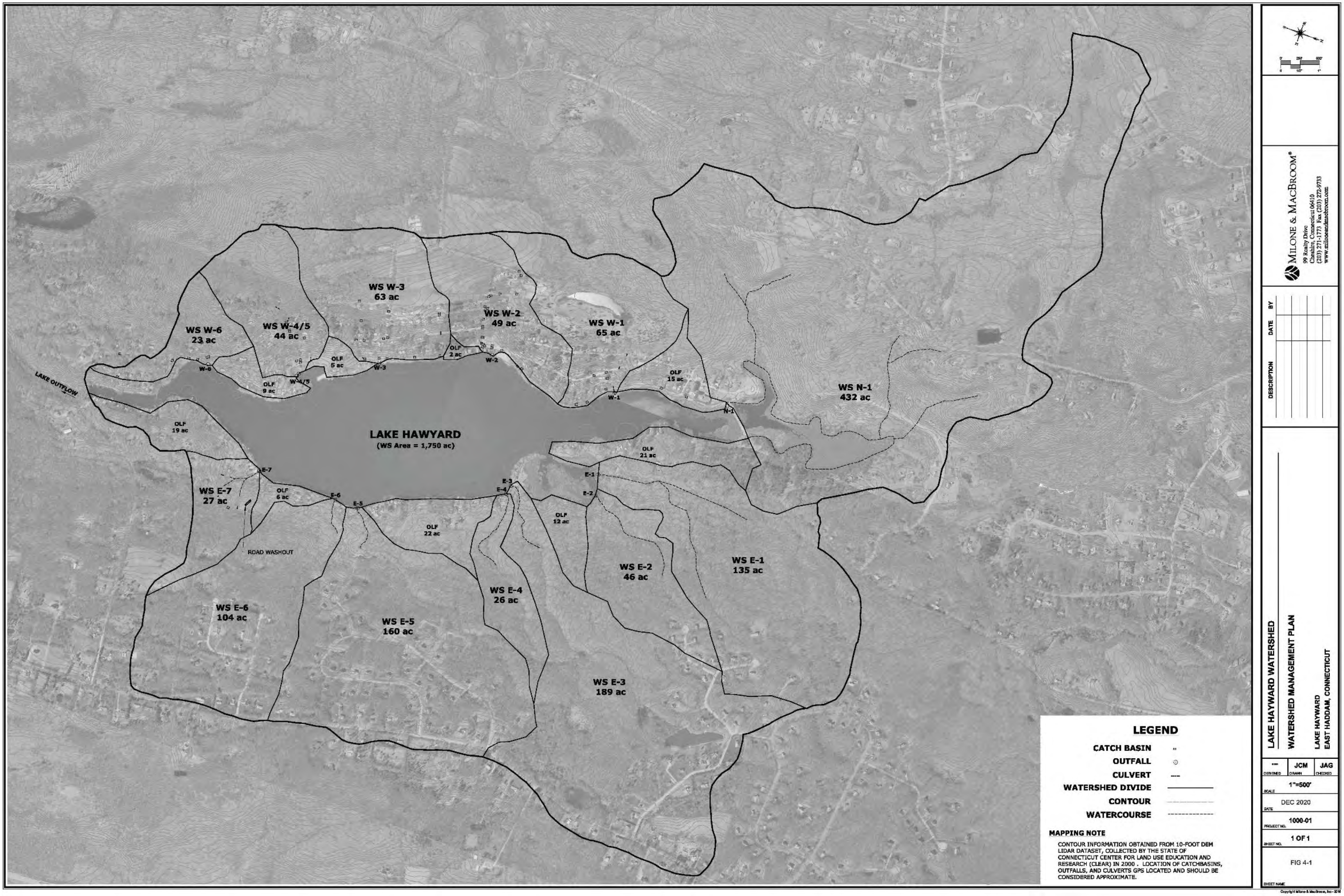
Figure 4-1 graphically shows the watershed and sub-watersheds. Table 4-1 presents a listing of the same.

TABLE 4-1
Summary of Sub-Basins of Lake Hayward

Sub-Basin Designation	Contributing Area	Type of Outlet	Priority for Mitigation	Primary Threats
N-1	432 acres	36-Inch CP	Low	Future Development
W-OLF1	15 acres	Overland Flow	Low	Stormwater
W-1	65 acres	24-Inch CMP	Moderate	Channel Stability/Erosion
W-2	49 acres	34-Inch CMP	High	Agriculture, Stormwater, Septic
W-OLF2	2 acres	Overland Flow	Low	Septic
W-3	63 acres	12-Inch CPP	High	Agriculture, Stormwater, Septic
W-OLF3	5 acres	Overland Flow	Low	Stormwater, Septic
W-4/5	44 acres	Buried CMP	Moderate to High	Septic
		20-Inch CMP	Moderate to High	Stormwater, Septic
W-OLF4	9 acres	Overland Flow	Low	Septic
W-6	23 acres	12-Inch CPP	High	Stormwater, Septic
E-OLF1	21 acres	Overland Flow	Low	Septic
E-1	135 acres	Tributary/Overland Flow	Low	Future Development
E-2	46 acres	Tributary/Overland Flow	Low	Future Development
E-OLF2	12 acres	Overland Flow	Low	Future Development
E-3	189 acres	Tributary/Overland Flow	Moderate	Future Development
E-4	26 acres	Tributary/Overland Flow	Low	Future Development
E-OLF3	22 acres	Overland Flow	Low	Future Development
E-5	160 acres	Tributary/Overland Flow	Moderate to High	Stormwater, Erosion
E-6	104 acres	Tributary/Overland Flow	Moderate to High	Stormwater, Erosion
E-OLF4	6 acres	Overland Flow	Low	Septic
E-7	27 acres	12-inch CMP	Moderate	Stormwater, Septic
E-OLF5	20 acres	Overland Flow	Low	Septic

Notes: CP = Concrete Pipe; CMP = Corrugated Metal Pipe; CPP = Corrugated Plastic Pipe

Figure 4-1
Sub-Watershed Delineation



Extensive field investigations and mapping were undertaken to document and map the contributing watershed to Lake Hayward as well as the collection and discharge system to the outfalls and tributaries that discharge into the lake. The collection system immediately surrounding Lake Hayward was documented through visual observations and survey using survey-grade Trimble global positioning system (GPS) equipment. The inventory included visual inspection, photo-documentation, measurement of outfall piping, and survey of the horizontal location of catch basins, sumps, conveyance piping, and outfalls. Collection systems and outfalls are discussed in detail in the subsequent sections.

4.2.2 West Side Stormwater Collection System

The west side of Lake Hayward is characterized by steep terrain sloping from west to east towards the lake. Intense amounts of erosion have occurred since the area was initially developed in the 1930s and 1940s. Slopes flatten significantly along the western border of the watershed and become less densely developed. A prominent feature of the western watershed border is the Allegra Farm, which is host to a “livery stable” for carriage rides hayrides, and sleigh rides.

The roadway system on the western side of Lake Hayward is comprised of a series of north/south oriented streets, mainly Lake Shore Drive along the lake, Ridgewood Road and Lookout Drive adjacent to the northern quarter of the lake; and Wildwood Road, Longwood Drive, and Briarcliffe Road along the remainder of the lake. These are connected by steep east/west oriented roadways, including Laurel Lane, Hayfield Road, and Town Road.

Despite the presence of catch basins and collection piping, drainage problems have plagued the western hillside for decades, with some residents reporting loss of substantial trees due to erosion of the root system, and damage to their properties from the erosive forces of stormwater runoff. In some instances, curbing has been constructed, which has improved the condition for some landowners, while exacerbating conditions for others. Throughout the collection system, chronic clogging of stormwater conveyance piping occurs.

Decades of the effects of the eroding hillside have deposited along the western shore of the lake, as evidenced by large sandy deltas and vegetated areas. Catch basins and stormwater conveyance piping have been observed to be full and non-functioning in some cases, and evidence of soil transport is plentiful. This condition is also apparent at the outfalls that discharge to the lake, as described more fully in Section 4.3.

4.2.3 East Side Stormwater Collection System

Unlike the westerly portion of the Lake Hayward watershed, the eastern side of the lake is rimmed by a single roadway, East Shore Drive, paved at the northern and southern ends and unpaved in between. Land use along East Shore Drive is entirely residential, with seasonal and year-round homes. Long stretches of the 1.9-mile road have only one home on either the lake side of the road or the upland side, with some stretches undeveloped on both sides. Beyond that are large areas of undeveloped land until you reach the outskirts of the watershed in Colchester, where three small subdivisions that support low density residential land uses are located. A large majority of stormwater flows to the lake via overland and tributary flow until it crosses East Shore Drive, at which point flow is contained in culverts and piping. Many of the small streams on the east side of Lake Hayward are seasonal and only flow in the springtime or following significant rainfall. A number of cross culverts convey flow from one side of East Shore Drive to the other, most with no formal system of catch basins or piping to the lake. Similar to the west side of the watershed, chronic clogging of stormwater and tributary conveyance piping occurs.

East Shore Drive is set back a good distance from the lake as compared to its sister road Lake Shore Drive on the western side of the lake. The eastern shore also supports a large undeveloped wetland area in the northern portion of the lake.

Table 4-2 is a summary of culverts identified along East Shore Drive on the eastern side of the lake.

TABLE 4-2
Summary of East Side Stormwater Conveyance Culverts & Bridges

Sub-Watershed Reference	*Culvert Size*	*Culvert Type*	*Observations (October 2015)*
E1	18”	Twin CPP	Dry
E2	12”	CPP	Dry
E3	24”	CPP	Running fast and clear
E4	18”	CP	Dry
E5	Arch	CMP	Flows full most of the year. Large delta at outfall to Lake.
E6	24”	CP	Flowing. Joins flow with the 30” E6 culvert.
E6	30”	CP	Trickle of flow. Joins flow with the 24” E6 culvert.
E7	12”	CPP	Dry and mostly cogged.
E7	12”	CPP	Dry and mostly clogged.
E7	12”	CPP	Running

Note: CPP = Corrugated Plastic Pipe; CP = Concrete Pipe; CMP = Corrugated Metal Pipe

4.3 Sub-Watersheds

4.3.1 North Shore Watershed

Sub-Basin N1

Sub-basin N1 drains approximately 432 acres of land and discharges to a wet marsh and ponded area north of Lake Shore Drive. There are no known point discharges to this northernmost portion of the lake. The area that contributes to sub-watershed N-1 encompasses portions of East Haddam and Colchester, including the residential area on Briarwood Drive, the eastern portion of Thornridge Drive, Buckley Hill Road from Lee Court to the Colchester Border near O’Connell Road, and a small portion of Taylor Road. This sub-watershed is largely undeveloped, with areas of low density residential development.

The culvert beneath Lake Shore Drive is a ±36-inch concrete pipe that conveys water beneath the road and hydraulically connects the main lake to the back water. The upstream end of the culvert (shown in the top photograph to the right) has been fitted with a steel grid trash rack. The downstream end of the culvert (shown in the bottom photograph to the right) discharges into a backwater scrub area of the lake. The pipe is oriented such that it is directed towards the bank. Some undercutting of the bank is evident but is not severe. The pipe is supported by a rock retaining wall that is in fair to marginal condition. Water was running clear on the day of inspection (4-17-16), with no evidence of sediment contamination. This is expected, as the area north (upstream) of Lake Shore Drive acts as a sediment forebay to the lake.

Based on the lack of visible water quality issues, erosion and/or accumulated sediment, this sub-watershed is considered to be a low priority area relative to stormwater quality impacts. This is largely due to the very low density of development within the sub-watershed and the impounded area upstream (north) of Lake Shore Drive that acts as a sediment forebay. The biggest threat to this sub-watershed is the potential for future development. This is discussed more fully in Section 7. Minor erosion on the right bank of the downstream end of the N-1 culvert should be monitored for signs of significant deterioration.

4.3.2 West Shore Watershed

Sub-Basin W-OLF1

An area of approximately 15 acres located between N1 and W1 drains to Lake Hayward via overland flow with no piped outflow and no formal collection system. This area includes portions of Ridgewood Road, Ridgewood Road Extension, Hillside Road, and Lake Shore Drive. This sub-watershed is entirely comprised of cottage development. Future stormwater management efforts in sub-watershed W-OLF1 should focus on resident education and voluntary stormwater management practices. These are discussed further in Section 7.

Sub-Basin W-1

Sub-basin W-1 drains approximately 65 acres, including portions of Ridgewood Road and Lookout Drive as well as the large largely undeveloped hillside to the west. A portion of Allegra Farm is located within this sub-watershed, including a sizable farm pond. Storm drainage collection components are located on Lake Shore Drive and Ridgewood Road.

A steep flow channel only several feet wide conveys water during the wet months and following rainstorms down the hill and to a 24-inch corrugated metal pipe that flows beneath Lake Shore Drive. The pipe has a mortared block headwall on both the upstream and downstream ends. A metal pipe spans the flow channel upstream of the culvert beneath Lake Shore Drive (shown in the left-hand photograph). Its purpose is unknown.

The downstream end of the outfall at W-1 flows beneath a lawn area and then discharges into the lake. A sizable vegetated delta has formed at this outfall, likely having developed over decades following the initial development around the lake and the subsequent formation of the incised drainage channel from the hill. Water that discharges from this outfall flows through a small channel that runs through the delta before discharging into the lake. The substrate is a mix of sand and small cobble and the outfall pipe is free of accumulated sediment.

This sub-watershed is considered to have moderate priority relative to stormwater impacts. Future efforts should focus on the stability of the flow channel and maintenance of a free flowing outflow at the decades-old delta. As with other sub-basins, future stormwater management efforts in this sub-watershed should include resident education and voluntary stormwater management practices.

<u>Sub-Basin W2</u>

Sub-basin W-2 drains approximately 49 acres, including portions of Lookout Drive, Ridgewood Road, Town Road, Hay Field Road, and East Lane as well as a portion of Lake Shore Drive and the northerly portions of Wildwood Road and Longwood Drive. This area encompasses a portion of Allegra Farm and the large grass field between Town Road and Longwood Drive. Except for the Allegra Farm fields, this sub-basin is densely developed with residential homes and cottages as well as tennis courts, a basketball court, and the pavilion at First Beach. The hillside within this sub-basin is quite steep and stormwater runoff can be intense.

Stormwater along Hilltop Road and Lake Shore Drive is collected and conveyed through catch basins, piping, and overland flow directed to a 34-inch corrugated metal pipe that discharges to the lake. Major sediment accumulation has occurred here, with a large underwater delta visible a significant distance into the lake (as seen in the photograph to the right). It appears that the flow path at the outfall may have been manually dug out at one time to maintain an open flow path. The pipe is partially clogged with sediment, with approximately three-quarters capacity remaining. This outfall was cited as one of the top 6 priority outfalls identified in the 2012 study Stormwater Management Study as was a second outfall immediately adjacent to it, which is no longer visible. Upon closer inspection, this pipe has been partially squashed, is more than half full of sediment, mostly underwater, and no longer functioning.

Given the high degree of sediment accumulation, the densely developed area draining to this outfall, and its proximity to a public bathing beach, this sub-watershed is considered to have high priority relative to stormwater impacts. Frequent catch basin clean-out, public education and implementation of volunteer stormwater management, and construction of a bio-detention or bio-infiltration basin are recommended.

Sub-Basin W-OLF2

A small area of approximately 2 acres located between W-2 and W-3 drains to Lake Hayward via overland flow with no piped outflow. This small area is densely developed with cottages on small lots. Future stormwater management efforts in this sub-watershed should focus on resident education and voluntary stormwater management practices.

Sub-Basin W3

Sub-basin W3 drains approximately 63 acres, including portions of Briarcliff Road, Longwood Drive, and Wildwood Road, all densely developed with cottages on small lots, and a portion of one of the Allegra Farm fields.

A 12-inch corrugated plastic pipe outfall pipe is visible but completely clogged with sediment, leaves, and debris (see left-hand photograph to the right. This outlet is not functioning at all. The upstream catch basin on Lake Shore Drive has been observed to have standing water and may be vulnerable to flooding during high intensity or prolonged storm events. The shoreline in the area of the outfall shows evidence of historic sediment accumulation and formation of a delta that extends well into the lake.

Given the steep hill that drains into this outfall, the density of development, and the notable accumulation of sediment, this sub-basin is categorized as a high priority for stormwater mitigation. Catch basin maintenance should be undertaken at least twice each year; the basin should be evaluated for suitability, size, cost, and long-term feasibility of a sediment trap; and accumulated sediment should be evaluated for removal at the outfall. There is little land area in this sub-basin to construct a sediment basin. As with other watersheds, public education will be important.

Sub-Basin W-OLF3

An area of approximately 5 acres drains directly to the lake between W-3 and W-4 along Lake Shore Drive, encompassing Second Beach. This is considered to be a low priority relative to stormwater mitigation.

Sub-Basins W-4 and W-5

Sub-basins W-4 and W-5 both drain to a small cove of Lake Hayward located just south of Second Beach. Together, they drain approximately 44 acres, including all or portions of Lake Shore Drive, Laurel Lane, Wildwood Road, Longwood Road, Briarcliff Road, and Cross Road. The contributing drainage area is extremely steep, with a system of catch basins and piping.

What has historically been identified as the W-4 outlet appears to be a near-completely buried corrugated metal pipe with no flow capacity. Stormwater appears to be flowing overland into the lake in this area, though several catch basins were identified in the upstream area.

A 20-inch corrugated metal pipe discharges into the cove just north of a paved patio area that extends nearly to the water's edge. The outfall carries drainage from catch basins on both sides of Lake Shore Drive. The pipe is visibly rusted on the bottom half and appears to be completely rusted through along portions of its length, evidenced by water bubbling from the ground. While the cove was dredged in 2014, the excavation did not extend to this area of the cove and historic sediment deposits are visible beneath the water near this outlet. The cove clearly acts as a form of settling basin for sub-basins W-4 and W-5.

Further to the south of the cove, another outfall has been identified on historic maps, though no pipe is visible at this time.

Sub-Basin W-OLF4

An area of approximately 9 acres drains directly to the lake between W-5 and W-6 along Lake Shore Drive on the south side of Second Beach. This is considered to be a low priority relative to stormwater mitigation.

Sub-Basin W-6

Sub-basin W-6 drains approximately 23 acres of steep and very steep terrain, including portions of Cragmere Road, Longwood Road, Wildwood Road, and Lake Shore Drive. A number of catch basins collect water from the steep hillside and route it beneath Lake Shore Drive north of Third Beach.

The culvert discharges onto bare ground on the waterward side of Lake Shore Drive and flows overland down a hill before discharging into the lake. This outfall was cited as one of the top 6 priority outfalls within the Town of East Haddam as identified in the 2012 study entitled "*Stormwater Management Priorities: Roadmap for Rural Towns Study*" funded by the Long Island Sound Futures Fund and coordinated by the Eightmile River Wild & Scenic Coordinating Committee. Given the steepness of the contributing area to this sub-basin and the historic poor water quality, it is considered to be a high priority sub-basin.

4.3.3 Eastern Watershed

Sub-Basin E-OLF1

A long narrow sub-basin of overland flow is located between sub-basin N-1 and E-1, approximately 21 acres in size, generally between East Shore Drive and the lake. This basin includes the public boat launch. There are few developed parcels within this sub-basin and except for the paved road, ground cover is largely wooded. This sub-basin poses a relatively low priority threat to stormwater impacts and lake quality.

Sub-Basin E-1

Sub-basin E-1 drains approximately 135 acres of steep, mostly wooded terrain, including a small area of residential development near the outskirts of the watershed towards the end of the Melanie Lane cul-de-sac. This is the fourth largest sub-basin that drains to Lake Hayward.

A single stormwater pipe crosses East Shore Drive within sub-basin E-1, consisting of twin 18-inch corrugated plastic pipes (CPP). Often, no flow can be observed in the pipes, even after prolonged periods of rain. The ground upstream and downstream of the crossing is well vegetated and there was no evidence of erosion or sedimentation. Downstream of the twin culverts, overland flow sheds towards the lake.

Aerial photographs show evidence of two seasonal streams within basin E-1, which combine upstream in the watershed before reaching East Shore Drive. Under most conditions, however, there is no visible flow path from the road to the lake.

The low-density development, coupled with heavy vegetative cover and overland flow make this a low priority basin with regard to stormwater quality impacts. Future development will largely be driven by local zoning code within the Town of Colchester, discussed in Chapter 7.

Sub-Basin E-2

Sub-basin E-2 drains approximately 46 acres of largely undeveloped wooded land. The exception is a small residential area at the end of the Hunters Court cul-de-sac in Colchester. The crossing within sub-basin E2 consists of a single 12-inch CPP. A hill drains to the culvert on the east side of the road with what appeared to be placed rocks to dissipate flow, though visibility was hindered by the heavy fall leaf cover. No erosion was evident on the upstream or downstream side of the crossing and no active flow was occurring.

Aerial photographs show evidence of a seasonal stream within basin E-2, which discharges beneath East Shore Drive. Under most conditions, however, there is no visible flow path from the road. Downstream of the culvert, overland flow sheds towards the lake.

Low-density development coupled with heavy vegetative cover and overland flow make this a low priority basin with regard to stormwater quality impacts.

Sub-Basin E-OLF2

Sub-basin E-OLF2 drains approximately 12 acres of undeveloped land between sub-basins E-2 and E-3. This area is largely wooded with moderate slopes. It is considered to have a low potential to add sediment and/or non-point source pollutants and therefore is considered to be a low priority sub-watershed with respect to stormwater impact.

Sub-Basin E-3

Sub-basin E-3 drains approximately 189 acres of land, including the residential areas along Melanie Road and West Road within the Town of Colchester along the outskirts of the watershed. A stormwater pipe crossing beneath East Shore Drive is a single 24-inch CPP. Flow has been observed at this location running fast and clear, with a clearly defined channel both upstream and downstream of the culvert. There is no evidence of erosion. Water ponds upstream of the culvert and has been observed shooting out in a jet on the downstream side. Flow dissipates somewhat by rocks that have been placed in the channel on the downstream side of East Shore Drive.

Further downstream, flow spreads out and winds its way through the vegetated area between the road and the lake. Flow turns north and then under a concrete pipe at a driveway crossing that serves several homes. Beyond that, flow dissipates further as it makes its way to the lake in the back marshy cove. There is no evidence of erosion or turbidity.

Sub-Basin E-4

Sub-basin E-4 drains approximately 26 acres of nearly all undeveloped woodland.

The crossing at sub-basin E4 is a single 18-inch concrete pipe. There was no evidence of flow on numerous inspections; however, an adjacent neighbor indicated that in more typical years (i.e. non-drought), the culvert carries water much of the year. On the upstream side, a depression has formed, likely due to high velocity and ponded water under wetter conditions. There was no evidence of erosion or sedimentation in this area. The slope from the road to the lake was steeper in comparison to other crossings. It is unclear if the flow from this culvert joins the flow from E3.

Sub-Basin E-5

E-5 drains approximately 160 acres of land, making it the third largest sub-basin. It is also the most heavily developed contributing sub-basins on the east shore of the lake, including portions of West Road and all of Woodbine Road, Cirillo Drive, and Sweetbriar Court within the Town of Colchester.

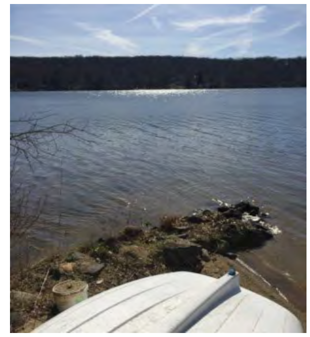
The size of this sub-watershed in combination with the amount of development and impervious surfaces is evidenced by the flow in the lower part of the sub-watershed. The crossing at sub-basin E5 is a squashed corrugated metal arch pipe culvert beneath East Shore Drive. The channel in both the upstream and downstream directions is extremely well defined and it is clear that this sub-watershed has active flow through much of the year.

Water flows downstream from the crossing at East Shore Drive between two cottages and then discharges directly to the lake. A large delta has formed at the outlet, submerged during higher lake levels but clearly visible. Given the size and density of development in this sub-basin, it represents a significant potential source of flow and sediment to the lake. Additional assessment of watershed practices and potential for post-development stormwater management are recommended. This sub-basin is considered to have moderate to high priority relative to stormwater impacts.

Sub-Basin E-6

Sub-basin E-6 drains an area of 104 acres, including a portion of West Road and all of Brookside Drive and Meadow Lane, all residentially developed areas within the Town of Colchester. Two crossings beneath East Shore Drive occur within this sub-basin within 50 feet of one another. The northerly pipe, a 24-inch concrete pipe, has been observed passing less flow than the southerly pipe, a 30-inch concrete pipe. The southerly pipe crosses the East Shore Drive and bends northerly before joining flow form the northern crossing. Water typically runs clear across a sandy bottom flow channel, with some sand build-up evident on the downstream side of the 30-inch (southerly) culvert.

Water that discharges from the two culverts beneath East Shore Drive flows overland in a small stream to its outlet on the east shore of the lake. The discharge has formed a visible delta out into the water, as can be seen in the photograph to the right.



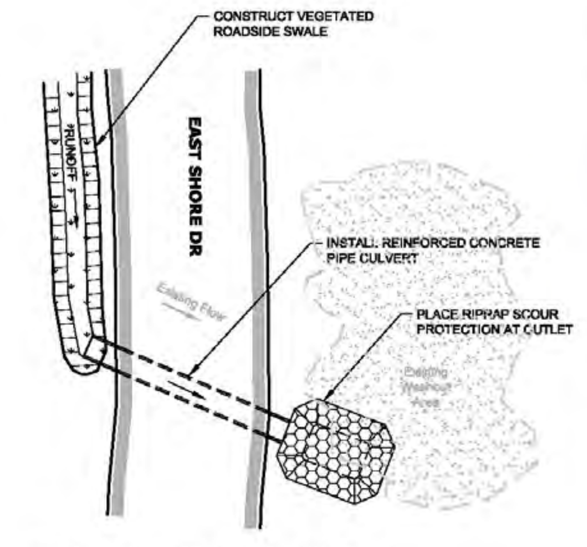
This watershed has a moderate potential to add sediment to the lake, as evidenced by the existing delta.

Sub-Basin E-7

Sub-basin E-7 drains approximately 27 acres of primarily forested land, with low density residential development. East Shore Drive is unpaved within this sub-watershed. Along one segment of East Shore Drive, a drainage channel has been cut into the eastern (upslope) side of the road that drains the hillside to the east. However, the ditch dead-ends at the road surface and stormwater runoff has nowhere to go but up, over, and across the road towards the lake. This condition has existed for a number of years, causing the road to wash out during particularly wet conditions and form a sheet of ice during wet, cold conditions in the winter.

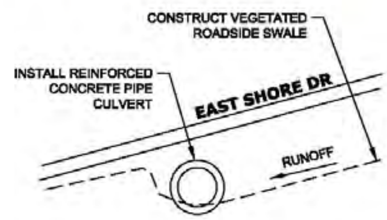
Until the spring of 2016, a large area on the downslope (lake) side of East Shore Drive had been covered with gravel and, while not ideal, afforded some energy dissipation for the sheeting flow across the unpaved roadway. However, when the road was regraded in 2016, as it is every spring, the gravel was destroyed, and erodible soil was left in its place.

A cross culvert and energy dissipator is recommended within this sub-basin to provide a less destructive and a more erosion resistant method of draining water from the east side of East Shore Drive to the west. On May 11, 2016, representatives of the LQIC met with representatives of the Town of East Haddam to discuss potential solutions to this ongoing source of sediment to the lake and a winter hazard when the road becomes covered in a sheet of ice. The Town concurred with the LQIC recommendations and stated their intention to pursue an easement with the landowner on the lake side of East Shore Drive to enable construction of the remedial measures by town forces. Below is a schematic drawing of the solution.



CULVERT INSTALLATION - PLAN VIEW
(NOT TO SCALE)

EXISTING WASHOUT PHOTO



TYPICAL CROSS SECTION
(NOT TO SCALE)

Numerous culvert crossings occur within sub-basin E-7. The most northerly crossing is a 12-inch CPP that was not carrying any flow on the day of inspection. A catch basin to the south accepts flow from a turquoise 4-inch or 6-inch pipe pitching down from the hill, but the outlet of the catch basin, which appears to discharge to the north, appears crushed and non-functioning where it would otherwise discharge at the 12-inch CPP culvert crossing. On the downstream side of the crossing, water flows overland through a forested area towards the lake. Riprap is evident on the downstream side of the crossing, suggesting that at times, flow and velocity may be significant here.

Further to the south, several additional culverts cross beneath East Shore Drive. These appear to be localized attempts at shedding water across the road from individual homes. They are largely clogged with sediment and debris and not functioning well.

The final crossing within sub-basin E7 occurs near East Shore Drive and has been observed actively flowing, following significant periods of rain. The flow in this area from the road to the lake occurs in a circuitous path, crossing beneath several low-lying plank footbridges, along a stacked rock wall and through a wooded area. Eventually, this stream joins several other localized flow paths and eventually discharges into the lake through a galvanized pipe that flows adjacent to several cottages.

The pipe discharges through a cracked concrete wall into the lake. The pipe is half submerged into the lake sediment and appears to be only marginally operational.

4.4 Stormwater Quality

Table 4-3 presents the primary contributors to stormwater pollutants, their impacts, and potential remedies. Nutrients and oil and grease are largely related to land uses and practices and are addressed in Section 7.0 of this Plan. Suspended solids are largely due to erosion within the watershed and solids that are carried in from the pavement, including most notably road sand.

TABLE 4-3
Primary Contributors to Stormwater Pollutants in the Lake Hayward Watershed

Contaminant	Potential Sources	Impacts	Potential Remedies
Suspended Solids	▪ Road Sanding ▪ Erosion	▪ Causes Turbidity ▪ Vehicle for Other Contaminants ▪ Reduces Depth ▪ Unsightly Deposition	▪ Deep Sump Catch Basins ▪ Catch Basin Cleaning ▪ Street Sweeping ▪ Stabilization of Erosion Sites
Nutrients (Phosphorus & Nitrogen)	▪ Fertilizers ▪ Farming Practices ▪ Failing or Underperforming Septic Systems ▪ Wildlife, Pets, Nuisance Species	▪ Promote Eutrophication	▪ Education/Practices ▪ Septic Repair/Replacement
Oil & Grease	▪ Vehicular Leakage on Roads, Driveways ▪ Poor use/practices	▪ Oil Sheen ▪ Volatile Organics	▪ Oil/Water Separators ▪ Hydrodynamic Separators

4.5 Best Management Practices

There are typically no quick fix or silver bullets to stormwater management. A multi-faceted approach is usually necessary. Improvements in stormwater quality can occur through land use controls, source controls, and/or treatment controls. Examples of each are provided in Table 4-4.

Land use controls are often regulated through local development policies that generally only apply to new construction or redevelopment, not to existing development. Land use controls may have application in the outer extents of the Lake Hayward watershed, where build-out has not occurred. These would be controlled through East Haddam, Colchester, and Salem local reviews through the respective Planning & Zoning and Inland Wetland Commissions.

Source controls focus on reducing or eliminating the cause of reduced stormwater quality. This will be important in the Lake Hayward watershed.

Treatment controls should be the last choice, as they come with the highest capital costs, require the greatest land area, and often have substantial maintenance requirements.

TABLE 4-4
Stormwater Management Controls

Land Use Controls	Source Controls	Treatment Controls
Stream Buffer Requirements	Public Education	Settling Practices
Floodplain Restrictions	Illicit Discharge Elimination	Infiltration Practices
Wetland Protection	Spill Prevention and Clean-up	Filtering Practices
Steep Slope Area Restrictions	Dumping Prevention	
Open Space	Materials Management	
Cluster Development	Street and Parking Area Cleaning	
Erosion and Sediment Controls	Storm Drainage System Maintenance	

4.6 Potential Mitigation Opportunities

There are a variety of measures used to collect, treat, and manage stormwater. Measures that should be considered include:

- underground oil and grit separator structures
- detention/retention basins
- bioswales
- rain gardens and rain barrels
- infiltration galleries

A multitude of factors must be considered before selecting the best stormwater management practice for a particular watershed. These factors include permitting issues, construction costs, long-term maintenance costs, and land availability. When improving the stormwater quality and point discharges, the primary treatment focuses on the removal of oil, suspended solids (grit), nitrogen, phosphorus, and (in recreational areas) bacteria. The following are options for stormwater treatment.

Oil and Grit Separator Structure

Oil and grit separator structures are installed underground and are typically connected to the storm drainage system toward the end of the drainage system (near the outlet). These structures are intended to allow suspended sediments to drop out of suspension and typically have a controlled outlet that prevents floatables such as oil from discharging through the separator. The separator structure device contains features (baffles, weirs, etc.) that slow incoming stormwater velocities to a point where suspended solids and sediment (grit) can settle out of suspension (i.e., sink to the bottom of the structure) and allow oil to rise into the catchment area. The oil and grit separator must be cleaned twice a year to be effective over the long term. Several manufacturers sell a multitude of prefabricated units. Some manufacturers have additional filtering devices that can be added to the oil and grit separator that can filter other parameters such as nitrogen and/or phosphorus, but these filters are expensive, and overall efficiency is suspect at this time.

Water Quality Detention/Retention Basin

Example of a Water Quality Detention Basin

Water quality detention/retention basins are a more natural approach to treating and managing stormwater because the stormwater is directed into a man-made vegetated depression where suspended solids and sediment can drop out of suspension, water temperatures are allowed to reach ambient levels, and excess nutrients such as nitrogen and phosphorus as well as bacteria can be absorbed by vegetation. The basins can be designed to be dry, moist, and/or a wet pond-type system. A forebay is constructed at the base of the contributing stormwater outfalls, and the basin bottoms are typically seeded and planted with a variety of shrubs and herbaceous material that is capable of filtering out pollutants. The basins do require routine maintenance including removal of accumulated sediment within the forebay and vegetation management (mowing) at least once a year.

Bioswales

Bioswales are very similar to water quality detention/retention basins but are typically smaller in scale and are not usually designed to treat more than the first flush of runoff. These swales are smaller and therefore can be implemented in areas that cannot accommodate larger basins. The function of the swale is similar to a basin in that stormwater is directed into a vegetated swale allowing sediment and excess nutrients to be filtered and absorbed. Bioswales should be mowed at least once a year to help control vegetation.

Examples of Bioswales

Rain Gardens and Rain Barrels

Rain gardens are a small water quality feature not more than 6 inches deep designed to treat the first flush of runoff from a driveway, building roofs, and/or other impervious surfaces. Stormwater is allowed to infiltrate into the underlying soil and/or be absorbed by the plants within the rain garden. The rain garden is usually planted with native herbaceous and/or shrubby vegetation. These gardens are typically maintained by private property owners. Rain barrels provide opportunity to collect stormwater from building roofs and reuse collected water for watering lawns and/or gardens. Rain gardens and rain barrels are relatively inexpensive methods for treating stormwater.

Examples of Rain Gardens

Infiltration Galleries

Infiltration galleries allow stormwater from impervious surfaces to be collected in underground galleries and allowed to infiltrate into the underlying soils naturally. This method of stormwater management allows the stormwater runoff temperatures, especially during the summer months, to cool and reach ambient level temperatures. In order for infiltration galleries to be effective the underlying soils must be conducive to promoting infiltration. Soils high in sand content are best whereas soils dominated by silts and clays are not as effective for infiltration.

Examples of Infiltration Galleries

4.7 Recommendations

The following actions are recommended for the Lake Hayward watershed:

1. Construct Additional Stormwater Treatment Measures in the Western Watershed to Mitigate Impervious Surfaces and Erosion – The density of development, coupled with the steep slopes on the western side of Lake Hayward, provide an opportunity for stormwater remediation. The most critical sub-watersheds relative to pollutant contributions are W-2, W-3, and W-6.

2. Install a Hydrodynamic Separator Demonstration Project – Installation of a properly sized hydrodynamic separator unit at the lower end of the stormwater collection system on the western side of Lake Hayward would provide valuable water quality remediation. This will require modeling of the catchment area, identification of suitable land area, and consultation with the Town of East Haddam relative to ongoing maintenance.

3. Disconnect Runoff Paths on West Shore Hillside – Much of the western watershed flows directly downhill, either overland or in piping, and discharges into the Lake. Disconnecting these flow paths will provide opportunities for stormwater to deposit sediment before reaching the lake, and for infiltration into the ground.

4. Work with Municipalities to Prioritize Street Sweeping and Catch Basin Clean-Out – The streets immediately surrounding Lake Hayward are located within the Town of East Haddam. Use of these roads year-round necessitates application of sand and salt to maintain safer driving conditions in the winter months. The existing catch basins, where they exist, are shallow and in some cases can become filled to capacity with sand and debris.

5. Petition for Minimizing Road Sand and Salt – A certain amount of road sanding and salting is necessary; however, in areas with sensitive natural resources, such as Lake Hayward, the program should be implemented to use the minimum necessary to ensure public safety.

6. Develop a Maintenance Program for Conveyance Piping – Develop and fund a maintenance program for stormwater piping throughout the watershed to eliminate chronic clogging.

7. Educate and Encourage a Low Impact and Sustainable Development Approach to Stormwater Management – There are few regulations at the local, state, or federal levels that apply to developed residential areas. Most stormwater management controls apply to new development and to urban centers, municipal facilities (i.e. DPW garages, landfills, transfer stations), large commercial operations (i.e. box store parking lots), and industrial facilities. Develop design alternatives to incorporate Low Impact and Sustainable Development retrofits to the system. Possible improvements include removal of curbing, disconnecting drainage areas, infiltration, and vegetated swale. Determine if work will be required outside of road right-of-way.

8. Install Deep Sump Catch Basins – Where shallow catch basins occur in the watershed; they should be replaced with deep sump basins that are periodically cleaned out. This will reduce the amount of sediment that eventually makes its way into the lake.

9. Install In-Stream Velocity Dissipation to Reduce Bank Erosion – Some of the tributaries that flow into Lake Hayward have steep slopes which are conducive to bed and bank erosion. Installation of velocity dissipation through rock vane or similar structures, can slow the velocity and protect against erosive forces.

5.0 INVASIVE AQUATIC VEGETATION CONTROL

5.1 Invasive Species in Lake Hayward

The aquatic invasive plants fanwort (*Cabomba caroliniana*) and variable watermilfoil (*Myriophyllum heterophyllum*) are present at Lake Hayward. The proliferation of aquatic invasive plants is a threat to recreation and the ecology. The presence and density of rooted aquatic bed plants relate to water quality, but additional factors also control their presence and species distribution including; sediment quality, water transparency and depth.

5.2 History of Treatment Program

Herbicide treatments of various scales have occurred annually since 2003. Additional aquatic plant inventories and public outreach events have been conducted by the CT Agricultural Experiment Station.

2000 – In 2000, Lake Hayward had a significant problem with the invasive aquatic plant fanwort to the extent that the area near the spillway was barely swimmable and could only be negotiated by kayak. A similar situation existed at the State boat launch at the north end of the lake. Hydro-raking, which had been occurring on the lake, was discontinued because the "puréeing" effect was feared to be exacerbating the proliferation of fanwort.

2001 – In May of 2001, an interim report from Northeast Aquatic Research indicated that the growth of fanwort was worse than anticipated. While the extensive growth of the plants was clearly visible at both the north and south ends of the lake, there was additional extensive growth along the lake bottom to the depth of 10 or 12 feet as well. In the fall of 2001, the Property Owners' Association of Lake Hayward (POALH) board entered into a $40,000 two-year contract with Northeast Aquatic Research (George Knocklein) to study methodologies to control the proliferation of aquatic plants at Lake Hayward. 75% of that contract was funded by the Connecticut Department of Environmental Protection (DEP).

2002 – Based upon ongoing feedback from Northeast Aquatic Research, it was apparent that Lake Hayward had a significant weed problem with the invasive fanwort, and it became important for POALH to develop an action plan to mitigate its growth. Inquiries were made to DEP as to assistance they might provide. DEP responded that while they were highly committed to assisting communities in preserving lake water quality, providing funding for weed control was not part of their mission. The POALH board identified and evaluated seven methodologies as part of its action plan, including:

- Do Nothing – Deemed unacceptable
- Drawdown of the Lake Over Winter – Deemed not feasible due to a lack of mechanical means
- Introduce Fish Species that Feed on Fanwort – No confidence that one problem could be solved without creating another
- Hydro-raking – Deemed Unacceptable based upon past experience
- Dredging – Found to be prohibitively expensive

- Herbicide Treatment with Slow Release Pellets – Not pursued, as a quicker response time was desired
- Herbicide Treatment (Liquid) – Identified as a preferred solution

In September 2002 Aquatic Control Technology (ACT) was selected as the preferred treatment vendor based on their track-record with DEP, their experience, and their recommendations for the treatment of Lake Hayward. As required in the DEP permitting process, ACT was required to conduct a survey in the spring and fall of each year to monitor and report on the control of all aquatic plants in Lake Hayward and provide recommendations for ongoing treatment as needed.

<u>2003</u> – Aquatic Control Technology treated the entire Lake with the systemic herbicide Sonar in the first attempt to control the growth of fanwort. The expense for the first treatment was $75,850. The fall 2003 inspection of the lake by ACT confirmed that the treatment was successful in controlling the growth of fanwort and had begun to bring the issue under control.

<u>2004-2007</u> – A program was initiated to escrow funds from Property Owners Association of Lake Hayward (POALH) taxes for future weed treatment activity. Water quality testing was continued; the aquatic weed problem appeared to be under control; and other mission critical infrastructure issues were being addressed. Annual spring and fall Inspections were conducted by ACT at a cost of $2,300 per year. In 2007 spot treatment took place, costing $2,500. The fall 2007 inspection of the lake by ACT confirmed that fanwort had rebounded to a point that a second whole lake treatment of the lake using Sonar was recommended.

<u>2008</u> – In 2008, the entire Lake was treated using both liquid and pelletized forms of Sonar in the ongoing efforts to control fanwort. The pelletized Sonar was distributed at the heavier concentrations of grow back areas located at both the north and south end of the lake. The expense in 2008 was $87,800. The fall 2008 inspection by ACT confirmed another successful application project.

<u>2009-2011</u> – Spring and fall inspections performed by ACT verified that the grow back of fanwort was significantly reduced. ACT indicated that the two whole-lake treatments were having a compounded impact on controlling fanwort. Annual expenses averaged $3,100 per year. In the summer of 2010, it was confirmed that the invasive species milfoil was now appearing on the west side of the lake north of First Beach along Lake Shore Drive. The density, however, was not at an actionable level. Following their inspection in the fall of 2011, ACT recommended a new approach to controlling invasive aquatic plants in Lake Hayward. Based on the success of the two whole-lake treatments using Sonar, ACT recommended that POALH consider modifying its approach away from whole-lake treatment to spot treatment in areas where concentrations of invasive species were present. The benefits of this approach were twofold: (1) cost savings could be gained by using less herbicides; and (2) this new approach was less impactful on the desirable aquatic plants throughout the lake.

<u>2012</u> – In 2012, the lake association implemented the spot treatment protocol using the contact herbicide Clipper to control fanwort. The primary treatment areas included the boat launch at the north end of the lake, the second beach lagoon, and the area at the south end of the lake by the spillway. Unfortunately, the application permit approval from the Department of Energy & Environmental Protection (DEEP, formerly DEP) for the 2012 treatment was delayed due to

habitat concerns raised by DEEP staff. The concern was that the weed treatment could upset the habitat of certain invertebrate species including the Tabanid fly, bog copper butterfly, and horse fly. DEEP required POALH complete a survey to verify that the habitat of these invertebrates would not be adversely impacted by the treatment plan. POALH successfully argued that the treatment plan would be completed long before the gestation and incubation of these invertebrate species. Thus, if a survey was to be undertaken prior to lake treatment there would be nothing to measure. There were no further delays in issuing the treatment permit.

2013-2015 – The spot treatment protocol continued during this period with the new goal of managing both fanwort and milfoil using the herbicide *Clipper* to control fanwort and the herbicide *Reward* to control milfoil. The primary treatment areas for fanwort included the boat launch at the north end of the lake, the second beach lagoon, and the area at the south end of the lake by the spillway. *Reward* was applied along the northern edge of Lake Shore Drive on the west side of the lake. The annual treatment and monitoring expense for this period was $15,450, $17,990, and $18,100 respectively.

2016-2018 – During this period, the treatment program targeted areas with fanwort and milfoil identified during the pre-treat survey conducted by Solitude in late May/early June each year. There was evidence that the systemic root killing aspect of *Clipper* was having an accumulative impact on fanwort. The control of fanwort shifted to maintenance mode and the focus of invasive weed control shifted to milfoil due to its aggressive nature.

In 2018, the occurrence of visible algae blooms became more problematic and Solitude recommended that POALH institute a water testing program to gather data to assist in the study of algae production in Lake Hayward. The treatment and testing investment was $19,150 in 2016; $18,400 in 2017; and $17,175 in 2018. The reduction in investment dollars reflected the reduction of square footage of treatment locations.

2019 – Due to a bureaucratic disconnect in 2019, a weed treatment permit was not secured in a timely fashion and thus weed treatment was not conducted that year. The lake association worked with its limnology partners at Northeast Aquatic Research to develop and execute a water testing program at the deepest location of Lake Hayward. The sampling protocol included taking in-situ water quality measurements from 0 to 11 meters in one-meter increments. The data included temperature, dissolved oxygen (mg/l), and percent dissolved oxygen. Specimens of lake water were collected at 3, 6, 9, and 11 meters respectively for subsequent analysis of total phosphorous, total nitrogen, total iron, and ammonia. Water samples were collected in the water column from lake surface to a depth of five feet to conduct algae analysis. Secchi disk readings were taken during every survey. The testing program was conducted on the 1st and 15th of each month from June to October. A summary report of the findings was published in the winter months. While no expense was incurred for weed treatment in 2019, $3,760 was spent for instrumentation acquisition and water sample analysis.

2020 – Treatment for managing the infestation of both fanwort and milfoil continued in 2020. The model of treating targeted area identified in the pre-treatment plant survey was continued as well. The deep-water sampling program also continued in 2020. Additionally, at the recommendation of Northeast Aquatic Research, the water sampling was expanded to take samples at a depth of 3 meters near the inlet of the lake. The testing protocol remained the same, simply modified for a shallower testing location. A summary report and analysis of the data captured at both locations is currently being analyzed for publication. The investment for the 2020 water quality program was $10,504 based on a discounted treatment plan offered by Solitude. The 2020 final year-end report from Solitude is expected in early 2021. Following further analysis of the water sampling data, further strategic decisions will be made as relative to active management of algae blooms. A comprehensive review of the pros and cons are of taking such action will occur.

Connections to other plan elements: Nuisance and invasive aquatic vegetation can cause problems for recreational uses. Aquatic invasive plants also have negative ecological impacts by reducing plant diversity.

5.3 Long-Term Goals

The long-term goal with regard to invasive species is to implement a balanced approach of monitoring and treatment in combination with community outreach and education.

5.4 Recommendations

The following actions are recommended for the Lake Hayward watershed:

1. Continue to Engage Professional Services as Necessary – ACT or other management service providers, CT Agricultural Experiment Station, Eightmile River Wild and Scenic Watershed (Eightmile) and Nature Conservancy will be consulted relative to watershed-level invasive management.

2. Ongoing Monitoring of Aquatic Vegetation – Maintain monitoring and treatment to minimize the area of the lake that has aquatic invasive plants. This should reduce the area requiring treatment and reduce costs and herbicide impacts.

3. Public Education – Post better signage to educate residents and the public about how invasive species can be introduced into the lake, along with prevention methods that should be taken. The lake association entered into a comprehensive education program to inform residents of best practices and identify their role in preservation of the lake with timely articles in newsletters and website postings. Refer to Table 8-2.

4. Monitoring – Seek funding to police the public boat launch.

5. Continue to Engage Stakeholders – It will be important to continue to coordinate with stakeholders towards controlling invasive species in Lake Hayward, including the following entities:

   - Lake Hayward Property Owners
   - Property Owners' Association of Lake Hayward
   - CT DEEP
   - East Haddam Lakes Association
   - East Haddam Land Use Department

- East Haddam Inland Wetlands Commission
- East Haddam Planning Department
- East Haddam Public Works Department
- Colchester Land Use Department
- Colchester Inland Wetlands Commission
- Colchester Planning Department
- Eight Mile River Consortium
- Long Island Sound Study Management

6.0 ECOLOGY

6.1 Introduction

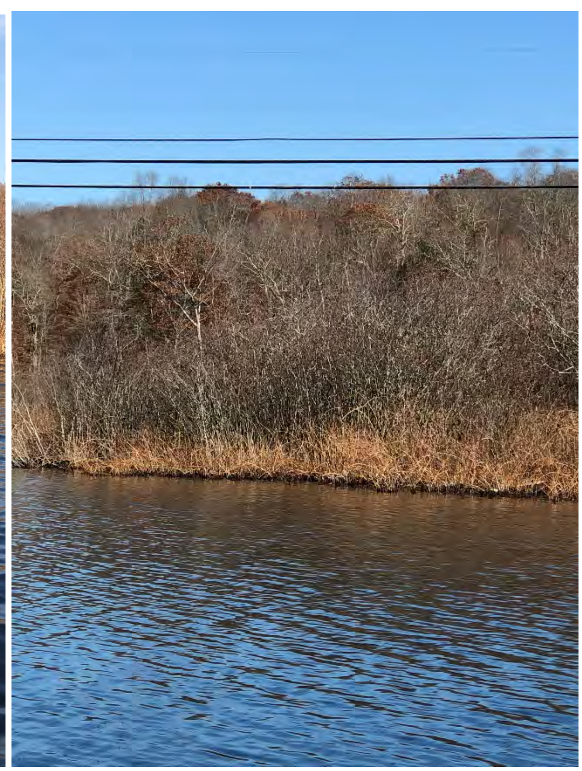
Lake Hayward is surrounded by medium density residential uses, with greater density on the western side of the lake. Much of the lake is immediately bordered by developed residential lots, with varying types of vegetation at the land/water interface ranging from maintained lawns to constructed rain gardens. The photos below capture a range of existing conditions on the east side of the lake.

Photos of the eastern shoreline of Lake Hayward

The western shoreline of Lake Hayward is characterized by more densely developed residential land uses, with Lake Shore Drive traversing between the lake and the homes in the northern half of the lake. The western shoreline tends to be less vegetated at the water/land interface. The photos below capture a range of existing conditions on the east side of the lake.


Photos of the western shoreline of Lake Hayward

The northern portion of the lake perimeter as well as a large wetland system on the eastern side of the lake support large wetland systems. The photos below show the eastern wetland. These photos were taken in the late fall.

Photos of the eastern inlet and wetland system of Lake Hayward

The most extensive wetland area occurs at the northern inlet to the lake, which is bisected by Lake Shore Drive, which connects the upstream and downstream ends with a single culvert.

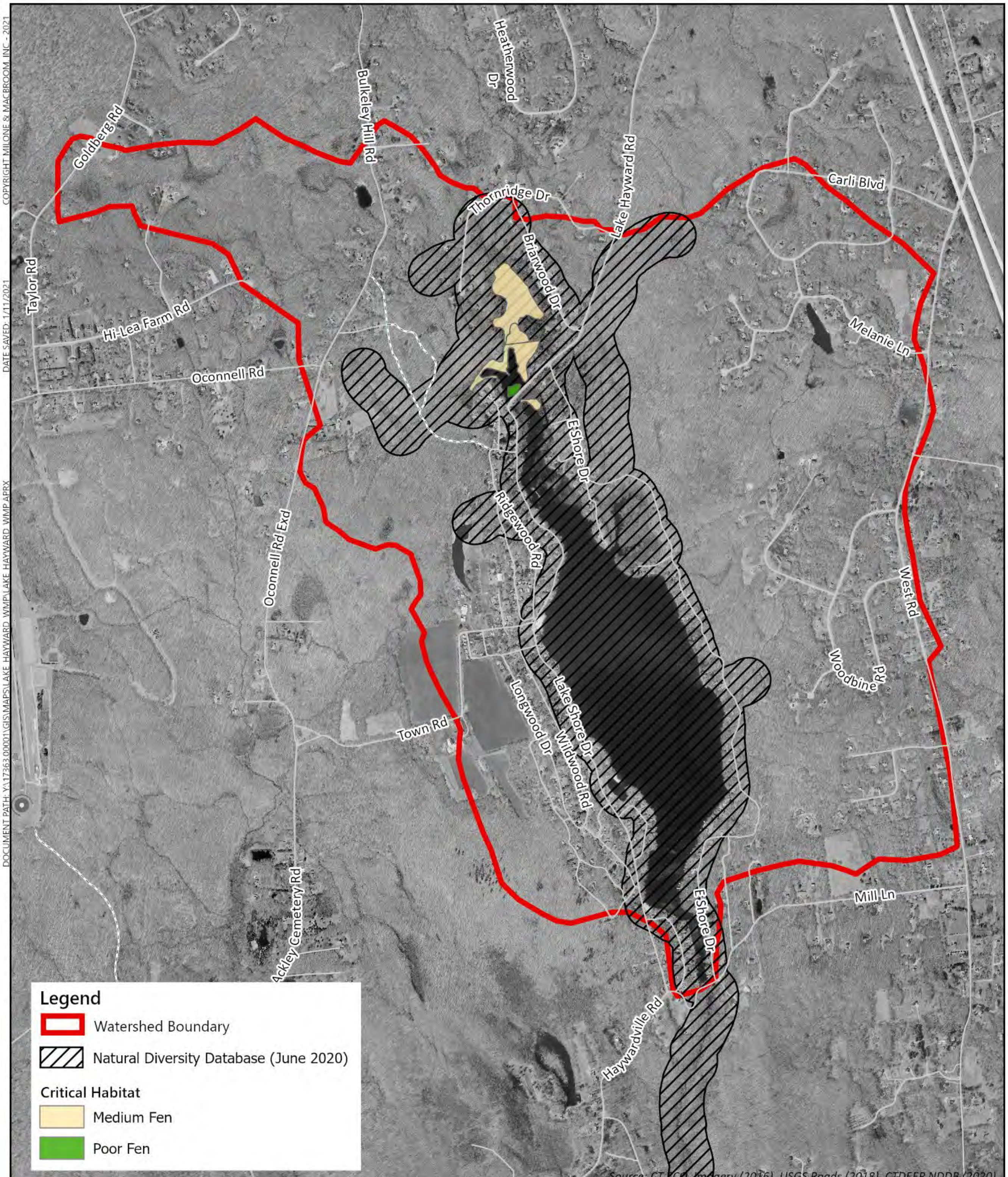
Photo of the northern inlet and fen wetland system of Lake Hayward

6.2 Sensitive Biological Species

In December 2020, the Connecticut Department of Energy & Environmental Protection (DEEP) was contacted relative to sensitive species in or near Lake Hayward Natural Diversity Data Base (NDDB). Natural Diversity Database information includes all information regarding critical biological resources available at the time of the request. This information is a compilation of data collected over the years by the Department of Energy and Environmental Protection's Natural History Survey, cooperating units of DEEP, landowners, private conservation groups and the scientific community.

Figure 6-1 shows previously identified areas of sensitivity as denoted by cross-hatching that covers the entire lake and a buffer of wetland surrounding it, including the large wetland area at the northern terminus of the lake.

In a letter dated December 28, 2020, DEEP responded that according to their records, there are known extant populations of State Listed Species that occur in the vicinity of Lake Hayward, including those listed on Table 6-1.



MILONE & MACBROOM 99 REALTY DRIVE CHESHIRE, CT 06410 203.271.1773 WWW.MMINC.COM	Natural Diversity Data Base Lake Hayward Watershed Management Plan Lake Quality Improvement Committee Lake Hayward East Haddam, CT	N 0 1,000 Feet	SCALE 1 in = 1,800 ft DATE 1/11/2021 PROJ. NO. 17363.00001 **FIG. 6-1**

TABLE 6-1
NDDB Listed Species at Lake Hayward

Scientific Name	Common Name	State Status
	Vertebrate Animals	
Notropis bifrenatus	Bridle shiner	State Specie of Special Concern
	Invertebrate Animals	
Lycaena epixanthe	Bog copper	State Specie of Special Concern
Merycomyia whitneyi	Tabanid fly	State Threatened Specie
Tabanus fulvicallus	Horse fly	State Threatened Specie
	Critical Habitat	
Poor fen	Subtype shrub thicket	---
Medium fen	Subtype sedge, shrub thicket	---

6.3 Aquatic Ecology

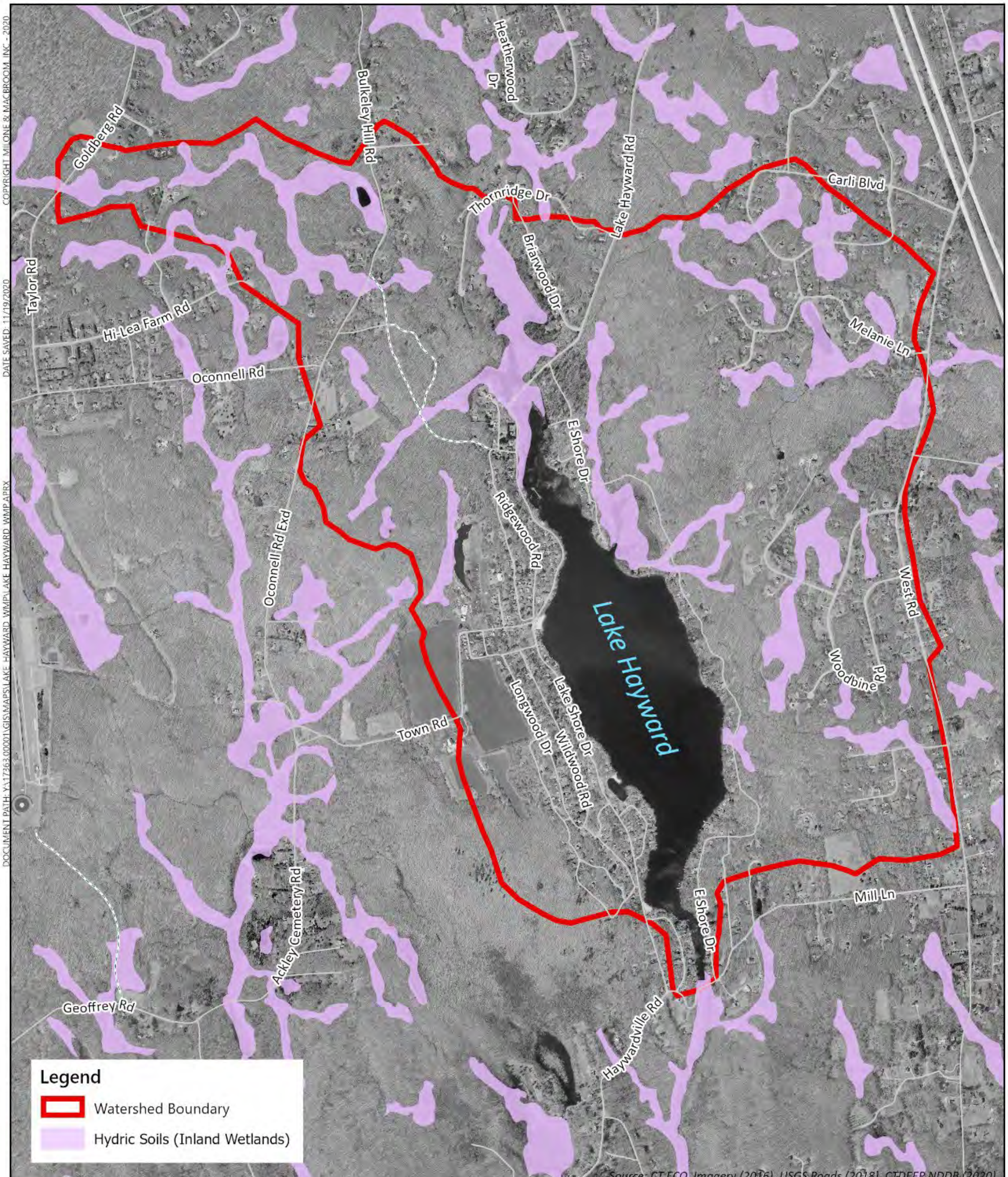
Healthy ecological conditions in the lake and watershed promote better water quality, which in turn provides habitat for macroinvertebrate and fish species. The macroinvertebrate assemblages within Lake Hayward are indicative of a lentic system. The species richness within the lake would likely vary based on the available habitats. The northern and eastern wetland portions of the lake are expected to have the most complex habitats for macroinvertebrates. Typical macroinvertebrates for this lake include chronomids, diptera, odonates, hemiptera and coleoptera.

Macroinvertebrate assemblages help support the higher trophic levels within the lake including the fish populations. The aquatic species presented in Table 6-2 have been observed in Lake Hayward.

TABLE 6-2
Observed Aquatic Species in Lake Hayward

Scientific Name	Common Name	Scientific Name	Common Name
Micropterus salmoides	Largemouth bass	*Lepomis macrochirus*	Bluegill
Micropterus dolomieu	Smallmouth bass	*Anguilla rostrata*	American eel
Esox niger	Chain pickerel	*Siluriformes*	Catfish
Pomoxis nigromaculatus	Black crappie	*Margaritifera margaritifera*	Fresh water mussels
Perca flavescens	Yellow perch	*Chelydra serpentina*	Snapping turtle

Various water dependent bird species have been observed in and around Lake Hayward, notably including the bald eagle, osprey, belted kingfisher, double crested cormorant, bufflehead, common merganser, hooded merganser, and spotted sandpiper. Additionally, various amphibians, including wood frog, bull frog, fowler's toad, American toad, and musk turtle have been observed in the lake as well as common crayfish and freshwater snails.



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Wetlands

Lake Hayward Watershed Management Plan
Lake Quality Improvement Committee
Lake Hayward
East Haddam, CT

SCALE	1 in = 1,800 ft
DATE	11/19/2020
PROJ. NO.	17363.00001

FIG. 6-2

In January of 2018, the DEEP Bureau of Natural Resources Inland Fisheries Division published its findings of a statewide lake and large river electrofishing survey. Table 6-3 lists the species collected in that effort. The bridle shiner has been identified within Lake Hayward and is listed as a special concern species within the state. Bridle shiner populations have been declining throughout much of their range. Due to their small size, they remain vulnerable to predation throughout their lives, and the introduction of non-native fish predators, such as largemouth bass, are likely contributing to their decline.

TABLE 6-3
DEEP Electrofishing Survey Results

Scientific Name	Common Name	Scientific Name	Common Name
Gamefish		*Sunfish*	
Micropterus salmoides	Largemouth bass	*Lepomis macrochirus*	Bluegill
Micropterus dolomieu	Smallmouth bass	*Lepomis gibbosus*	Pumpkinseed
Salmo trutta	Brown trout	*Non-Game Species*	
Esox niger	Chain pickerel	*Etheostoma olmstedi*	Tessellated darter
Larger Panfish		*Notopis bifrenatus*	Bridle shiner
Pomoxis nigromaculatus	Black crappie	*Notemigonus crysoleucas*	Golden shiner
Perca flavescens	Yellow perch	*Fundulus diaphanus*	Banded killifish
Ameiurus nebulosus	Brown bullhead	*Anguilla rostrata*	American eel

6.4 Wetland and Upland Ecology

The terrestrial communities within and around Lake Hayward consist of a combination of upland and aquatic environments. These environments have been shaped and created by a combination of natural and anthropogenic processes.

According to the CTDEEP Natural Diversity Database (NDDB) program's most recent listed species mapping (June 2020) Lake Hayward is located within a polygon area of concern (see Figure 6-1). A CTDEEP NDDB preliminary determination has been submitted and correspondence is forthcoming regarding the potential listed species found within the NDDB polygons.

As described in Section 2.4 of this Plan, the surficial geology around Lake Hayward consists of a combination of unsorted dense glacial till and well sorted glaciofluvial stratified drift deposits. The underlying bedrock geology consists of metamorphic schist and gneiss. The NRCS web soil survey mapping shows that there is a wide complex of soil series within the Lake Hayward watershed (see Figure 6-2). This plan will only highlight those soils located adjacent to the lake. The dominate upland and wetland soils series around the lake include:

Upland Soils

- Well drained Agawam fine sandy loam (29)
- Well drained Canton and Charlton fine sandy loam (61)
- Excessively drained Hinckley loamy sand (38)
- Somewhat excessively drained Merrimac loamy sand (34)

Wetland Soils

- Very poorly and poorly drained Ridgebury, Leicester, and Whitman fine sandy loam (3)
- Very poorly drained Catden and Freetown organic muck (18)

The upland ecology within the watershed consists of a combination of cover types that are correlated to existing land uses. The watershed is predominately deciduous mixed hardwood forest that consists of mixed oak, hickory, birch, and maple stands. Residential landscapes with a combination of lawn, ornamental landscaping, and wooded areas are intermixed within the watershed and surround the lake. Large open agricultural fields are found west of the Lake Hayward. All of these intermixed land uses help shape the habitat complexity and species diversity within this watershed.

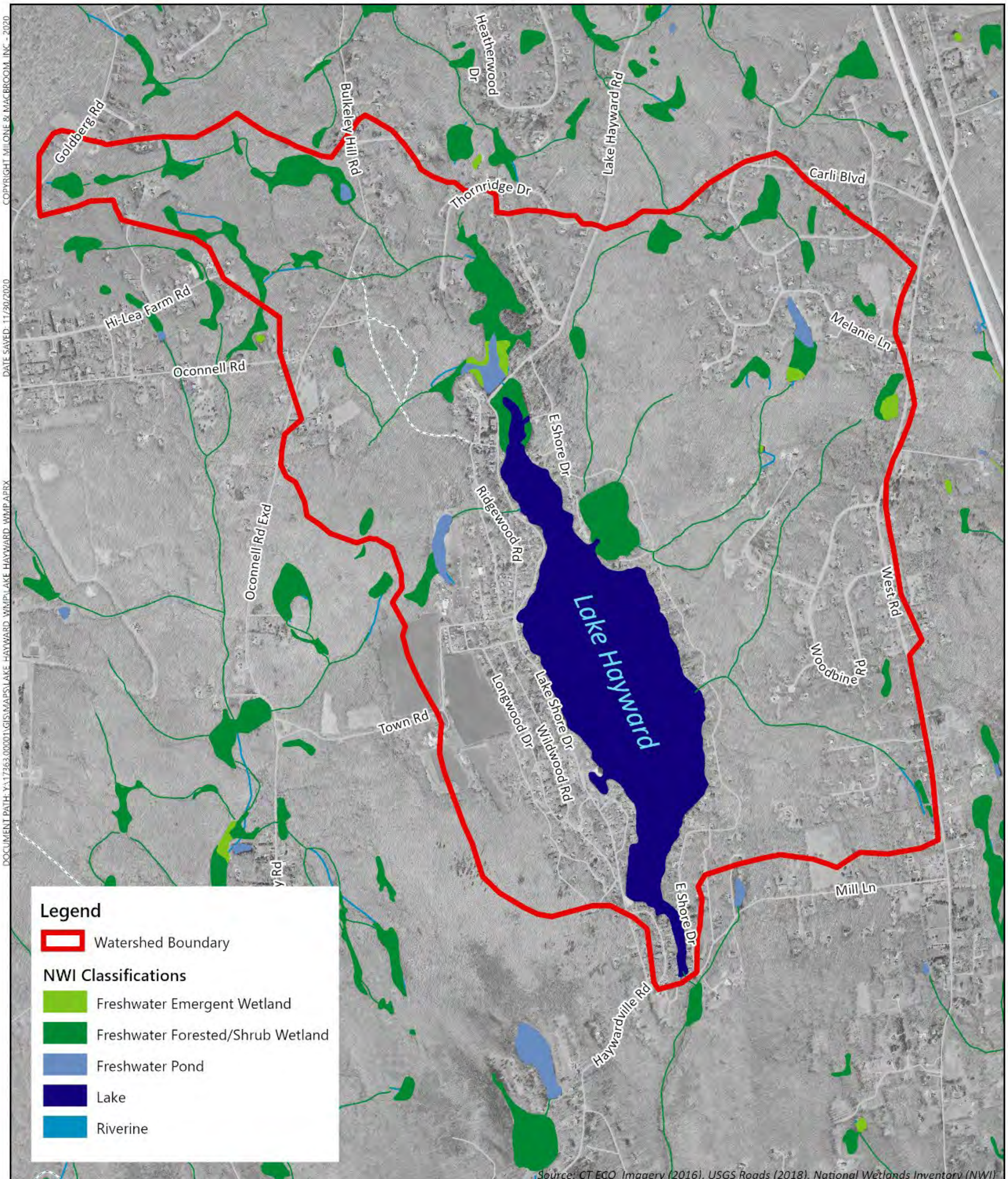
The wetland ecology within the watershed consists of a combination of cover types. The United States Fish and Wildlife Service National Wetland Inventory mapping identifies the following wetland cover types within the watershed: lake, freshwater lakes, freshwater forested/scrub shrub wetlands, and freshwater emergent wetlands (see Figure 6-3).

Using the Cowardin Wetland Classification system, the wetlands within the watershed belong to the palustrine system. This palustrine system includes unconsolidated bottom open water areas, deciduous broad-leaved forested wetlands, deciduous broad-leaved scrub shrub wetlands, and non-persistent emergent wetlands. When the lake was formed by anthropogenic activities, there were areas adjacent to the lake that were altered by the change in hydrology. Some existing wetlands may have become submerged and lost; some wetlands areas may have become wetter; and some previous upland areas may have been converted into wetlands. The wetland systems bordering the lake are primarily found along the northern and eastern shoreline of the lake with some smaller littoral wetlands located along the southern and western shores. Intensive wetland plant surveys have not been conducted in the northern portion of Lake Hayward. Rather, the plants listed in the following sections are based on limited site visits, photo interpretations, and lake resident observations.

Northern Wetland System

The northern wetland system consists of a scrub shrub/emergent marsh wetland system. This system has hummocks that provide growing conditions that support woody and herbaceous vegetation. The CTDEEP has mapped portions of this wetland as a critical habitat including medium and poor fen habitats. Fen wetlands are often classified as a mineotrophic peatlands. A fen wetland has a base pH that is neutral or alkaline, high base saturation, and low nutrient availability. The fen is typically dominated by sedges and grasses. Shrubs can be interspersed between the sedges and grasses. Water quality from both groundwater and surface runoff inputs are critical for protecting and maintaining these wetland systems.

The dominant vegetation within this wetland system consists of speckled alder (*Alnus rugosa*), highbush blueberry (*Vaccinium corymbosum*), silky dogwood (*Swida amomum*), common winterberry (*Ilex verticillata*), woolgrass (*Scirpus cyperinus),* swamp loosestrife (*Decodon verticillatus),* soft stem bulrush (*Schoenoplectus tabernaemontani),* tussock sedge (*Carex stricta*), soft rush *(Juncus effusus)*, yellow water lily (*Nuphar evina*), and a variety of other sedges. This wetland provides high quality wildlife habitat. Wood duck boxes are present. Based on observations from lake visitors, a wide variety of wildlife has been observed including common muskrat, great blue heron, mallard ducks, wood ducks, yellow warbler, common yellowthroat, northern catbird, swamp sparrow, snapping turtle, painted turtle, Northern watersnake, spring peeper, green frog, pickerel frog, and a wide variety of insects. In addition to providing wildlife habitat, this wetland provides important functions and values such as nutrient retention, toxicant retention, fish habitat, shoreline stabilization, aesthetic value, and potentially listed species habitat.



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National Wetland Inventory (NWI) Wetlands
Lake Hayward Watershed Management Plan
Lake Quality Improvement Committee
Lake Hayward
East Haddam, CT

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FIG. 6-3

The eastern wetland system consists of a scrub shrub/emergent wetland marsh wetland system. The dominant vegetation within this wetland system consists of speckled alder (*Alnus rugosa*), highbush blueberry (*Vaccinium corymbosum*), silky dogwood (*Swida amomum*), common winterberry (*Ilex verticillata*), woolgrass (*Scirpus cyperinus),* swamp loosestrife (*Decodon verticillatus),* soft stem bulrush (*Schoenoplectus tabernaemontani),* tussock sedge (*Carex stricta*), soft rush *(Juncus effusus)*, and yellow water lily (*Nuphar evina*). This wetland provides high quality wildlife habitat. Similar wildlife species as documented within the northern wetland would also inhabit this wetland system. The primary functions and values of this wetland include nutrient retention, toxicant retention, fish habitat, shoreline stabilization, aesthetic value, and potentially listed species habitat.

Other Shoreline Wetlands

Smaller shoreline wetlands are found sporadically along the southern and western shoreline. These wetlands are intermixed along the upland shorelines. Most of these segmented wetlands consist of palustrine scrub shrub and emergent wetlands. Vegetation is dominated by speckled alder, blue flag iris (*Iris versicolor*), broad leaved cattail (*Typha latifolia*), and woolgrass. These wetlands are limited in the functions and values that they provide due to their size and adjacent land cover. The primary functions of these shoreline wetlands are shoreline stabilization, nutrient transformation, and limited wildlife habitat.

6.5 Threats

The following threats have been identified in the Lake Hayward watershed:

- Additional development within the watershed
- Existing land uses and practices
- Stormwater runoff
- Future development potential
- Failing septic systems
- Nutrient loadings from farming operations

6.6 Opportunities

- Riparian buffer projects
- Education
- Monitoring

6.7 Recommendations

The following actions are recommended for the Lake Hayward watershed:

1. Maintenance of Upland Area Conditions – Monitor emerging issues in upland species including invasive species. Work with landowner partners to maintain healthy upland vegetation in the watershed.

2. Wetland Monitoring – Monitoring of the conditions in the wetlands north of the Lake could be considered as an indicator for how well that wetland retains nutrients and the water quality of the waters that enter the wetland.

7.0 FUTURE DEVELOPMENT

7.1 Jurisdictional Boundaries

The watershed of Lake Hayward includes portions of the Towns of East Haddam, Colchester and Salem. The export or loading of nutrients varies based on land use. Developed land increases nutrient loading and alters watershed hydrology. Minimizing these changes by improving conditions at developed sites can minimize impacts to water quality.

Approximately 49% of the contributing watershed to Lake Hayward are located within the Town of East Haddam. Approximately 45% lie within the Town of Colchester. Approximately 6% of the watershed lies within the Town of Salem, with only two residential roads (Brookside Drive and Meadow Lane) developed in Salem. Figure 7-1 depicts municipal boundaries.

7.2 Plans of Conservation and Development

In Connecticut, each municipality prepares a Plan of Conservation and Development that is updated once every ten years. The Plan sets the framework and policies for the character and quality of life in a town, including concentration and type of land uses, the character of the community, demographics, transportation network, quality of facilities and services, and protection of sensitive resources.

Town of East Haddam

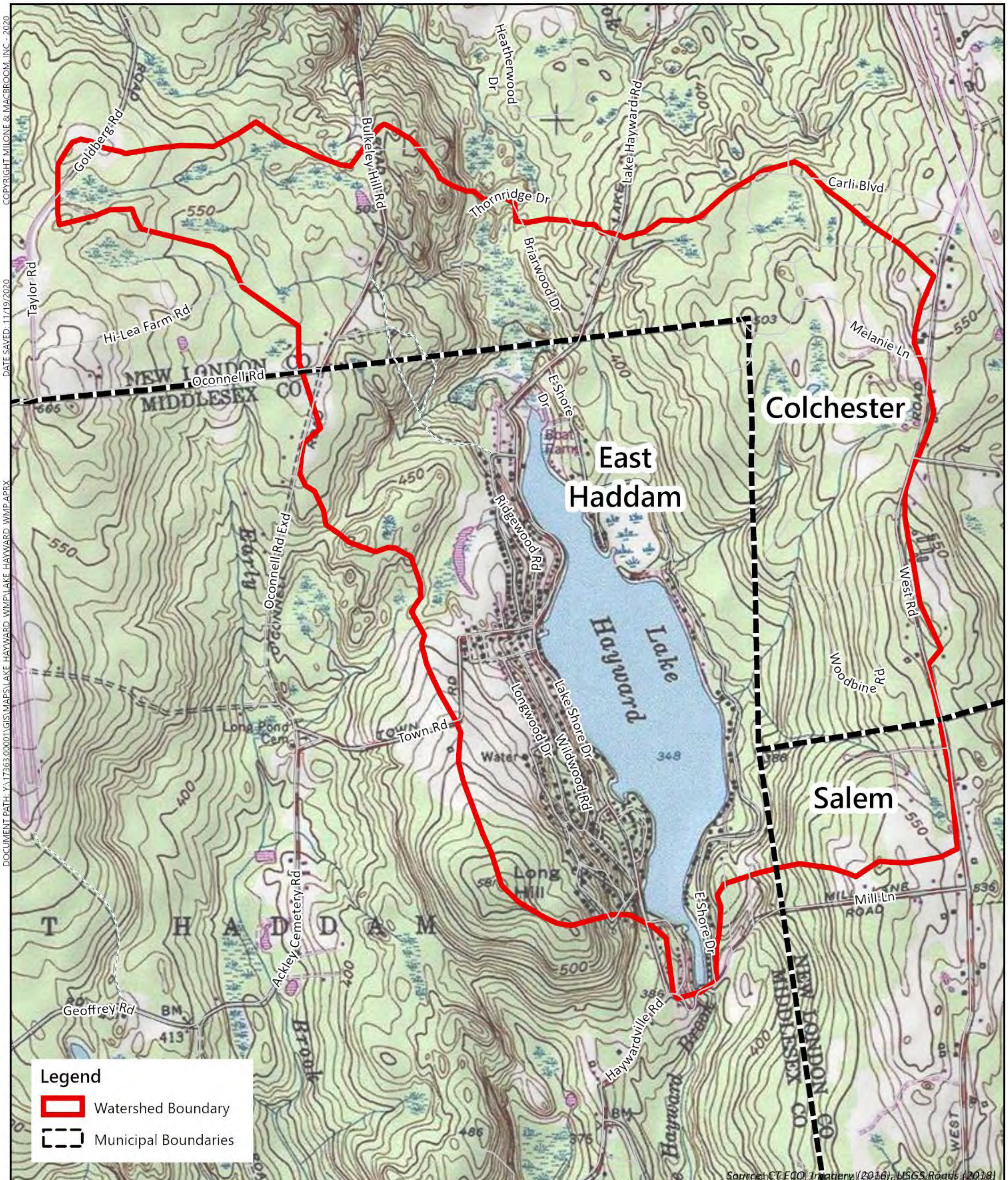
The Town of East Haddam most recently updated its Plan of Conservation and Development (POCD or Plan) in 2019. Chapter 4 of the plan is entitled “Protect East Haddam’s Landscape, Waters and Natural Environment” wherein East Haddam’s watersheds were ranked by importance according to the Town’s Open Space Acquisition Ordinance, with the Eightmile River receiving the highest rank. Lake Hayward’s importance as the headwaters of the Eightmile River cannot be overstated. Further, the Plan declares East Haddam’s support of the Eightmile River as one of the seven designated Wild & Scenic Watersheds in New England, through the tools and strategies provided in the Eightmile River Watershed Management Plan.

The Plan recognizes that East Haddam is home to many key habitats, including large upland forest, forested inland wetlands, shrub inland wetlands, large rivers and streams, and that their associated riparian zones and vernal pools are critical to wildlife diversity and success. These areas are noted in the plan as prime candidates for open space.

The East Haddam POCD identifies numerous recommended strategies that are relevant to the Lake Hayward watershed as follows:

- Preserve the natural, scenic and recreational qualities of East Haddam's waterbodies and waterways.

- Regularly clean storm drains and provide corrective action for siltation and damage to town roads and storm water infrastructure in order to be compliant with the municipal separate storm sewer systems (MS4).



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Municipal Boundaries within the Watershed

Lake Hayward Watershed Management Plan

Lake Quality Improvement Committee

Lake Hayward

East Haddam, CT

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DATE 11/19/2020

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FIG. 7-1

- Ensure that the State regularly cleans catch basins on state highways in order to be compliant with MS4

- Promote the use of non-chemical fertilizers and pesticides in order to prevent future runoff into East Haddam's surface and ground waters.

- Educate landowners on water quality issues and techniques for protecting water quality – removal of invasive species; maintenance or creation of vegetated buffer strips along lakes and streams; use of non-chemical fertilizers and pesticides; septic design and maintenance.

- Act in partnership with the Eightmile River Wild and Scenic Stewardship Committee in implementing the Eightmile River Watershed Management Plan to protect and enhance the watershed's Outstanding Resource Values (ORV).

- Educate public on the importance of riparian buffers and continue to enforce buffer requirements set forth in the zoning regulations and the Eight Mile River Watershed Overlay District.

- Maintain a high proportion of interconnected undeveloped open space, including expanses of woodlands, meadows and wetlands, to support habitats for native wildlife, bird and plant species

- Support groups working on conservation issues through educational programming, recreation and stewardship activities.

- Partner with East Haddam Public Schools and environmental non-profits to increase awareness and appreciation for open spaces, trails and waterways.

In short, the Town of East Haddam's POCD is extremely well aligned with the protection of Lake Hayward and implementation of sound watershed management practices. This plan and the action items required to implement it will leverage the policies and recommendations in the POCD to gain municipal and citizen support for the plan and to seek funding for ongoing efforts.

Town of Colchester

The Town of Colchester adopted its POCD in June of 2015. Similar to East Haddam's POCD, Colchester recognizes the need to protect water quality in the Eight Mile River; to preserve more open space; and to protect its natural resources. There appear to be no designated open spaces within the Lake Hayward watershed within the Town of Colchester; however, numerous properties off West Road do contain conservation easements. The future growth plan within the Lake Hayward watershed remains rural.

Given that the actual waterbody of Lake Hayward is located outside of Colchester, its watershed within the Town is not a focal point of the Colchester POCD. This underscores the importance of establishing a relationship with and a presence in Colchester relative to future development plans and future potential open space land acquisition.

7.3 Land Use & Zoning in the Watershed

Figure 7-2 depicts zoning designations within the Lake Hayward watershed. Zoning within each municipality is described below.

Town of East Haddam

Within the Town of East Haddam, the following developed roads lie within the Lake Hayward watershed:

- East Shore: East Shore Drive and Fedus Road

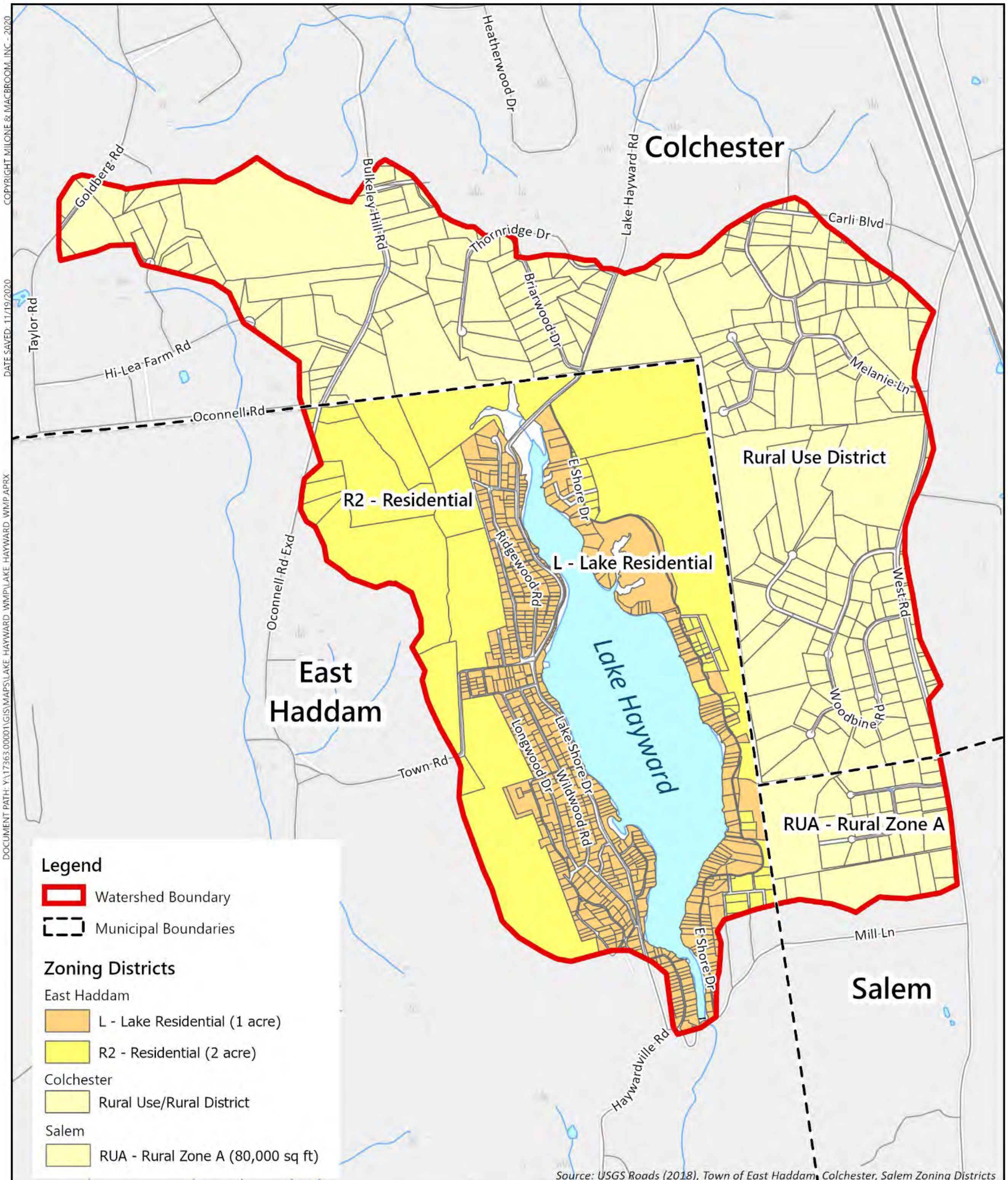
- West Shore: Lake Shore Drive, Ridgewood Road Extension, Hillside Road, Ridgewood Road, Lookout Drive, A portion of Town Road, Sunset Road, East Lane, Hay Field Road, Longwood Drive, Wildwood Road, Briarcliffe Road, Laurel Lane, Forest Way, Cragmere Road, and Glimmer Glen.

Glimmer Glen is a private road owned by the Property Owners Association of Lake Hayward (POALH).

The majority of watershed land within the Town of East Haddam is zoned R-2, meaning residential use with two-acre zoning. Allowable uses in the R-2 zone include single family dwellings and two-family dwellings, with a minimum lot size of four acres.

The parcels immediately surrounding Lake Hayward are in the L (Lake) District. Uses permitted in the L District include the following:

- Single Family Dwelling
- Seasonal Cottage
- Two Family Dwelling
- Home Occupation
- Letting of Rooms
- Educational, Religious, or Philanthropic Uses
- A Bonafide Club, Lodge, or Community House
- Parks and Playgrounds
- Agriculture, Farming, Forestry, Truck or Nursery Gardening
- Farm and Garden Product
- Home for the Aged, Nursing Home, Rest Home
- Public Facilities and Services
- Historic Park
- Tag Sales
- Seasonal Commercial Uses
- Accessory Uses
- Bed and Breakfast



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Zoning within the Watershed

Lake Hayward Watershed Management Plan
Lake Quality Improvement Committee
Lake Hayward
East Haddam, CT

SCALE 1 in = 1,800 ft
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PROJ. NO. 17363.00001

FIG. 7-2

Section 10.1.3.2 of the East Haddam Zoning Regulations establishes the Eightmile River Watershed Overlay District. The purpose and intent of this district is to protect the natural resources and control development's deleterious effects on its watersheds. The regulations state the following:

> "*The riparian and wetland features of the Eightmile River Watershed are a key component of the largely intact watersheds and natural character of East Haddam. In order to preserve a fully-functioning aquatic system in the Eightmile River Watershed, and to prevent damage to the critical buffer zone around its water bodies, the Eightmile River Watershed Overlay District is hereby established. Please note that this does not replace any obligation of the applicant to have a determination made by the East Haddam Inland Wetlands and Watercourses Commission or any other regulatory agency as whether additional reviews and permits are necessary.*"

The regulations designate a buffer area, citing protection of water quality, regulation of flow, preservation of wildlife habitat, and maintenance of important cultural and historical features of East Haddam. This buffer serves the following specific functions:
Regulation of water flow:

a. Promotes water infiltration and groundwater recharge.
b. Reduces flooding.
c. Reduces streambed scour.

19 - 51 Preservation of wildlife habitat:

a. Provides a unique habitat that supports a diverse species assemblage.
b. Shades, filters, and moderates stream flow, improving habitat for fish and other aquatic organisms.
c. Provides an effective travel corridor for terrestrial wildlife.

Protection of water quality:

a. Reduces sedimentation.
b. Filters out pesticides, heavy metals, and biocontaminants.
c. Removes excess nutrients that lead to eutrophication, including nitrogen and phosphorus.
d. Prevents erosion through bank stabilization by vegetation.

Preservation of views:

a. Provides a screen that protects privacy of riverfront landowners
b. Enhances landscape diversity resulting in improved aesthetics

The purpose of the Eightmile River Watershed Overlay District is to maintain a continuous buffer of native forest and shrubs around all watercourses and wetlands. The regulations note that the most effective riparian buffers should include a mix of trees, shrubs and herbaceous plants native to the region and appropriate to the environment in which they are to be planted.

The buffer from all major watercourses within the Eightmile River Watershed (but not the Lake Zone) is one hundred feet measured horizontally from all boundaries of the watercourse. The major watercourses are defined by the official Eightmile River Watershed Overlay District Map and includes the Eightmile River, the East Branch of the Eightmile River, Cranberry Meadow Brook, Hedge Brook, Burnham Brook, Early Brook, Muddy Brook, Strongs Brook, Malt House

Brook, and Lake Hayward Brook and three unnamed brooks. For all other streams and intermittent streams within R-2 and R-4 districts, the buffer from these watercourses are fifty feet measured horizontally from all boundaries of the watercourse.

Town of Colchester

Within the Town of Colchester, the following developed roads lie within the Lake Hayward watershed: A portion of West Road, Woodbine Road, Sweetbriar Court, Cirillo Drive, Melanie Lane, Hunters Court, Fran Lane, a short portion of Lake Hayward Road, a portion of Thornbridge Drive, Briarwood Drive, A portion of Bulkeley Hill Road, Lee Court, and a very small portion of Taylor Road. All of these roadways support single family residential land uses and are located within the Rural District Zone or Rural Use (RU) Zoning District.

According to Colchester's Zoning Regulations, the primary character determinants in the RU zone are the preservation and enhancement of existing natural resources, vistas, and open space in general. The intent of the district is to preserve rural character. Land uses in the rural use district areas are not served and have no plans to be served by municipal water and sewer. Agriculture operations are a large presence in the RU District. Except for the residentially developed roadways, the land area within the contributing watershed to Lake Hayward within the Town of Colchester is wooded and undeveloped.

The following uses are permitted in the RU District:

- Single-family and two-family dwellings and accessory uses to such dwellings
- Agricultural uses
- Home occupation
- Membership clubs that relate to outdoor activities
- Family day care homes

The following uses are allowed by special permit within the RU zone:

- Commercial kennel
- Accessory apartments
- Bed and breakfast
- Golf course
- Institutional and municipal land uses, including public utilities
- Day care/nursery schools
- Educational institutions
- Agricultural uses

Development as a conservation district is required where new roads or road extensions are proposed for any subdivision with more than four lots, with approximately two acre lots. For conventional subdivisions within the RU zone, a minimum lot size is approximately three acres. Proposed residential subdivision development in the RU District requires a minimum of 15% open space for conventional subdivisions and 25% for conservation subdivisions.

While there is a significant amount of potentially developable land area in the Town of Colchester within the Lake Hayward watershed, existing land use consists of low density single family land uses, with low density zoning for any future potential development.

The primary development issue to be addressed in RU is the cohesion of the natural and built environment, noting the primary goal of preserving the natural Landscape. A primary objective in this zone is to limit and direct on-site development intrusions that would affect various natural resources. Another focus is the preservation of agricultural lands and uses.

The following protections are designated in the RU zone in Colchester:

1. The existing landscape must be preserved in its natural state, insofar as practicable, by minimizing tree and soil removal. Any grade changes must be in keeping with the general appearance of the neighboring developed areas. The orientation of individual building sites must maintain maximum natural topography and cover. Existing site conditions are to be considered in road design. Designs that significantly alter the topography, tree cover, surface water buffers, and natural drainage are not be acceptable under the Zoning Regulations.

2. Streets within the RU zone must be designed and located in such a manner as to maintain and preserve natural topography, significant landmarks, and trees; to minimize cuts and fills; and to preserve and enhance views and vistas on or off the parcel being developed.

3. Development must be related harmoniously to the terrain and the use, scale, and architecture of existing buildings in the vicinity that have a functional or visual relationship to any proposed building.

4. All open space on lots (landscaped and usable) must be designed to add to the visual amenities of the area by maximizing its visibility for persons passing the site or overlooking it from nearby properties.

5. The removal or disruption of historic or traditional uses, stone walls, structures, or architectural elements musts be minimized in the RU zone insofar as practicable, whether these exist on the site or on adjacent properties.

7.4 Existing Inland Wetlands Regulation Protections

East Haddam

The East Haddam Inland Wetlands and Watercourses Commission is the main local regulatory authority charged with protection of these areas. The Conservation Commission and the Planning and Zoning Commission have advisory roles that can assist in the protection of wetlands, watercourses, and waterbodies. The Standards of the Lower Connecticut River Gateway Commission have been adopted as part of the East Haddam Zoning Regulations.

All “regulated activities” in the Town of East Haddam require a permit through the Inland Wetlands Commission. “Regulated activity” means any operation within or use of a wetland or watercourse involving removal or deposition of material, or any obstruction, construction, alteration or pollution, of such wetlands or watercourses. The Commission may rule that any activity that alters the existing rate, or quality, of any stormwater discharge or sheet flow conveyed to a regulated area or alters the hydrology or flow dynamics of a regulated area and is likely to impact or affect wetlands or watercourses is a regulated activity.

There are no extra protections afforded to the Eightmile River watershed, nor to Lake Hayward. Rather, these regulations are intended to regulate development that has the potential to directly impact a wetland or watercourse. The regulations would apply to any development within the Lake Hayward watershed that also impacts a mapped wetland.

Town of Colchester

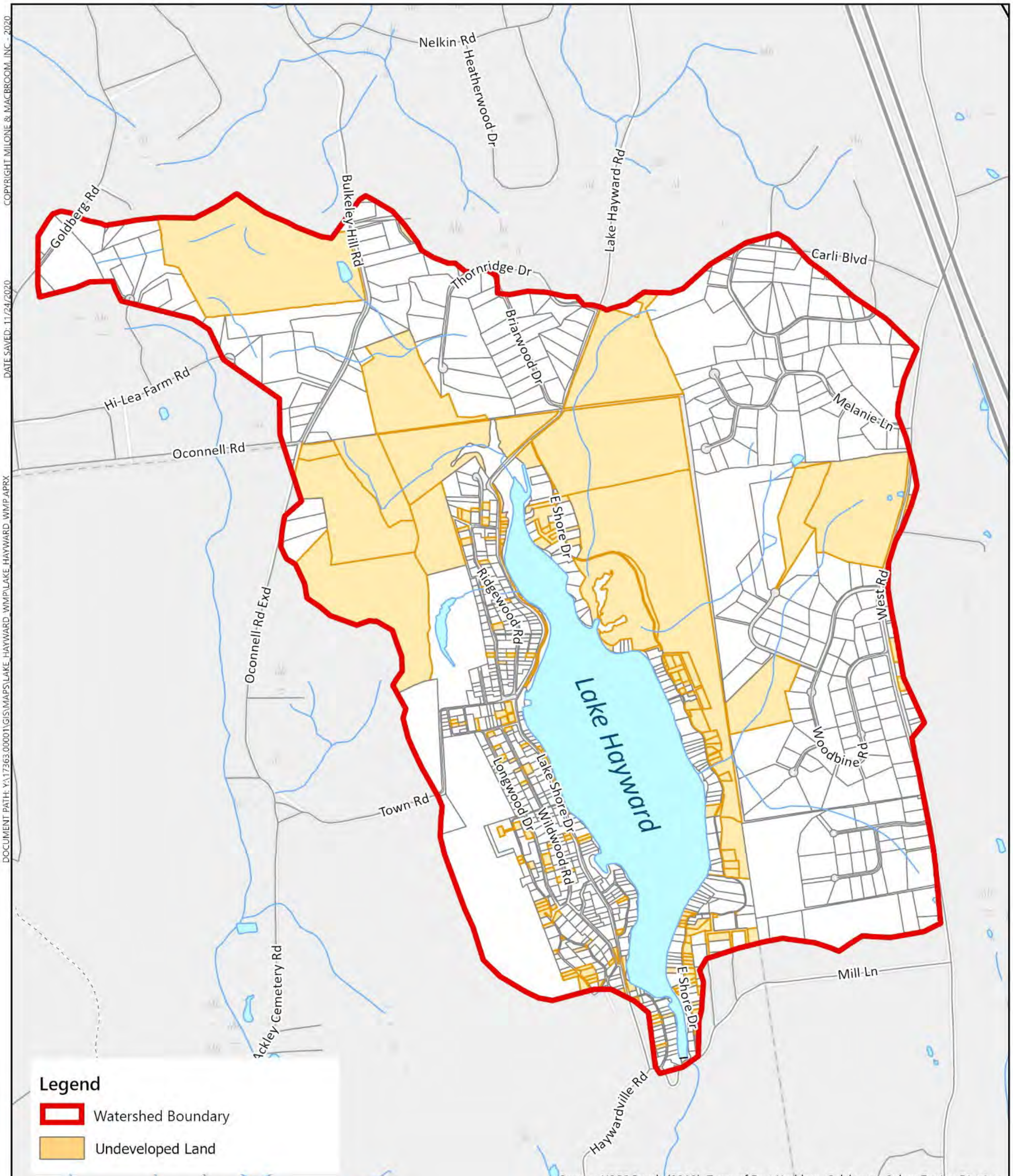
The Town of Colchester regulates inland wetlands and watercourses through its regulations (last updated on January 14, 2009; effective February 11, 2009). Regulated activities require a permit through Colchester's Inland Wetland Commission. Similar to the East Haddam definition "Regulated Activity" in Colchester means any operation within or use of a wetland or watercourse involving removal or deposition of material, or any obstruction, construction, alteration or pollution, of such wetlands or watercourses, but shall not include the specified activities in Section 4 of these regulations. Furthermore, any clearing, grubbing, grading, earth moving, excavating, filling, construction, removal or deposition of material, discharge of storm water, location of any subsurface waste disposal system or clear-cutting of trees within 75 feet of wetlands and one hundred feet of the ordinary high water line of any watercourses is a regulated activity.

7.5 Future Development Potential

Figure 7-3 depicts developed and undeveloped land within the Lake Hayward watershed (shown in light orange). Using a geographic information system (GIS) analysis, a build-out analysis was conducted to estimate the number of possible residential building lots could be developed within these undeveloped parcels as follows:

- Undeveloped/vacant land was isolated, excepting open space and/or protected lands.
- Environmental constraints, including wetlands (hydric soils), waterbodies, steep slopes exceeding 25 degrees, and 100-year flood zones were removed from the potentially developable land.
- The number of potentially buildable units was calculated for each parcel based on vacant land minus environmental constraint areas and divided by the minimum lot size based on underlying zoning regulations.
- The number of building lots was then multiplied by 70%. The 70% factor roughly accounts for right-of-way areas that would need to be included in a typical subdivision or neighborhood to account for roadways, stormwater management features, and the like.
- Finally, the computed lots were rounded down to the nearest whole number to get the total potential buildable units for each parcel of vacant land.

The above analysis yielded 37 potential developable units in Colchester and 71 potential developable units in East Haddam, for a total of 108. These numbers do not account for specific lot layouts or siting of suitable drinking water wells or septic systems. The analysis is presented graphically in Figure 7-4.



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Undeveloped Land within the Watershed

Lake Hayward Watershed Management Plan
Lake Quality Improvement Committee
Lake Hayward
East Haddam, CT

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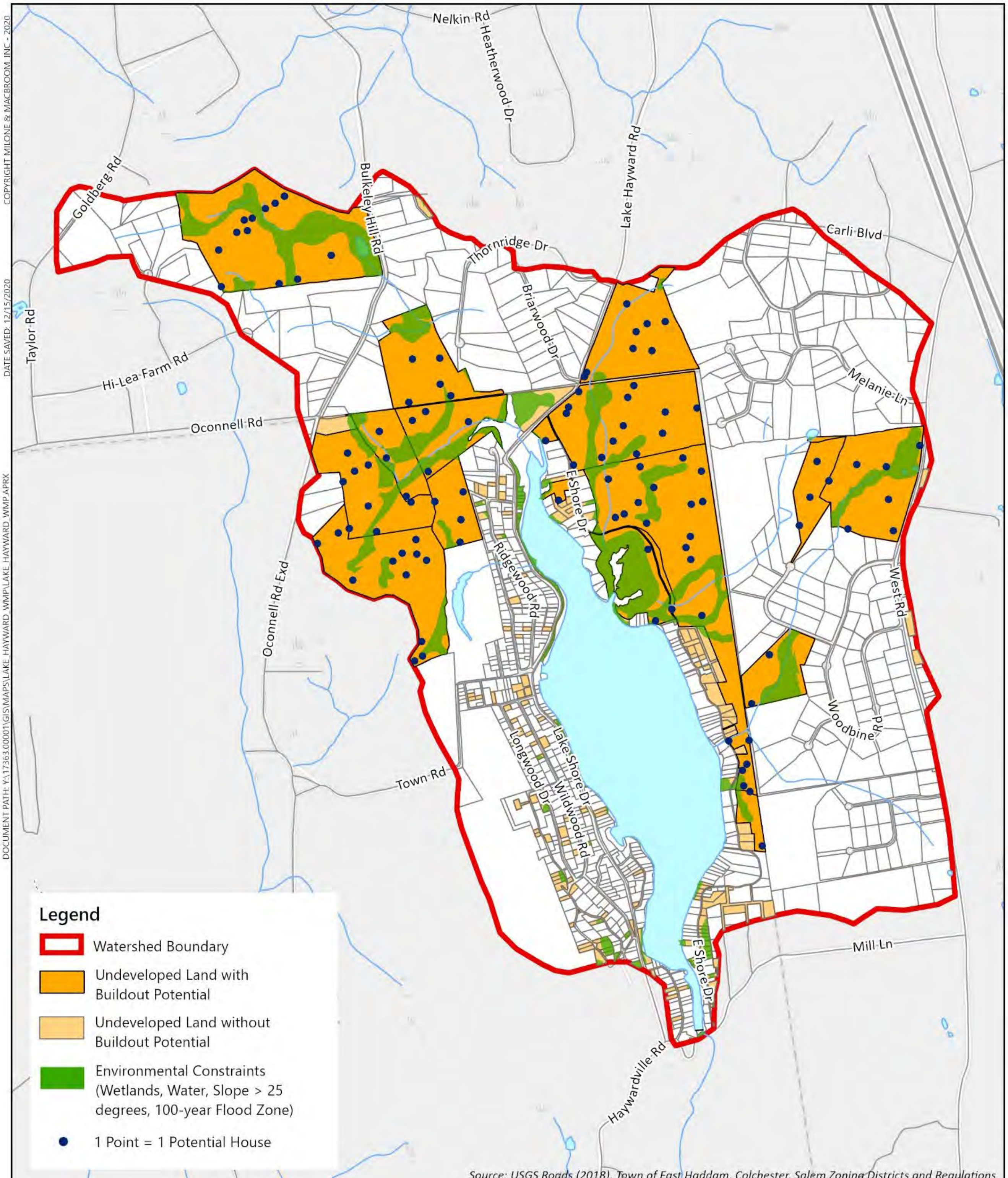
FIG. 7-3



MILONE & MACBROOM 99 REALTY DRIVE CHESHIRE, CT 06410 203.271.1773 WWW.MMINC.COM	Buildout Analysis Lake Hayward Watershed Management Plan Lake Quality Improvement Committee Lake Hayward East Haddam, CT	N 0 1,000 Feet	SCALE 1 in = 1,800 ft DATE 12/30/2020 PROJ. NO. 17363.00001 **FIG. 7-4**

Of concern is both the magnitude and the proximity of potentially developable land in relation to Lake Hayward and the potential for water quality degradation related to developed property and increased impervious surfaces as compared to undeveloped naturally vegetated land.

7.6 Recommendations

The following actions are recommended for the Lake Hayward watershed:

1. Preserve Open Space within the Watershed – One of the best protections that can be afforded in a watershed is to prevent the negative effects of development. Preserving open space land in perpetuity is therefore desired within the Lake Hayward watershed. Implementation of this Watershed Management Plan seeks to engage staff and commission members within the towns of East Haddam and Colchester such that they understand the importance of Lake Hayward as its own resource and in the context of the Eight Mile River watershed. The Open Space Committee in East Haddam has created a protocol for property purchases and has developed a format that prioritizes the various watersheds and specific areas throughout the town, including the Eightmile River watershed. This should put the land area within the Lake Hayward sub-watershed at a higher priority for acquisition of open space land. Colchester has also identified the Eightmile River as a regionally important waterbody and has prioritized the acquisition of open space within its municipal borders.

2. Ensure Protections are Incorporated into any New Development – Large expanses of land within the Lake Hayward watershed are currently undeveloped, with significant forest and interconnected wetlands making up the landscape. The most densely developed portion of the watershed is the residential community immediately surrounding the lake. The remainder of the watershed can be characterized as rural residential and farmland. While it is not possible to turn back the hands of time on development, limiting the potential impacts of future development is crucial. The right to develop land in Connecticut is regulated through the local land use regulations. Within these regulations, the stewards of Lake Hayward must work with local regulators to make sure that new projects meet exceptional standards for stormwater management. New construction includes renovation and expansion of existing single family homes that expand existing impervious surfaces. All new development within the watershed should incorporate state-of-the-art best management practices for stormwater management, including implementation of low impact and sustainable development practices whenever possible.

   The CT DEEP has prepared several documents related to reducing construction impact to nearby wetlands, watercourses, and water bodies. The 2002 *Guidelines for Soil Erosion and Sediment Control* can be used as either a primary guiding document or to set the minimum requirements for best management practices during construction activities. The primary focus of the guidelines is to prevent and control water-based erosion and associated sedimentation. The 2004 *Connecticut Stormwater Quality Manual* provides guidance on the measures necessary to protect these resources during new development, redevelopment, and upgrades to existing development. These measures include site planning, source control and pollution prevention, and stormwater treatment practices. The 2011 supplement to the 2004 manual provides information on the implementation of low-impact development technologies. These documents should be consulted and applied when new development is proposed.

3. Educate Landowners in Currently Developed Areas – Work with agricultural and forest landowners/producers (in conjunction with USDA-NRCS) to promote best practices. As with residential outreach, this requires willing landowner cooperation.

4. Work with Towns to Adopt an Overlay Zone – Overlay zones are adopted locally through the municipal planning and zoning regulations to protect an underlying sensitive resource. Many communities throughout Connecticut have adopted overlay zones to protect drinking water supply watersheds and groundwater aquifers, to maintain historic districts, to implement municipal development plans, and so on. The Eightmile River Overlay Zones in East Haddam is one example of this. Similar designation in Colchester and East Haddam within the Lake Hayward watershed and potential additions to the overlay district in East Haddam could be constructed such that any new development could be held to a higher standard in terms of maximum impervious cover, low impact and sustainable development, and stormwater management. Gaining support for such an initiative will require collaboration with municipal leadership and the respective planning and zoning commissions.

8.0 EDUCATION & OUTREACH (EPA Element E)

8.1 Overview

Before any meaningful improvements on the lake or within the watershed can take place, it will be important to garner the support and understanding of watershed residents as well as municipal officials and staff within East Haddam, Colchester, and to a lesser extend the town of Salem, which represents only a small, low intensity developed portion of the contributing Lake Hayward watershed. Lake quality protection and watershed management will ideally become a lake culture, with information passed on to future generations as a matter of course.

8.2 Summary of Efforts to Date

POALH and LQIC are active in outreach and education to lake area residents. Among the programs conducted to date include the following:

CT Agricultural Experiment Station Aquatic Invasive Workshop – Lake Hayward June 2014

- Septic system maintenance awareness and an annual clean-out raffle contest
- Annual lecture series on various topics, like the one shown in the photograph to the right
- Shoreline landscaping demonstration project at "Second Beach" on the western shore of the lake.
- POALH monthly publications that routinely include articles about watershed management and lake water quality, sent to nearly 400 west side residents
- Quarterly newsletters through *The East Side Gazette* focused on watershed management and lake water quality, sent to nearly 100 east side residents
- Website articles routinely appear on the POALH web page advising residents on topics of watershed management
- In the Fall of 2015, LQIC collaborated with Wesleyan University to host a semester-long project to evaluate Lake Hayward.
- Signs are periodically posted advising residents about lake quality treatment and best management practices, such as proper disposal of fall leaf clean-up
- One-on-one engagement with watershed residents and visitors

- Purchase of 500 copies of an educational pamphlet from the Connecticut River Coastal Conservation District entitled "*A Guide to the Stewardship and Protection of Backyard Wetlands, Ponds, Streams, Lakes, Rivers and Estuaries*" to be distributed to lake residents in the Spring of 2021.

8.3 Education and Outreach Audience

The vast majority of land use within the Lake Hayward watershed is residential, particularly in the immediate vicinity of the lake. Residential land use is important as a source of nutrients and bacteria to the lake. Additionally, residents are the primary recreational users. Residential and infrastructure (roadway and stormwater) are topic areas related by users. Stormwater and on-site wastewater are both sensitive to soil and groundwater conditions in the watershed.

8.4 Stakeholder Partners

The primary stakeholder partners for watershed management include the following:

- Residents within the watershed
- Farm owners within the watershed
- Visitors who use the State Boat Launch off East Shore Drive
- Local governmental representatives, including land use staff and commission members of planning, zoning, inland wetlands, and conservation boards
- State regulatory agencies such as the Connecticut Department of Energy & Environmental Protection (DEEP)
- Area land trusts
- The Eightmile River Watershed Association
- The Nature Conservancy
- The Connecticut Federation of Lakes
- Academic institutions, such as UConn, Yale, Connecticut College, and Wesleyan, all of which have active lake and ecology research programs

Table 8-1 presents numerous public education and outreach partnership opportunities.

TABLE 8-1
Public Education and Outreach Partnership Opportunities

Outreach Topic	Potential Outreach Partner
Agricultural Best Management Practices	UConn Cooperative Extension System, NRCS, CT Department of Agriculture
Invasive Plant Identification and Control	Eight Mile River Watershed Association
Lake Health and Water Quality	CT DEEP, Connecticut Federation of Lakes, NALMS
Low Impact & Sustainable Development	CT NEMO, CLEAR
Septic System BMPs for Homeowners	CT DPH, Chatham Health District
Small Farm BMPs	UConn Cooperative Extension System

8.5 Proposed Program

The proposed education and outreach program will build upon and expand the past and ongoing efforts by POALH and LQIC. The specific components described below will be incorporated into the program.

1. Develop Annual Topics for Public Education/Outreach – Each year LQIC will develop a list of topics and venues for education and outreach. LQIC will work with POALH and municipal representatives of the towns of East Haddam, Colchester, and Salem. Table 8-2 presents a summary of potential public outreach topics.

TABLE 8-2
Public Education and Outreach Topics

Topic	Synopsis
How septic systems work	Residential septic systems have many working components that must work together to properly treat waste and protect public health. The elements are explained.
How to maintain your septic system	There are three key elements in properly maintaining a septic system. (1) knowing what can be put in; (2) knowing what cannot put in; and (3) knowing when to pump out the system.
What NOT to put down the sink	Grease, oils, fats, paint, etc. will quickly overwhelm the biologic balancing act occurring inside your septic tank. An example, while baby wipes may be marketed as flushable, they do not break down and should not be flushed.
The difference between internal and external nutrient loading into the lake	Internal nutrient loading is the addition of nutrients that occurs through the decomposition of materials on the lake bottom. External loading occurs when nutrients wash into the lake from shore and surrounding homes. Phosphorous and nitrogen are two of the major components contributing to algae growth and both occur with both internal and external loading. Efforts should be taken to reduce the impact of external nutrient loading
The benefit of not adding leaves, grass, pine needles, or other organic material into the lake	Leaves, grass clippings, pine needles and other organic material will release nutrients through decomposition and external loading.
Limit the use of plant and lawn fertilizers	Phosphorous, nitrogen, and potassium are the major elements in fertilizer. Most, especially lawn fertilizer, will eventually work their way into the lake. Please use sparingly.
Utilization of riparian barriers along the lake edge	A riparian barrier is natural vegetation or plantings along the edge of the lake. Along with adding beauty to the property, they are also effective in slowing stormwater sediment from entering the lake. Additionally, they are also effective in discouraging geese from coming ashore.

TABLE 8-2
Public Education and Outreach Topics (Cont.)

Topic	Synopsis
Utilization of chain downspouts	Chain downspouts are an attractive alternative to the traditional downspout, and they slow the rate of water discharge. They are less effective in a heavy rainfall.
Not all aquatic plant species are bad	There are currently 27 different species of aquatic plants located at Lake Hayward. The invasive plant fanwort is the most problematic invasive weed. Though many people would rather not have them in their favorite swimming spot or fishing hole, native aquatic plants provide varied environmental benefits to the lake. The plants control erosion, help to control nutrients, and provide a habitat for fish.
Reduce the P	P is the chemical symbol for phosphorous. Phosphorous is one of the major elements contributing to algae production. There are multiple ways to reduce the amount of phosphorous entering the lake.
Lake Hayward bathyscaph map	Lake Hayward is a relatively shallow lake. The depth around most of the lake is 10-12 feet. The deepest point is 35 feet located near the center of the lake.
Lake Hayward watershed map	Lake Hayward sits at the bottom of a geographical 'bowl'. This feature lends itself to significant external loading of nutrients and debris every time it rains.
Storm water management	One of the primary objectives of storm water management to slow down the velocity of water exiting storm drainage piping entering the lake. In 2021, the lake association will be investing in a stormwater retention basin as part of a stormwater management plan.
Water Testing of the lake	Beginning in 2019, a water sampling program was initiated collecting temperature, secchi disk reading, nutrient sampling, and algae sampling at pre-determined locations in the lake. The data is then analyzed and published in an annual report.
Watershed stream testing	In 2021, the water sampling program will be expanded to include the sampling of inbound streams.
History of weed treatment at LH	In 2001, George Knocklein completed as survey of aquatic plants in the lake and outlined the scope of the invasive weed problem. In 2003 the first treatment of the entire lake to control fanwort occurred. This treatment model continued for several years until 2008 when the 'spot' treatment program was introduced treating concentrated area of invasive species. That program continues today.
The role of all stakeholders	Lake Hayward is not just 'our' lake. There are multiple stakeholders including the towns of Colchester and East Haddam, the Eight Mile River consortium, Long Island sound, East Haddam land use, East Haddam inland wetlands, CT DEEP, and most importantly recreational use of the lake for generations to come.

TABLE 8-2
Public Education and Outreach Topics (Cont.)

Topic	Synopsis
Goose the geese	In spite of their bucolic appeal, geese are a nuisance if not manage well. Efforts are currently underway to modify geese behavior in coming ashore and to seek habitation elsewhere.
Why mechanical weed harvesting is not an option	Many years ago, an attempt to control the invasive aquatic plant fanwort was made using mechanical harvesting. All that did was to puree the plant during the extraction process and create more seedlings to be removed the following year. The model would not work well over the long term.
Why lowering the lake level to control weeds is not an option	While lowering the water level over the winter and having access to the plants and/or letting them freeze works for many lakes, the spillway at the Lake Hayward dam does not have a valve or mechanical method to lower the water level of the lake. Additionally, the contributing watershed is not large enough to refill the lake in a single season but would likely take years.
Why establishing a speed limit is important	Lake Hayward is unique that gasoline powered boats are not authorized on the lake. That said, today's electric motor technology to facilitate moving watercraft at high speeds is here thus creating wakes and a hazard to swimmers unaccustomed to such swift watercrafts. Lake Hayward is currently establishing a 6 MPH regulation.
Lakeside Landscaping and How to Keep Water on YOUR Property	Often large-scale erosion problems can be avoided through many small but important measures taken on one property at a time. Taking steps to keep stormwater runoff from leaving your property can pay large dividends in watershed management.

2. Municipal Stakeholder Engagement – On an annual basis, provide an overview to the Planning & Zoning Commission members and Inland Wetland and Watercourse Commission members in the towns of East Haddam, Colchester, and Salem that identifies the boarder of the Lake Hayward contributing watershed and request their assistance in maintaining good watershed practices for new developments.

3. Residential Landscaping – Shoreline and watershed residential landscaping is an area for ongoing outreach. Improved practices at residences can reduce runoff volume, retain nutrients on the landscape, minimize Canada geese presence and improve shoreline ecological conditions. Use Association spaces as models for individual residential practices.

4. Residential Septic System Maintenance – Continue to encourage residential maintenance. A longer-term assessment of wastewater issues should include an assessment of soils in developed areas to determine where problems may occur and examine possible solutions including smaller scale systems with leach fields in the surrounding area or longer piped connections to existing area sewer systems.

5. Pet Waste Management – Pet waste is another nutrient and bacterial source that requires outreach and voluntary compliance by residence to achieve results. Outreach on this topic will be combined with other residential outreach and education efforts.

6. Low Impact and Sustainable Development – Educate and encourage landowners to utilize low impact and sustainable development practices when undertaking improvements. These will include measures such as leaving driveways unpaved, minimizing impervious surfaces, creating vegetation buffers between the developed portions of their property and the lake, and creating swales and rain gardens to manage stormwater runoff.

7. Stormwater management for the Homeowner – Develop a simple, one-page checklist for the lake community residents and their guests/renters that provides a list of best practices.

8. Engage the farming community within the watershed – Engage with and explore best management practices with the owners of the two active farms located on the outskirts of the watershed within the Town of East Haddam – Allegra Farm and Cold Spring Farm.

9. Erosion control – Annually monitor active erosion within the watershed and identify areas in need of attention/remediation.

9.0 RECOMMENDED MANAGEMENT MEASURES (EPA Element C)

9.1 Priority Areas

Based on the foregoing assessment, the following priority actions will be targeted at Lake Hayward. Implementation measures are described in Section 10.0.

Priority Area #1 – Expand Community Outreach and Education

- Implement a multi-tiered outreach and education program to engage watershed residents, visitors, and municipal partners with the goal of gaining support for watershed management implementation efforts.
- Develop annual topics for public education/outreach.
- Engage municipal stakeholders on an annual basis.
- Undertake annual outreach efforts relative to residential landscaping, residential septic system maintenance, pet waste management, low impact and sustainable development, stormwater management, agricultural practices, and erosion control.

Priority Area #2 – Secure Future Project Funding

- Identify appropriate funding sources that are well-matched and with high likelihood of success to fund watershed management initiatives.
- Continue to work with the Town of East Haddam to receive an annual allocation of funding towards watershed management.
- Continue to work with POALH and others to continue to fund quality treatment and watershed best management practice (BMP) measures.

Priority Area #3 – Undertake Dam Repairs

- Undertake dam safety improvements as recommended following the most recent inspection.
- Conduct regular dam safety inspections as required by law.
- Maintain the integrity of the dam through maintenance and required repair/replacement as needed.

Priority Area #4 – Institute Stormwater Management Measures

- Identify, design, fund, and construct stormwater improvement projects in the watershed to mitigate impervious surfaces and erosion, including a bio-detention basin behind the tennis courts along Lake Shore Drive.
- Install a hydrodynamic separator demonstration project.
- Disconnect runoff paths on the west shore hillside, upgradient from Lake Shore Drive.
- Work with the towns of East Haddam and Colchester to undertake regular street sweeping and catch basin clean-out and petition them to minimize road sanding and salt application.
- Work with the Town of East Haddam to correct chronic erosion problems along East Shore Drive.
- Develop and fund an annual maintenance program for stormwater piping throughout the watershed to eliminate chronic clogging.
- Encourage the towns of East Haddam and Colchester to replace existing shallow catch basins with deep sump catch basins to increase the amount of sediment captured by these structures.
- Work with property owners to construct rain gardens, install erosion control measures, and plant riparian buffers.

- Educate and encourage a low impact and sustainable development approach to stormwater management on individual properties.

Priority Area #5 – Stabilize Erosion Sources

- Identify, design, fund, and construct bank erosion stabilization projects in the watershed.
- Install in-stream velocity dissipation in the tributaries that discharge into Lake Hayward to reduce the transport of suspended solids and subsequent deposition in the lake.
- Working with property owners, identify ongoing erosion issues on individual properties and formulate solutions to correct them.

Priority Area #6 – Reduce Nutrient Input

- Through community outreach and education, raise the awareness of the impacts of phosphorus on lake water quality and strive to significantly reduce use of phosphorus within the watershed.
- Encourage the cessation of fertilizer or the use of no phosphorus fertilizer.
- Correct erosion problems.
- Correct failing and underperforming septic systems.
- Employ measures to control the Canada Goose population.

Priority Area #7 – Correct Failing and Underperforming Septic Systems

- Undertake a grass roots effort to educate and mobilize property owners to investigate, repair, and maintain their septic systems.
- Conduct annual pump-out drives.
- Request a septic system monitoring survey by Chatham Health District within the watershed.

Priority Area #8 – Manage Nuisance and Invasive Aquatic Vegetation

- Conduct annual professional monitoring for invasive species within the lake.
- Continually educate visitors, particularly at the public boat launch. Post signage.
- Monitor boat launch activities to control introduction of invasive species.
- Continue to engage professional services as necessary for invasive species control.

Priority Area #9 – Monitor and Attempt to Avoid Algae Blooms

- Continue the annual monitoring program for lake water quality.
- Visually monitor, document, and conduct laboratory analysis of samples of algae blooms.

Priority #10 – Monitor Water Quality

- Continue the rigorous water quality monitoring program as described in Section 3 of this WMP.
- Engage project partners and technical service providers as sources of water quality data.
- Expand the library of previous studies.

Priority Area #11 – Maintain the Tranquil Quality of Lake Hayward

- Adopt a speed limit for powered watercraft.
- Conduct a voluntary monitoring program.
- Post speed limit at public boat launch.

Priority Area #12 – Maximize Open Space in the Watershed

- Work with municipal officials and staff within the towns of East Haddam, Colchester, and Salem to maximize undeveloped open space areas within the watershed.
- Ensure protections are incorporated into any new development within the watershed.

- Educate landowners in currently developed areas, both within and outside of the immediate lake proper.
- Work with the towns of East Haddam and Colchester to adopt protective overlay zones.

Priority Area #13 – Manage the Canada Goose Population

- Educating property owners about low-cost measures to discourage geese from grazing on grass areas
- Where possible and on publicly owned or POALH owned land, plant vegetation that discourages geese.
- Identify, fund, and execute additional measures to reduce the goose population.

Priority Area #14 – Undertake Localized Sediment Removal

- Identify funding sources and undertake sediment removal projects in areas with chronic deposition, primarily near stormwater and tributary outlets.

Priority Area #15 – Protect Existing Natural Habitat

- Monitor and maintain upland areas for invasive plant species and maintain healthy upland vegetation in the watershed.
- Periodically monitor wetlands adjacent to the lake.

9.2 Pollutant Load Reduction (EPA Element B)

The projected effectiveness of the structural Best Management Practices (BMPs) were modeled in STEPL to estimate pollutant load reduction in the watershed. The sediment and pollutant load reductions are computed using known BMP efficiencies included in the EPA STEPL model algorithms described in Section 1.7 of this Plan.

The following BMPs were modeled in accordance with the prioritized areas and recommendations as described above and in the preceding sections of this Plan.

Priority Area #4 – Institute Stormwater Management Measures

4.1 Construct a stormwater bio-detention basin behind the tennis courts along Lake Shore Drive in sub-watershed W-2. This sub-watershed includes the horse paddocks at Allegra Farm. This BMP is estimated to capture and treat 90% of the sub-watershed.

4.2 Install a hydrodynamic separator (W-3). This would capture and treat a portion of the agricultural operation at Cold Spring Farm. This BMP is estimated to capture and treat 90% of the sub-watershed.

4.3 Work with the towns of East Haddam and Colchester to undertake regular street sweeping and catch basin clean-out and petition them to minimize road sanding and salt application. Sub-watersheds W-1 through W-6 as well as E-5 through E-7 were modeled, as these areas are closest to the lake with the highest roadway network and development density. This BMP is estimated to capture and treat 50% of the watershed.

4.4 Work with property owners to construct individual rain gardens on their properties. This BMP was modeled as "LID Infiltration Swale" and assumed a 50% homeowner cooperation/adoption rate.

Priority Area #5 – Stabilize Erosion Sources

5.1 Install in-stream velocity dissipation in the tributaries that discharge into Lake Hayward to reduce channel erosion, the transport of suspended solids, and subsequent deposition in the lake. W-1, measured 900 feet of stream channel from small pond to Lake Hayward, assumed 5 feet wide and 2 feet deep, sandy soils, eroding over last 20 years, and repairs being 95% efficient. This BMP was also applied to E-5 and E-6. Other smaller and localized sources of erosion were not modeled.

The Urban BMP Tool within STEPL was used to estimate the effects of each of the proposed projects listed above in each sub-watershed, as specified above. Results are presented in Tables 9-1 through 9-4 below. The most striking results are predicted with the construction of the stormwater bio-detention basin in sub-watershed W-2, with a predicted 17.5% reduction each of nitrogen and phosphorus, and stabilization of eroding watercourses, with a predicted 11% reduction in nitrogen, 23.7% reduction in phosphorus, and 76% reduction in total suspended solids (TSS). These reductions are based on the STEPL algorithms, which may underestimate TSS reduction in W-2, given the visible sediment delta at the outfall from that sub-watershed.

TABLE 9-1
Nitrogen (N) Reduction Post-BMPs

BMP ID No.	BMP	Applied to Sub-Watershed(s)	Existing N Load (lb/year)	BMP Reduction in N Load (lb/year)	Percent Reduction in N Load
4.1	Stormwater Bio-Detention Basin	W-2	434.2	75.9	17.5%
4.2	Hydrodynamic Separator on Lake Shore Drive	W-3	1,318.2	7.0	0.5%
4.3	Enact Street Cleaning, Reduce San/Salt Use	W-1, 2, 3, 4, 5, 6 E-5, E-6, & E-7	4,4325.2	---	---
4.4	Rain Garden Construction on Private Property	All	6,740.8	253.6	3.8%
5.1	Stabilize Eroding Watercourses	W-1, E-5, E-6	2,678.6	295.5	11.0%

TABLE 9-2
Phosphorus (P) Reduction Post-BMPs

BMP ID No.	BMP	Applied to Watershed(s)	Existing P Load (lb/year)	BMP Reduction in P Load (lb/year)	Percent Reduction in P Load
4.1	Stormwater Bio-Detention Basin	W-2	118.1	17.5	17.5%
4.2	Hydrodynamic Separator on Lake Shore Drive	W-3	280.8	1.3	0.5%
4.3	Enact Street Cleaning, Reduce San/Salt Use	W-1, 2, 3, 4, 5, 6 E-5, E-6, & E-7	831.7	8.6	1.0%
4.4	Rain Garden Construction on Private Property	All	1,385.4	60.0	4.3%
5.1	Stabilize Eroding Watercourses	W-1, E-5, E-6	480.5	113.8	23.7%

TABLE 9-3
Biochemical Oxygen Demand (BOD) Reduction Post-BMPs

BMP ID No.	BMP	Applied to Watershed(s)	Existing BOD Load (lb/year)	BMP Reduction in BOD Load (lb/year)	Percent Reduction in BOD Load
4.1	Stormwater Bio-Detention Basin	W-2	13.4	---	---
4.2	Hydrodynamic Separator on Lake Shore Drive	W-3	2,577.8	---	---
4.3	Enact Street Cleaning, Reduce San/Salt Use	W-1, 2, 3, 4, 5, 6 E-5, E-6, & E-7	28,903.1	215.1	0.7%
4.4	Rain Garden Construction on Private Property	All	22,352.4	---	---
5.1	Stabilize Eroding Watercourses	W-1, E-5, E-6	8,063.0	591.0	7.3%

TABLE 9-4
Total Suspended Solids Reduction Post-BMPs

BMP ID No.	BMP	Applied to Watershed(s)	Existing TSS Load (lb/year)	BMP Reduction in TSS Load (lb/year)	Percent Reduction in TSS Load
4.1	Stormwater Bio-Detention Basin	W-2	85,400	---	---
4.2	Hydrodynamic Separator on Lake Shore Drive	W-3	113,000	1,000	0.8%
4.3	Enact Street Cleaning, Reduce San/Salt Use	W-1, 2, 3, 4, 5, 6 E-5, E-6, & E-7	767,200	5,800	0.8%
4.4	Rain Garden Construction on Private Property	All	438,600	20,600	4.7%
5.1	Stabilize Eroding Watercourses	W-1, E-5, E-6	422,800	321,200	76.0%

10.0 IMPLEMENTATION

10.1 Interim, Measurable Milestones (EPA Element G)

The following interim, measurable milestones have been identified:

1. Completion of public education initiatives.
   - → Publication and distribution of the East Shore Gazette.
   - → Publication and distribution of POALH newsletters.
   - → Presentations to the watershed community.
   - → Distribution of public education flyers.
   - → Posting of watershed management related signage and posters.

2. Construction of stormwater mitigation projects.
   - → Construction of a bio-detention basin on the west side of the lake behind the existing tennis courts.
   - → Construction of a hydrodynamic separator demonstration project.
   - → Construction of erosion stabilization projects.

3. Maintenance of stakeholder/partner communications and coordination.
   - → Documentation of periodic meetings with POALH representatives.
   - → Posting of website materials regarding lake and watershed management, working collaboratively with the Town of East Haddam.
   - → Annual communication with the land use and wetland commissions in the towns of East Haddam, Colchester, and Salem to make them aware of the watershed area in their towns and providing recommendations for best management practices when reviewing new development proposals.

4. Maintenance of catch basins.
   - → Implementation of a program of annual catch basin maintenance, working with the Town of East Haddam.
   - → Installation of deep sump catch basins in the watershed to replace existing shallow catch basins to increase the efficiency of sediment capture.

5. Quarterly LQIC meetings.
   - → Conduct quarterly (or more frequent) meetings of the Lake Quality Improvement Committee to document progress on WMP recommendations.

6. Complete grant applications for plan implementation.
   - → As available, complete grant applications for action elements of this WMP, for capital improvements, maintenance activities, and educational components.

7. Complete educational materials for lake residents.
   - → Document occurrences of education and outreach efforts.

8. Water quality improvements.
   → Document water quality on an ongoing basis through field measurements and laboratory analysis associated with the current water quality monitoring program and compare trends in a report published annually.

9. Achieve less frequent algae blooms.
   → Document of episodic algae blooms.

10. Document distribution of fanwort and other invasive species.
   → Document coverage of invasive species through annual monitoring conducted by trained professionals.

10.2 Indicators to Measure Progress (EPA Element H)

Table 10-1 presents indicators will be used to measure progress for each of the identified priority areas.

TABLE 10-1
Measurement Indicators

Priority Area	Action Item	Measurable Metric
#1	Expand Community Outreach and Education	Documentation of publications, meetings, and events
#2	Secure Future Project Funding	Documentation of grant applications filed, funding sought through other means, and outcomes
#3	Undertake Dam Repairs	Documentation of dam inspections and contracted work
#4	Institute Stormwater Management Measures	Documentation of designed, funded, and completed projects
#5	Stabilize Erosion Sources	Documentation of designed, funded, and completed projects
#6	Reduce Nutrient Input	Documentation of completed corrective measures
#7	Correct Failing and Underperforming Septic Systems	Documentation of completed repairs and replacements
#8	Manage Nuisance and Invasive Aquatic Vegetation	Documentation of monitoring, educational efforts, and application of in-lake treatments
#9	Monitor and Attempt to Avoid Algae Blooms	Annual reporting
#10	Monitor Water Quality	Annual reporting
#11	Maintain the Tranquil Quality of Lake Hayward	Filing of petition and adoption of speed limit
#12	Maximize Open Space in the Watershed	Documentation of meetings and outreach efforts, inventory of open space lands, and adoption of overlay zones
#13	Manage the Canada Goose Population	Documentation of completed control measures
#14	Undertake Localized Sediment Removal	
#15	Protect Existing Natural Habitat	Annual visual monitoring results

10.3 Monitoring Components (EPA Element I)

Monitoring and assessment is essential to determining the effectiveness of individual and collective watershed measures. Ongoing water quality monitoring, both in the lake and in the watershed, will allow an assessment of trends and episodic events. The following elements will be included in the long-term monitoring program for Lake Hayward:

- Continued monitoring for bacteria for public beaches
- Continued in-lake monitoring program, both field parameters and laboratory analysis
- Continued in-stream monitoring
- Visual monitoring of lake buffer
- Visual monitoring of sedimentation at stormwater and tributary outlets
- Continued monitoring and documentation of occurrence of algae blooms
- Annual survey of invasive species
- Documentation of public education and outreach activities
- Documentation of meetings with local officials.

10.4 Implementation Costs

Table 10-2 summarizes anticipated implementation costs for the capital improvement costs associated with this WMP. These do not include costs that would be incurred by individual landowners in addressing issues on their properties, such as failing septic systems or localized erosion.

TABLE 10-2
Implementation Costs

Action	Anticipated Planning/Design Cost	Anticipated Implementation Cost
18. Implement public outreach and education program (annual)	N/A	$5,000
19. Secure future project funding (annual)	$3,000	N/A
20. Undertake dam reconstruction	$15,000	$230,000
21. Conduct periodic dam inspections (each)[1]	N/A	$3,000
22. Construct a bio-detention basin behind tennis courts	$8,000	$40,885
23. Undertake a hydrodynamic separator demonstration project	$10,000	$50,000
24. Disconnect stormwater runoff paths (each)	$3,000	$21,000
25. Conduct regular street sweeping and catch basin maintenance	*	*
26. Arrest erosion problems along East Shore Drive (each)	$5,000	$25,000
27. Replace existing shallow catch basins	*	*
28. Stabilize eroding banks (each)	$5,000	$15,000
29. Periodically treat the lake for invasive species control (annually)	N/A	$20,000
30. Take action to discourage goose population	$2,000	$50,000
31. Manage invasive aquatic vegetation (annual)	$1,500	$25,000
32. Continue to monitor water quality in the lake and tributaries (annual)	N/A	$10,000
33. Adopt a speed limit for powered watercraft	N/A	N/A
34. Undertake localized sediment removal/dredging (each project)	$15,000	$100,000

[1]Every 2 years by POALD engineer; State DEEP inspection every 7 years.
*Work to be undertaken by the municipality

10.5 Funding Programs

Property Owners' Association of Lake Hayward – Each year POALH adopts a budget, including invasive species management, water quality testing, beach monitoring, and support for LQIC initiated activities.

Town of East Haddam – The Town of East Haddam has provided annual funding for watershed management activities at Lake Hayward. The magnitude of funding has supported public outreach efforts and other ongoing initiatives but is not substantial enough to undertake many of the larger initiatives.

Connecticut Department of Energy & Environmental Protection – DEEP administers the EPA Clean Water Fund Section 319 Grant program for non-point source pollution training and projects. The program funds projects up to $50,000. Additionally, DEEP recently announced an additional grant program for aquatic invasive species control on lakes, ponds, and rivers. Press release at https://portal.ct.gov/DEEP/News-Releases/News-Releases---2020/DEEP-Announces-Availability-of-Grants.

10.6 Technical and Financial Assistance Needed (EPA Element D)

Technical and financial assistance will be needed to undertake certain elements of this plan, including the following:

- Annual assessment of invasive species
- Annual water quality testing
- Public outreach and education
- Engineering design and construction of stormwater management treatment and erosion control measures
- Lake treatment for invasive species
- Dam safety improvements

10.7 Implementation Schedule (EPE Element F)

Table 10-3 on the following page presents the implementation schedule for each identified priority area.

10.8 Watershed Management Plan Updates

Each year, a report will be developed to document the progress of the implementation actions associated with the subject WMP. These updates will be included as Appendix C. When conditions require, edits to the body of the WMP will be made, and revision dates recorded.

TABLE 10-3
Implementation Schedule

Priority	Action	Primary Lead	Support Responsibility	Target Deadline
#1	Expand Community Outreach and Education	LQIC	POALH	Ongoing
#2	Secure Future Project Funding	LQIC	POALH	January 2021
#3	Undertake Dam Repairs	POALH	N/A	December 2021
#4	Institute Stormwater Management Measures	LQIC & POALH	Towns of East Haddam & Colchester	September 2021
#5	Stabilize Erosion Sources	LQIC & POALH	Town of East Haddam	September 2022
#6	Reduce Nutrient Input	LQIC & POALH	Town of East Haddam	Ongoing
#7	Correct Failing and Underperforming Septic Systems	Property Owners	Chatham Health District	Ongoing
#8	Manage Nuisance and Invasive Aquatic Vegetation	POALH	LQIC	Annually
#9	Monitor and Attempt to Avoid Algae Blooms	POALH	LQIC	Annually
#10	Monitor Water Quality	LQIC & POALH	N/A	Annually
#11	Maintain the Tranquil Quality of Lake Hayward	LQIC	POALH	May 2021
#12	Maximize Open Space in the Watershed	LQIC & POALH	Towns of East Haddam & Colchester	Ongoing
#13	Manage the Canada Goose Population	LQIC & POALH	N/A	Ongoing
#14	Undertake Localized Sediment Removal	LQIC & POALH	N/A	September 2023
#15	Protect Existing Natural Habitat	LQIC	POALH, DEEP, Municipal IWCs	Ongoing

APPENDIX A
Pollutant Load Modeling Output

Table A - Land Use by Subwatershed

			Cropland	Feedlot	Urban						Forest				
Model	**STEPL WS Name**	**Watershed IDs**	**Agricultural**	**Feedlot**	**Low Density Residential**	**Medium Density Residential**	**Rural Residential**	**Utility**	**Vacant < 1ac (Residential Area)**	**Urban**	**Open Space**	**Vacant > 1ac (Forested Area)**	**Forest**	**Water**	**Grand Total**
	A-WS1	**WS E-1**			1.65	0.49	41.75		1.01	44.90	0.07	86.00	86.06	0.00	**130.96**
	A-WS2	**WS E-2**					12.61			12.61		30.44	30.44	0.01	**43.06**
	A-WS3	**WS E-3**				0.07	117.86		0.99	118.92		59.58	59.58	0.06	**178.56**
	A-WS4	**WS E-4**			0.51	0.17	15.46		0.83	16.97		7.12	7.12	0.09	**24.18**
A	**A-WS5**	**WS E-5**				1.13	123.41		0.73	125.28		20.33	20.33	0.07	**145.68**
	A-WS6	**WS E-6**			0.03	1.16	90.83		1.10	93.12		5.53	5.53	0.02	**98.66**
	A-WS7	**WS E-7**			8.51	3.56	12.71		1.28	26.06		0.18	0.18	0.00	**26.24**
	A-WS8	**WS N-1**			4.35	2.67	202.07		1.55	210.64		201.53	201.53	3.80	**415.98**
	A-WS9	**WS W-1**	27.15	2.00	0.49	9.83			0.84	11.16	2.41	18.99	21.40		**61.70**
	A-WS10	**WS W-2**	17.60		1.84	17.91	0.62		3.03	23.39	0.18		0.18	0.04	**41.22**
	B-WS1	**WS W-3**	17.74	0.50	1.29	17.22	1.99	3.53	2.87	26.91	12.94		12.94	0.01	**57.61**
B	**B-WS2**	**WS W-4/5**			1.59	14.74			2.08	18.41	21.18		21.18	0.01	**39.59**
	B-WS3	**WS W-6**			1.06	9.62			4.10	14.78	4.74		4.74	0.00	**19.52**
	C-WS1	**OLF E-1**			5.45	3.45		0.59	2.80	12.30	0.40	6.54	6.94	0.73	**19.97**
	C-WS2	**OLF E-2**					0.00			0.00		11.35	11.35		**11.35**
	C-WS3	**OLF E-3**			1.72	6.20	0.36		4.72	13.00		7.32	7.32	0.31	**20.63**
	C-WS4	**OLF E-4**			2.13	1.20	0.31		1.31	4.96		0.69	0.69	0.19	**5.84**
C	**C-WS5**	**OLF E-5**			5.57	4.87	0.54		6.71	17.69			0.00	0.14	**17.83**
	C-WS6	**OLF W-1**			0.74	6.47			2.74	9.95		1.67	1.67	0.32	**11.95**
	C-WS7	**OLF W-2**			0.00	1.14			0.19	1.33			0.00	0.04	**1.37**
	C-WS8	**OLF W-3**				3.14			0.50	3.64	0.62		0.62	0.14	**4.39**
	C-WS9	**OLF W-4**			0.53	6.20			0.39	7.12			0.00	0.17	**7.29**
		Grand Total	**62.48**	**2.50**						**813.14**			**499.78**	**6.17**	**1,383.58**

Table B - Hydrologic Soil Classification by Subwatershed

Model	STEPL WS Name	Row Labels	Group A	Group B	Group C	Group D	Group C/D	Group B/D	Grand Total
A	A-WS1	WS E-1	0.50	53.45	29.20	14.38	21.13	15.22	133.88
	A-WS2	WS E-2		16.59	20.33	6.71	2.04	0.18	45.85
	A-WS3	WS E-3	4.20	97.84	17.33	30.26	4.55	32.34	186.52
	A-WS4	WS E-4	4.47	11.98	4.37	3.37	0.04	1.70	25.93
	A-WS5	WS E-5		57.21	2.91	27.74	1.45	69.66	158.97
	A-WS6	WS E-6		27.21	30.70	13.50		30.82	102.23
	A-WS7	WS E-7		25.79				0.02	25.80
	A-WS8	WS N-1	42.69	225.02	56.31	66.52		35.40	425.93
	A-WS9	WS W-1		28.06	23.04	9.26			60.36
	A-WS10	WS W-2		18.77	29.73				48.50
B	B-WS1	WS W-3		30.22	30.96	0.40			61.58
	B-WS2	WS W-4/5		35.59	2.77	4.92			43.29
	B-WS3	WS W-6		13.17		8.44			21.61
C	C-WS1	OLF E-1	10.85	6.48				2.76	20.09
	C-WS2	OLF E-2		7.91	3.41	0.13			11.45
	C-WS3	OLF E-3		16.21	3.57	0.10	1.41		21.29
	C-WS4	OLF E-4		5.05		0.60		0.06	5.71
	C-WS5	OLF E-5		17.69					17.69
	C-WS6	OLF W-1	5.77	4.02	1.94	0.06		2.97	14.77
	C-WS7	OLF W-2		1.22					1.22
	C-WS8	OLF W-3		4.77					4.77
	C-WS9	OLF W-4		7.48					7.48
		Grand Tota	68.48	711.74	256.58	186.41	30.61	191.11	1,444.93

Table C - Number of Septic Systems, per Subwatershed

Model	STEPL WS Name	Watershed IDs	Septic Systems
A	A-WS1	WS E-1	14
	A-WS2	WS E-2	6
	A-WS3	WS E-3	49
	A-WS4	WS E-4	7
	A-WS5	WS E-5	76
	A-WS6	WS E-6	27
	A-WS7	WS E-7	10
	A-WS8	WS N-1	60
	A-WS9	WS W-1	35
	A-WS10	WS W-2	87
B	B-WS1	WS W-3	84
	B-WS2	WS W-4/5	50
	B-WS3	WS W-6	48
C	C-WS1	OLF E-1	11
	C-WS2	OLF E-2	0
	C-WS3	OLF E-3	23
	C-WS4	OLF E-4	4
	C-WS5	OLF E-5	28
	C-WS6	OLF W-1	21
	C-WS7	OLF W-2	7
	C-WS8	OLF W-3	10
	C-WS9	OLF W-4	22
		Grand Total	679

APPENDIX B
List of Previous Studies

Lake Hayward Studies

- 1940 – A Contribution to Regional Limnology by Deevey (data from 1937-1939)
- 1984 – Chemical and Physical Properties of CT Lakes by Frink & Norvell (data from 1973 to 1974)
- 1978 – A BacteriologicaAl & Limnological Study of Three Lakes in East Haddam by Battoe (data from 1976-1977)
- 1982 – Trophic Classification of Seventy CT Lakes by CT DEP (data from 1974)
- 1990 – Calculations and Tables Relating to Lake Hayward by BEC, Inc.
- 1991 – Trophic Classification of Forty-Nine CT Lakes by CT DEP (data from 1989)
- 1992 – Ecology of Lake Hayward, Analysis and Summary of Existing Data Through 1991 by Baillie
- 1995 – Water Quality Characteristics of Selected Public Recreational Lakes & Ponds in CT by Healy & Kulp, USGS (data from 1989)
- 1991 – Lake Hayward Inflow stream Water Quality Survey Data by CT DEC
- 1991 – Proposed Lake Hayward West Subdivision Wetland Assessment Report by Baystate Environmental Consultants
- 1995 – CT Lakes, A Study of the Chemical and Physical Properties of Fifty-Six CT Lakes by Canavan & Siver (data from 1991-1993
- 2003 – Diagnostic/Feasibility Study of Lake Hayward by Northeast Aquatic Research (data from 2000-2001)
- 2003-2016 – Biannual (twice a year) Aquatic Control Technology (ACT) Secchi water clarity and phytoplankton measurements
- 2017-Present – Biannual (twice a year) SOLitude (SOL) Secchi water clarity and phytoplankton measurements
- 2005 – Lake Hayward Water Data by CT Agricultural Experiment Station
- 2015 – Lake Hayward Survey by Wesleyan
- 2015-Present – Mostly biweekly (every two weeks) Secchi water clarity measurements by LQIC
- 2015-Present – Mostly monthly total phosphorus and chlorophyll-a measurements by LQIC

APPENDIX C
Annual WMP Updates

(Future Appendix)