Lake Fairlee
Lake and Watershed Action Plan (LWAP)
Fairlee, West Fairlee, & Thetford, Vermont

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TABLE OF CONTENTS

Appendices

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1.0 EXECUTIVE SUMMARY

- The White River Natural Resources Conservation District is working with Bear Creek Environmental, and other project partners to conduct lake watershed action planning within the Lake Fairlee watershed in Vermont. The Lake and Watershed Action Plan (LWAP) aims to address key water quality issues and to promote the long-term health and sustainability of the Lake.

- Nutrient Reduction: The LWAP outlines strategies to reduce sediment and phosphorus loading to Lake Fairlee by reducing nutrient runoff, promoting best management practices, implementing erosion control measures, improving stormwater management and providing vegetated buffers along inlet tributaries.

- Shoreline Protection and Restoration: The establishment and maintenance of native vegetation along the lake shoreline is important for filtering of contaminants and habitat. The LWAP also provides recommendations for protection of critical wetland habitat and improved shoreland habitat. Bioengineering techniques, such as installing native vegetation and natural materials, is recommended to enhance habitat and provide a greater connection between the aquatic and terrestrial landscape.

- Project Identification and Prioritization: Twenty projects have been identified and prioritized in the LWAP to improve lake water quality. These projects were identified through the assessment of three sectors: Lakeshore, Streams, and Roads. The projects were prioritized based on 1) Improvement in water quality, 2) Landowner support, 3) Improvement and protection of riparian and aquatic habitat, 4) Cost effectiveness, and 5). Socioeconomic benefits.

- Conceptual designs and cost estimates were completed for ten moderate and high priority projects with written landowner interest. The projects include: Eight stormwater improvement projects and two lakeshore improvement project using bioengineering.

- Public Outreach: A meeting will be held in June 2023 to present the LWAP and to garner interest in project development and implementation.

- Funding and Implementation: The next step is to seek grant/funding opportunities and collaborate with local organizations to leverage local, state and federal resources.

2.0 INTRODUCTION

Lake Fairlee is a naturally-formed lake situated in the towns of Fairlee, Thetford, and West Fairlee, Vermont. With many uses ranging from recreation to aesthetics, the lake is very important to the surrounding communities. Over the past several decades, the health of the lake has been declining as issues such as water quality impairment and invasive species have become present in the watershed. Lake Fairlee has shown increasing concentrations of nutrients over the past several years. Local initiatives exist within the watershed to improve water quality, wildlife habitat, and ecosystem health of the lake. Lake and Watershed Action Plans (LWAP) can be used to help guide the efforts of community lake associations, such as the Lake Fairlee Association.

2.1 LWAP Goals and Components

According to the document *Technical Guidelines to Conducting a LWAP* (VT DEC 2022a) authored by the Vermont Department of Environmental Conservation's Watershed Management Division, "a Lake and Watershed Action Plan (LWAP) is designed to identify and communicate the problems and fixes within a lake watershed to best protect water quality, wildlife habitat, and the lake's ecosystem health." LWAPs integrate water quality, ecological, economic, recreational, and other types of data to identify and address problems affecting a lake and its watershed.

There are three main focus areas for LWAP studies: shoreland, tributaries, and roads. The shoreland refers to lands immediately adjacent to the lake. In Vermont, the *shoreland is typically defined as lands within 250 feet from the mean water level*. This area immediately adjacent to the lake is a sensitive area and land uses changes in this area can have direct impacts on lake ecosystem health.

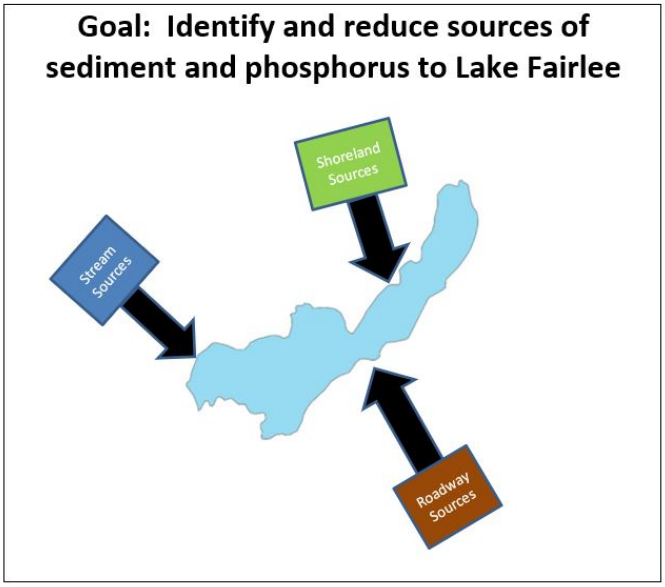
Tributaries refer to the streams that flow into the lake. Historic and current management of streams can greatly impact their physical stability, biological health, and water quality.

Streambank erosion has been documented as an important source of sediment and nutrients that can impact downstream water quality. Adjacent land uses also contribute to the health of tributaries and ultimately the lake downstream.

Roads are the third focus area for LWAP development. Many sections of roads in Vermont are *hydrologically connected, meaning that runoff from them has the potential to make it into nearby surface waters*. Roads that do not adhere to best management practices for stormwater management or that may have erosion issues can present significant sources of sediment and nutrients to surface waters.

2.2 Lake Fairlee Project Goals

The primary goal of the Lake Fairlee LWAP is to identify sources of sediment and phosphorus that are entering the Lake and to work with project partners to develop and implement projects that reduce those sources. LWAP project partners include the Lake Fairlee Association, Vermont Department of Environmental Conservation Watershed Management Division, Two Rivers-Ottauquechee Regional Commission, the towns of Fairlee, Thetford, and West Fairlee, private landowners, and the White River Conservation District. A project kick-off meeting was held on November 18, 2021 to discuss the goals of the Lake Fairlee LWAP project with these partners.



Numerous local initiatives exist within the watershed led by the Lake Fairlee Association and lakefront landowners. The Lake Fairlee Association is comprised of residents within the watershed taking action to preserve and maintain the health of the lake. Local residents started

the Treasure Island Exploratory Committee with the goal to revitalize Treasure Island, a town-owned recreation area located on the northwest side of the lake. The group aims to establish trails through natural areas, as well as create recreational infrastructure to encourage sustainable enjoyment of the island. The association also leads the Lake Fairlee Water Quality Action Committee. The committee includes water quality monitoring within the watershed conducted by local volunteers and has a goal of addressing rising phosphorus levels in surface waters within the watershed. Additionally, the association does work within the watershed to increase awareness of and reduce the spread of the aquatic invasive species water milfoil.

3.0 WATERSHED INFORMATION

Lake Fairlee is a 462-acre lake situated in the towns of Fairlee, Thetford, and West Fairlee, Vermont. The lake drains to the Ompompanoosuc River, which is a tributary to the Connecticut River. Lake Fairlee is naturally formed, but lake levels are regulated by a 12-foot-high dam at the outlet. The lake's watershed is just over 20 square miles in size with two major streams that flow into the lake, Blood Brook and Middle Brook.

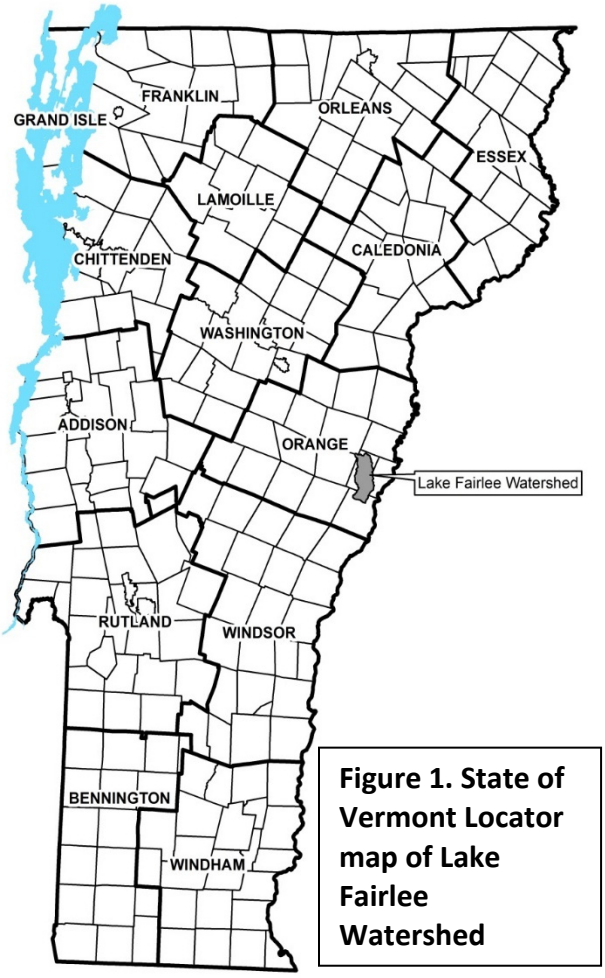


Figure 1. State of Vermont Locator map of Lake Fairlee Watershed

Building Density

Development is present throughout the watershed. Many homes and businesses line the lakeshore, including multiple summer camps. Development within the watershed was examined by looking at building locations. According to data from the Emergency-911 program, there are 525 buildings located within the Lake Fairlee watershed. Development is centered around the lakeshore area, as well as Middlebrook Road and Blood Brook Road. The highest

building densities are on the southwest and northwest side of the Lake, with building densities close to 200 units per square mile (Appendix A, page 1).

Road Density

High road densities can lead to negative ecological impacts on lakes, including runoff and pollution, habitat fragmentation, alteration of hydrological processes, introduction of invasive species, and noise and disturbance that can stress wildlife in the vicinity of the lake. A total of roughly 44 miles of road are present within the watershed, according to road centerline data from the Vermont Center for Geographic Information. Total road lengths by road class are included in Table 1 below.

The road density is approximately 2.2 miles per square mile within the Lake Fairlee Watershed. The road network is denser around the lake and is 2.8 mile per square mile within a 1-mile radius of the Lake and 3.5 miles per square mile within 250 feet of the Lake. Jones and Grant (1996) cited in Forman and Alexander (1998) suggest increased peak flows in streams may be apparent at road densities of 3 to 5 miles per square mile. This road density is within the range of that found within the Lake Fairlee lakeshore. For purposes of this Action Plan, *lakeshore is defined as the land surrounding a lake that is within 250 feet of the lake's mean water level*. This greater density of roads within the lakeshore points to the importance of implementing best management practices (BMP) to reduce sediment and phosphorus loading to road surfaces in close proximity to the Lake.

Table 1. Road Class and Length within Lake Fairlee Watershed

Road Class	Road Class Description	Length (mi)
2	Town Highway, Class 2	7.1
3	Town Highway, Class 3	12.0
4	Town Highway, Class 4	13.9
8	Private Road, but not for display on maps	5.0
30	State Highway	3.7
96	Discontinued Road	1.7
97	Discontinued Now Private	0.4
TOTAL		43.8

Watershed Land Cover

Land cover within the watershed was also examined. 2016 land cover data created for the State of Vermont by the University of Vermont Spatial Analysis Laboratory were reviewed. As shown on the map on page 2 of Appendix A, the Lake Fairlee watershed is primarily forested (84% total watershed area). Less than one percent of the watershed area is developed (Table 2).

Table 2. Vermont Base Land Cover dataset 2016 Land Cover for Lake Fairlee watershed

Classification	Area (acres)	Percent of watershed area
Tree Canopy	11,155.0	83.6%
Grass/Shrub	1,540.9	11.6%
Bare Soil	16.4	0.1%
Water	513.0	3.8%
Building	21.1	0.2%
Road	45.2	0.3%
Other Paved Surfaces	51.7	0.4%

Lakeshore Land Cover

The lakeshore was evaluated using the Vermont Base Land Cover dataset from 2016. A 250-foot buffer was created around the Lake and the percentage of land with tree canopy, grass/shrub, and impervious surface was summarized. Lake buffer land cover information for Lake Fairlee (Table 3) is compared with landcover data for other lakes that is provided in the Lake Elmore Watershed Action Plan (Fitzgerald Environmental Associates, LLC, 2020). A map showing the land cover within the 250-foot buffer is provided in Figure 2.

Table 3. Land Cover – 250-Foot Buffer Around Vermont Lakes						
Lake	**Watershed (Sq. Mi.)**	**Lake Area (Acres)**	**Lake Perimeter (Miles)**	**Tree Canopy**	**Grass/ Shrub**	**Impervious**
Fern	0.8	67	2.3	84%	8%	8%
Dunmore	20.8	1040	11.5	74%	14%	12%
Fairlee	20.3	457	8.3	**67%**	22%	11%
Eden	7.2	198	6.1	65%	22%	13%
Bomoseen	37.5	2415	22.9	61%	26%	13%
Little/St. Catherine	14	1085	16	58%	30%	12%
Elmore	8.4	222	3.3	50%	34%	16%
Lake Fairlee information provided by Bear Creek Environmental, LLC Other lake information from Fitzgerald Environmental Associates (2020) 2016 Land cover data from University of Vermont						

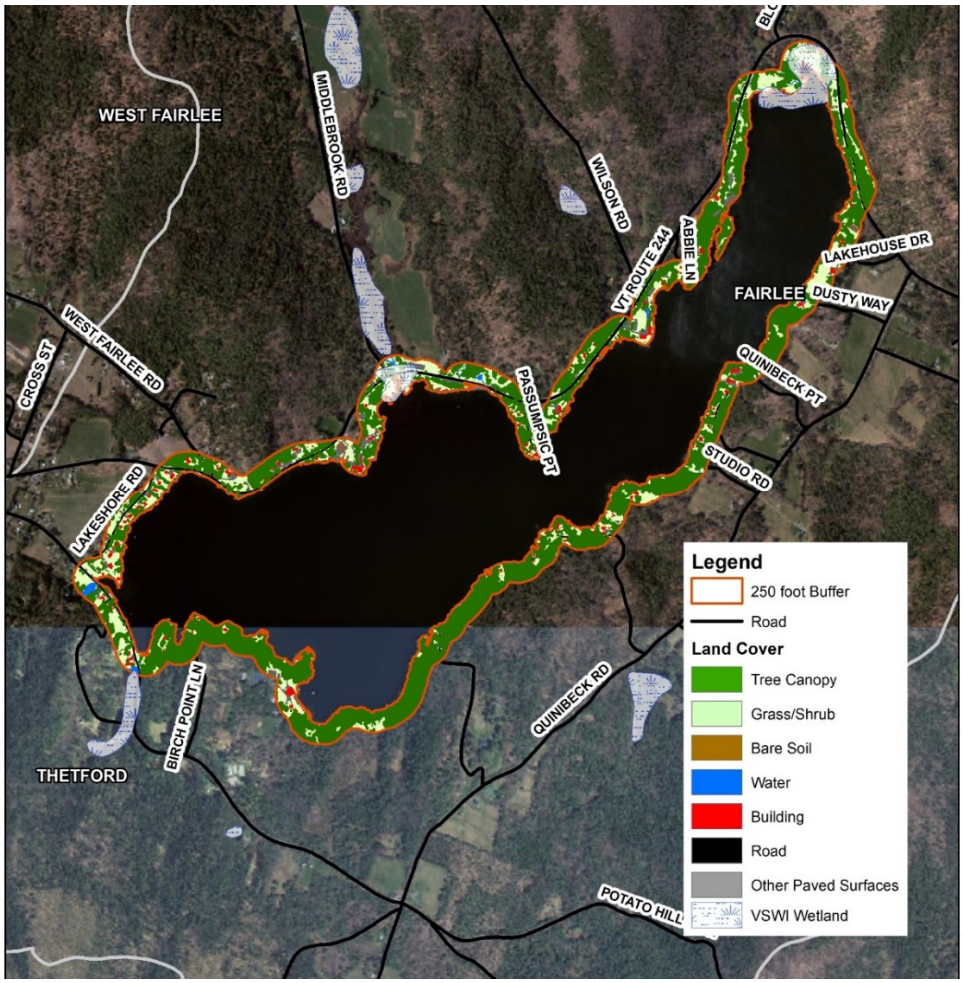


Figure 2. Lake Fairlee Land Cover Data within 250-Buffer Around Lake (UVM Land Cover 2016)

50 foot Buffer

An analysis was completed using geographic information system (GIS) software to identify parcels that have more than 50 percent grass within the 50-foot buffer adjacent to Lake Fairlee. A 50-foot buffer was determined to be important, as that is the minimum width, which is expected to effectively treat stormwater runoff and protect water quality (Vermont DEC, LakeWise Info Sheet: Lakeshore Buffers). The UVM land cover dataset from 2016 was once again used for the analysis. The grass/shrub category was first split into areas of grass and shrubs based on orthophotos. Areas in wetlands were classified as shrub rather than grass.

Based on the GIS analysis, the total area of the 50-foot buffer around the lake is 45.5 acres and this includes 102 parcels. The GIS analysis was intended to assist in prioritizing lakeshore properties for riparian planting projects using the following prioritization scheme:

- **Highest priority**– Residential parcels with more than 75% grass in the 50-foot buffer are highest priority for buffer plantings within the lakeshore.

- **Moderate priority** - Parcels with 50 to 75% grass in the 50-foot buffer are moderate priority for buffer plantings adjacent to Lake Fairlee.

- **Lower priority -**Parcels with 25 to 50% grass in the 50-foot buffer are lower priority for buffer plantings, but buffer enhancement would contribute to the overall health of the lake.

The GIS analysis at this micro scale was problematic, as the parcel boundaries did not match up with the edge of the Lake. In some instances, there was a vegetated buffer of 50 feet along the Lake that was beyond the parcel boundaries, and in other instances the parcel boundaries matched up with the edge of the Lake, but didn't accurately reflect land cover within the 50-foot buffer. This points to the importance of securing additional funding to conduct on the ground lake assessments through the LakeWise program. Riparian buffer planting projects identified through LakeWise are considered high priority for funding.

Wetlands

Wetlands adjacent to inlet streams and within the Lakeshore provide many natural functions including filtration of runoff, habitat for aquatic and terrestrial species, flood protection, shoreline erosion control, recreation, and aesthetics. Wetlands are prevalent along the major inlet streams (Middle Brook and Blood Brook) and at the northern end of Lake Fairlee (Appendix A, page 3). The protection of these wetlands is vital for protecting lake health.

4.0 WATERSHED DATA LIBRARY

An important part of the LWAP planning process is the compilation and review of existing data for a lake and its watershed. Bear Creek Environmental reviewed existing water quality, biological, road inventory, stream geomorphic assessment, geospatial data, and more as part of the digital library creation. The library is contained in a Microsoft Excel workbook titled "Lake Fairlee_LWAP_DigitalLibruary_030722_compressed.xlsx". Many of the maps in the Excel file have been reproduced in pdf format and are contained in Appendix A. A summary of the library is included below.

- Municipal Roads General Permit Road Erosion Inventory data
- Phase 2 Stream Geomorphic Assessment – tributaries
- Geospatial (GIS) data – surface waters, roads, land cover, development, wetlands, water quality monitoring sites
- Water chemistry monitoring – Lake Fairlee inlet streams
- Biomonitoring
- Lake Scorecard

Municipal Road Inventories

During 2018 through 2021, Two Rivers-Ottauquechee Regional Commission conducted road erosion inventories for the towns of Fairlee, Thetford, and West Fairlee. These inventories followed the protocols set forth by the Vermont Department of Environmental Conservation Watershed Management Division titled "Municipal Roads General Permit (MRGP)-

Road Erosion Inventory (REI)". Roads inventoried included the town road systems. Road segments were assigned scores of "Meets", "Partially Meets", or "Does Not Meet" the MRGP.

Of all segments included in the assessment, only three were assigned the "Does Not Meet" score (Appendix A, page 4). Two of these segments were located on Bear Notch Road in Fairlee and one was on Quinibeck Road in Thetford. The majority of road segments were assigned to the "Fully Meets" category, and a handful "Partially Meets".

Stream Geomorphic Assessment

During 2010, a Phase 2 Stream Geomorphic Assessment was completed for two streams within the Lake Fairlee watershed, Blood Brook and Middle Brook. A total of 3.3 miles on Blood Brook and 2.7 miles on Middle Brook were included, as well as reaches below the outlet of Lake Fairlee. Both tributaries were found to be part of large wetland complexes upstream of the lake. The stream reaches assessed on Blood Brook were found to be in fair to good condition for both habitat and geomorphic characteristics. Major impacts noted included lacking riparian buffers, streambank instability and loss of vegetation due to the presence of livestock, historic channel straightening and armoring, and invasive plant species on the banks and in the buffer. The lowest section of Middle Brook was found to be heavily influenced by beaver activity as the brook flows through a large wetland complex. Upstream of this area, the brook flows through agricultural lands, above which a dam creates Middle Brook Pond. Major stressors noted from assessment of Middle Brook included impacts to buffers due to adjacent agricultural lands and historic straightening. Habitat condition was noted as fair to good and geomorphic condition was fair for all reaches assessed on Middle Brook.

River Corridor Plan

Bear Creek Environmental authored a river corridor plan in 2011 that includes the Blood Brook and Middle Brook assessment data. The plan also identifies potential projects to restore and protect these streams. Potential projects identified for Blood Brook included river corridor easements, livestock exclusion, stream cleanup, culvert replacement, arresting headcuts

(incision), and riparian buffer plantings. Opportunities identified on Middle Brook included river corridor easements, riparian buffer plantings, culvert replacement, and dam removal.

Water Quality Data

Water chemistry data found on the Vermont Integrated Watershed Information System (IWIS) were reviewed by Bear Creek Environmental to understand possible phosphorus loading to Lake Fairlee from inlet tributaries. Water quality monitoring by the lay monitoring programs has taken place during the summer months for the past three years. Based on information provided by the Vermont Department of Environmental Conservation (VTDEC), five of the inlet streams (Blood Brook, Lochearn Creek, Middle Brook, Norway Creek, and Route 244 Tributary) were sampled near their mouth for total phosphorus in 2020. Grab water chemistry sampling took place on five dates during summer 2020. In addition, Blood Brook and Middle Brook, the major inlet streams were sampled in 2021 and 2022. Samples have been collected by Dale Gephart of the Lake Fairlee Association. A map of the water quality stations is provided on page 5 of Appendix A.

2020 Results: The results of the 2020 water quality monitoring of the five inlet streams are provided in Figure 3. The total phosphorus concentrations were compared to the Vermont Water Quality Standard of 15 µg/L for medium high gradient streams (MHG). Blood Brook, Middle Brook and Norway Creek had reported total phosphorus concentrations of greater than 15 µg/L on all five sampling dates. The total phosphorus concentration for Lochearn Creek and the Route 244 tributary did not exceed 15 ug/L on any of the five sampling dates. Samples were collected under low flow conditions; however, no flow data are available for those sampling dates. Therefore, the water quality data could be used to screen for elevated concentrations in the grab samples during the summer, but could not be used to understand the loading of phosphorus to the lake from the inlet tributaries.

The water quality data can be viewed at:

https://app.powerbigov.us/view?r=eyJrIjoiZjVmOTdlM2EtOTk1OC00NTU4LWJiYWQtNGU0MmZkYmI5ZDc3IiwidCI6IjIwYjQ5MzNiLWJhYWQtNDMzYy05YzAyLTcwZWRjYzc1NTljNiJ9

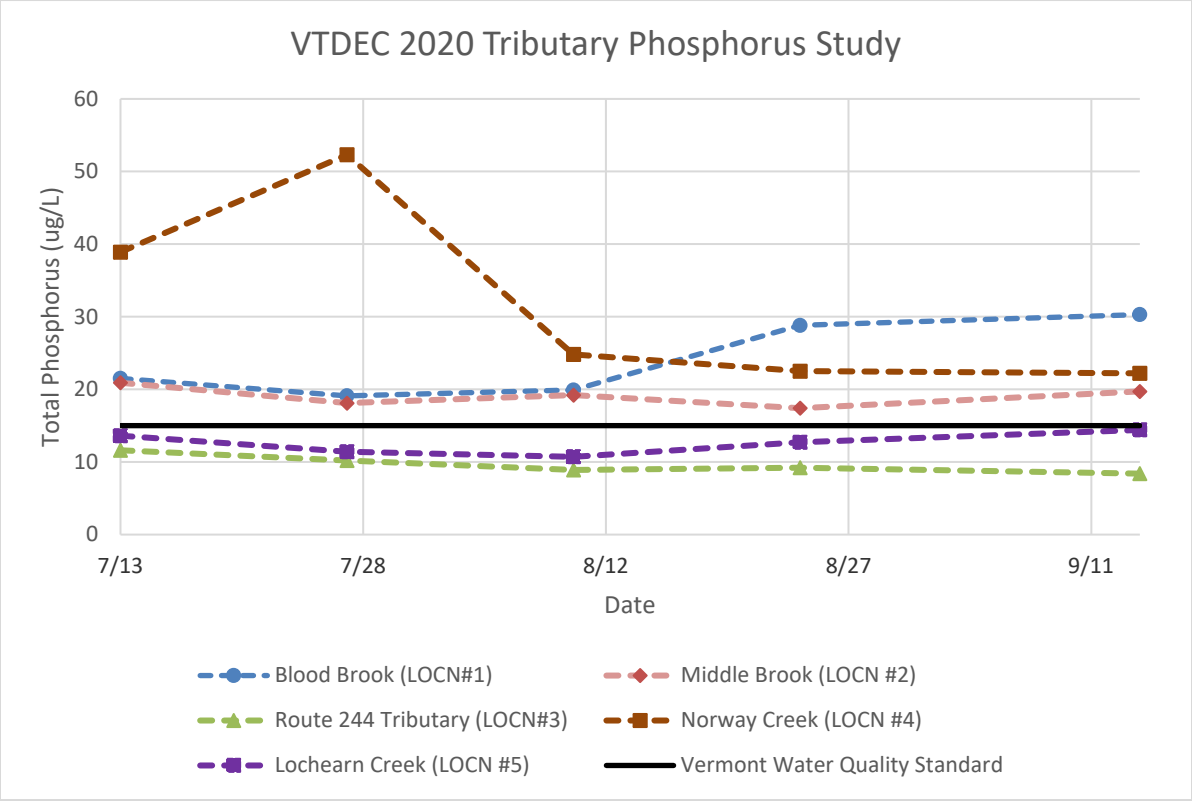


Figure 3. 2020 Water Quality Phosphorus Results for Five Inlet Streams

Water quality stations on the main inlet streams to Lake Fairlee (Blood Brook and Middle Brook) have been sampled by members of the Lake Fairlee Association and have been analyzed at the State LaRosa Laboratory (VT DEC 2022b). Samples in 2021 were analyzed for total phosphorus, total nitrogen, and chloride. In 2022, samples were generally only analyzed for total phosphorus. Sampling in 2021 took place eight times between mid-May and mid-August. In 2022, sampling took place ten times, starting in late April and going through late July.

The stream sampling stations are intended to bracket different potential impacts and to understand total phosphorus levels prior to flowing into the lake. Four sampling stations (from upstream to downstream) are located on **Blood Brook**:

- Brushwood – baseline near headwaters
- Godfrey – bracketing of agriculture
- Marsh Hill (added in 2022) – bracketing of agriculture

- King Hill – at inlet to Lake

Four sampling locations (from upstream to downstream) are located on **Middle Brook**:

- Scrutton Hill: baseline near headwaters
- Upper Middle Pond Brook (sampled in 2022)
- Lower Middle Pond Brook (sampled in 2022)
- Route 244 – at inlet to Lake

2021 Results: The 2021 Middle Brook and Blood Brook total phosphorus results are provided below in Figures 4 and 5. Based on information provided by VTDEC, samples were collected under baseflow conditions with the exception of the samples from July 20 and August 2, which were collected during a rain (freshet) event. For Middle Brook, the station at the lake inlet had noticeably higher total phosphorus concentrations than the upper station in the headwaters. All of the concentrations at the mouth of Middle Brook were at or above the VWQS of 15 µg/L, indicating there are sources of phosphorus between the two monitoring stations. On Blood Brook, total phosphorus concentrations were below the VWQS of 15 µg/L on all sampling dates with the exception of the two freshet events on July 20 and August 2 (circled in Figures 4 and 5).

2022 Results: The 2022 water quality data clearly illustrate that the mainstem tributaries are a source of phosphorus to the lake during freshet events (circled in Figure 6). Total phosphorus concentrations were at or above the VWQS of 15 µg/L on the June 1 and June 27 sampling dates. Blood Brook at King Road, located near the inlet of the Lake, had the highest concentration (82.9 µg/L).

Biomonitoring: Macroinvertebrate kick net sampling has been conducted by the VTDEC in the headwaters of Middle Brook on two occasions, September 2012 and September 2017. On both sampling dates, the community assessment was excellent.

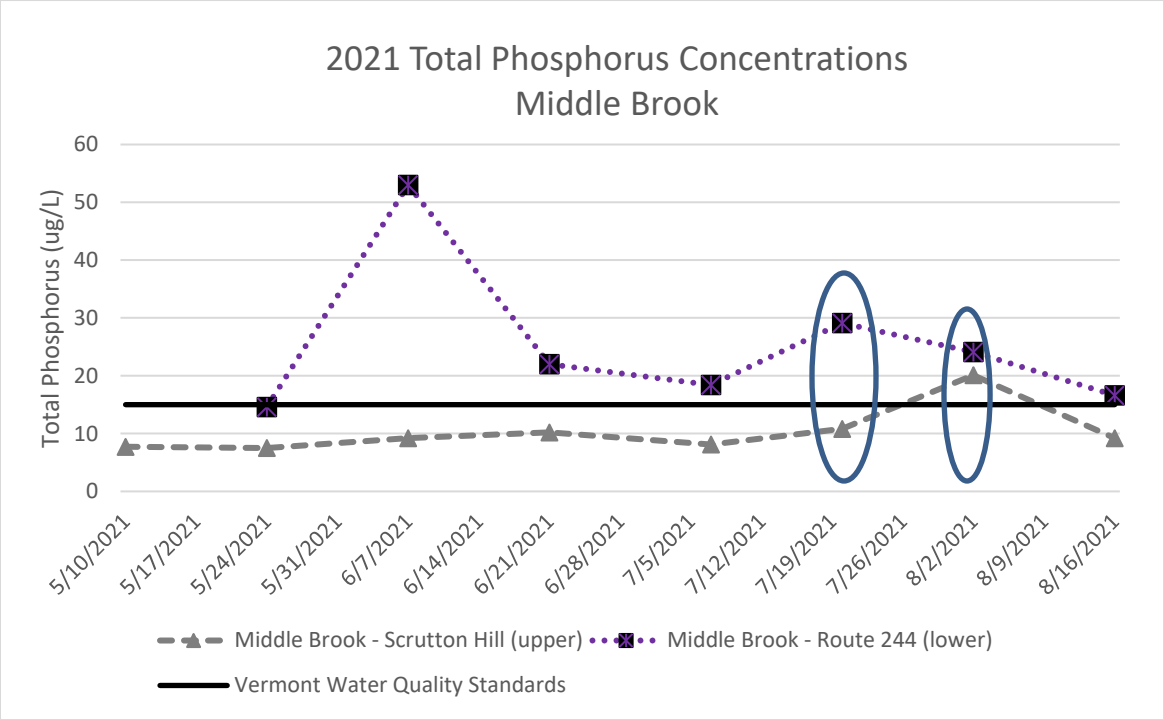


Figure 4. 2021 Total Phosphorus Concentrations on Middle Brook

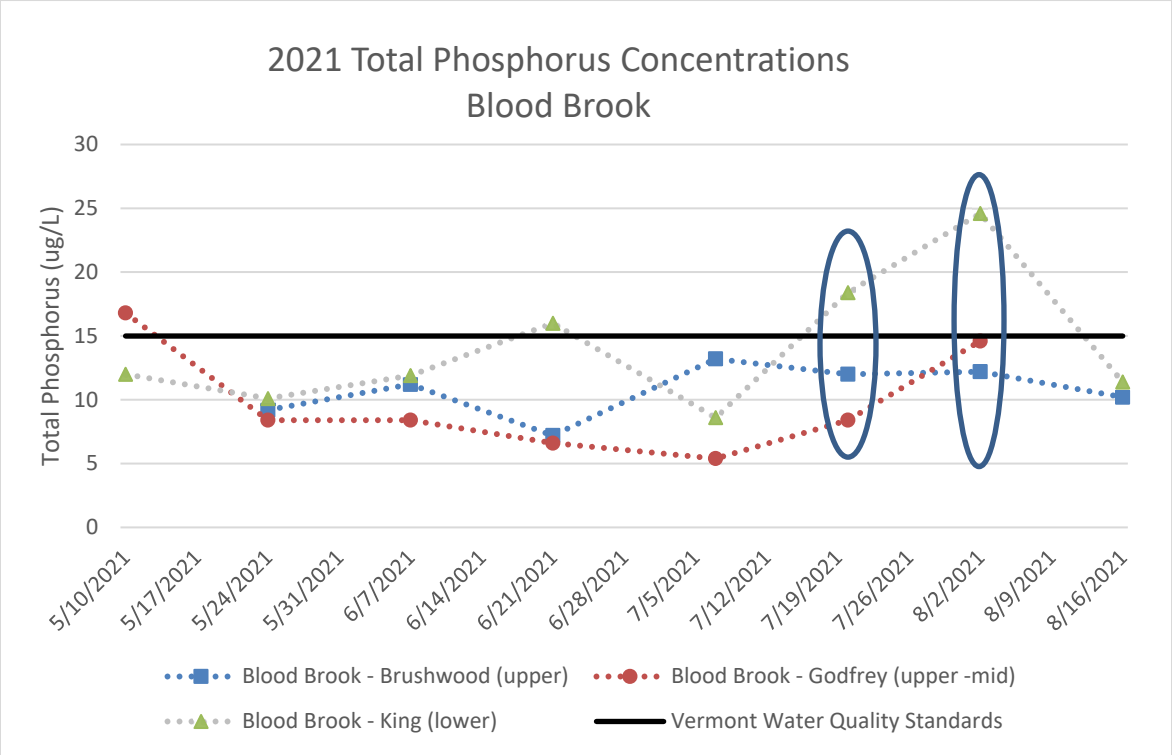


Figure 5. 2021 Total Phosphorus Concentrations on Blood Brook

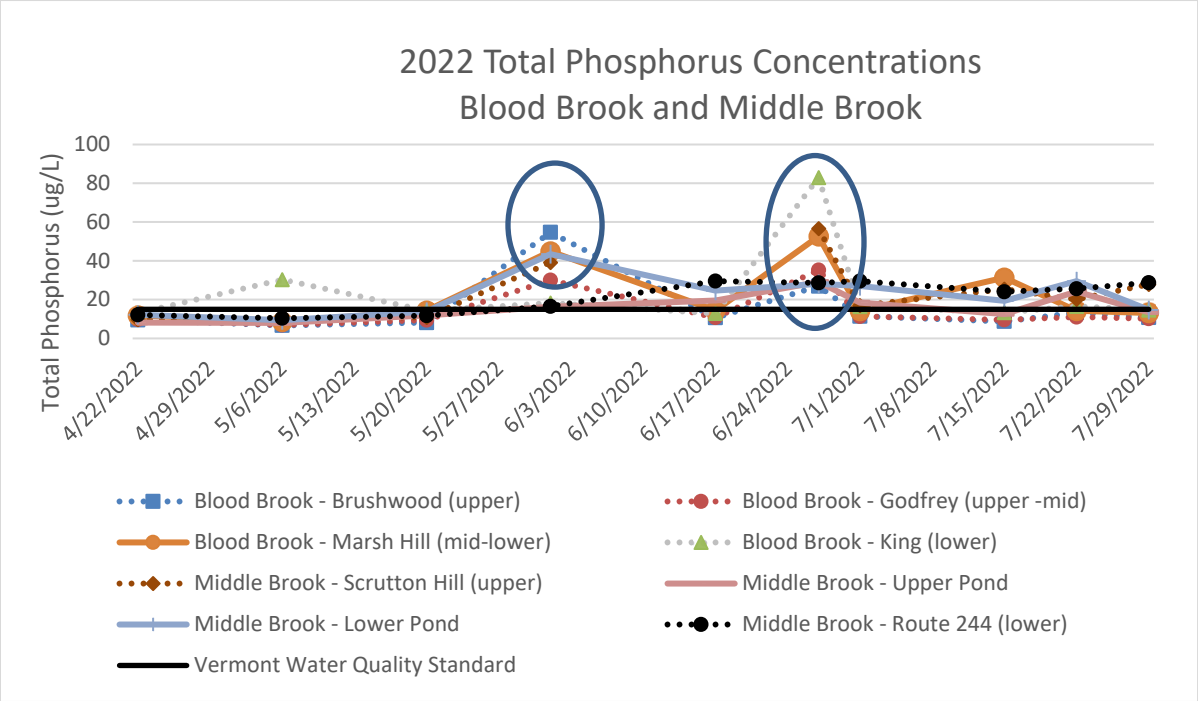


Figure 6. 2021 Total Phosphorus Concentrations on Blood Brook

Lake Scorecard

The VTDEC provides a score card (Figure 7) to assess the health of lakes in Vermont and to answer the question "how is the lake doing". More information about the score card can be found at https://anrweb.vt.gov/PubDocs/DEC/WSMD/Lakes/Lake_Score_Cards/FAIRLEE.HTML

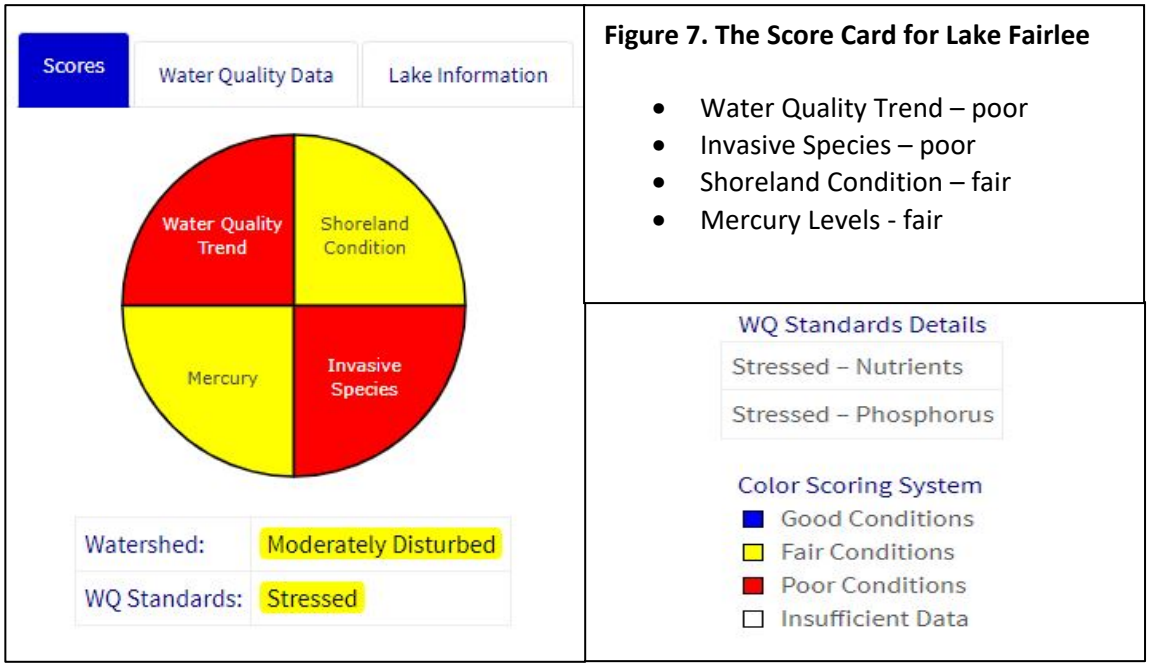


Figure 7. The Score Card for Lake Fairlee

- Water Quality Trend – poor
- Invasive Species – poor
- Shoreland Condition – fair
- Mercury Levels - fair

5.0 ASSESSMENTS

Three sectors (lakeshore, streams, and roads) were assessed to identify water quality problem areas. Problem summary sheets were developed to compile the information from the lakeshore, stream and road assessments. The summary sheets include the following:

- Project Name
- Level of Landowner Commitment
- Site Location and Locator Map
- Site Description and Design Considerations
- Permitting Needs
- Cost Estimate Range
- Restoration/Water Quality Improvement Objectives

5.1 Lakeshore Assessments

Members of the Lake Fairlee Association (LFA) toured the lake shoreline with White River Conservation District (WRNRCD), Bear Creek Environmental (BCE), and Ripple Natural Resources (RNR) on June 16, 2022. During the boat trip, the LFA shared their knowledge of the lake community. BCE returned to several areas of concern that were identified during the tour to investigate the source of sediment or other issues.

Over the summer of 2022, WRNRCD carried out 18 LakeWise assessments covering 37% of the shoreline of Lake Fairlee (Figure 8). Following these visits, eleven properties were awarded the Lakewise designation. Review of the assessment reports identified several projects with a high level of landowner interest. The summer camps and public areas receive very high use during the summer months and are often the largest waterfront properties. For these reasons these projects received the greatest focus.

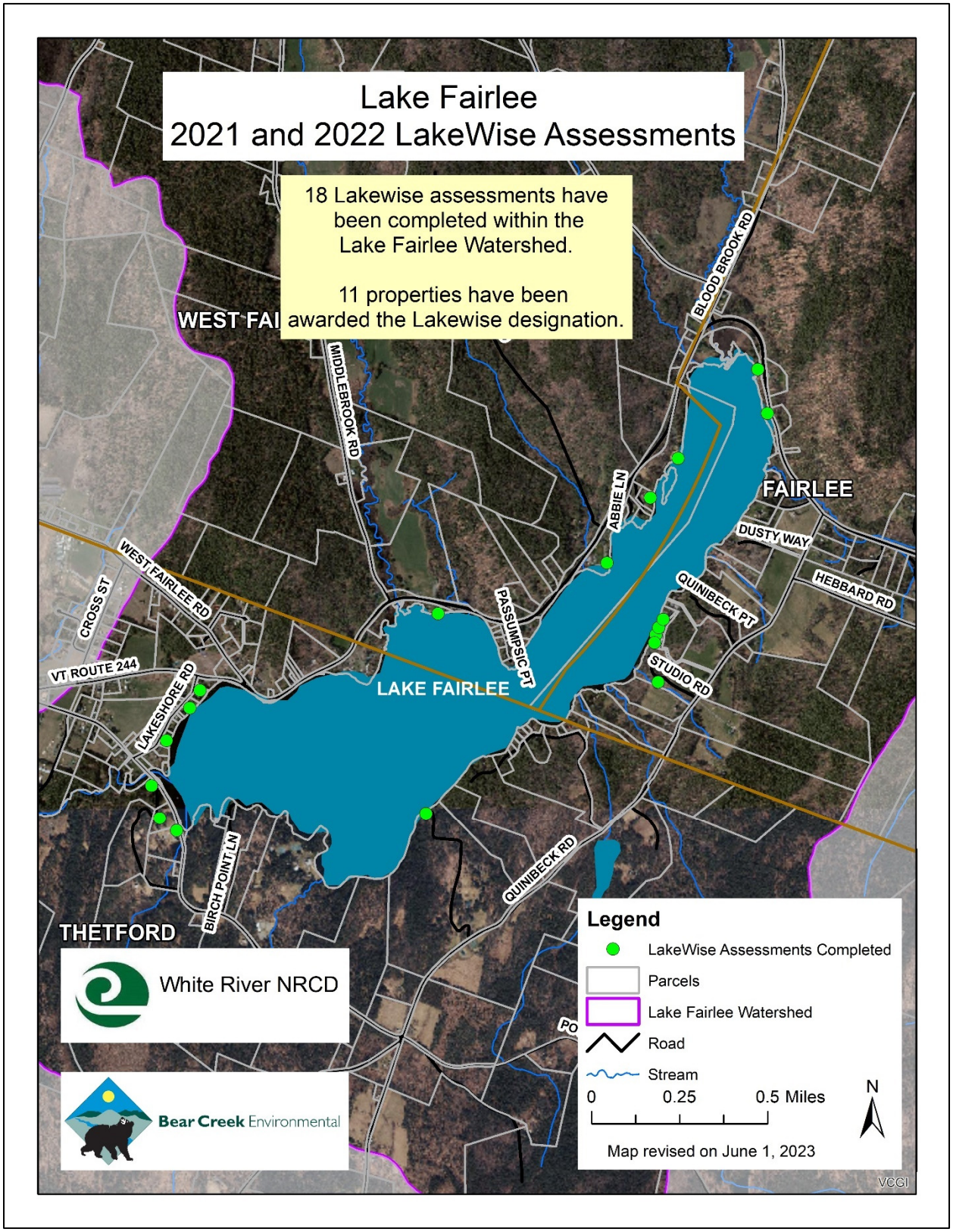


Figure 8. LakeWise Assessment Completed in Lake Fairlee Watershed 2021-2022.

5.2 Stream Assessments

Target Streams

The two major inlet streams to Lake Fairlee, Blood Brook and Middle Brook, were selected for the stream assessment component of the Lake Watershed Action Plan (LWAP). The stream length selected included 3.3 miles on Blood Brook and 2.7 miles on Middle Brook, for a total of 6.0 stream miles (Figure 9). These stream reaches were previously assessed as part of a stream geomorphic assessment conducted by Bear Creek Environmental, LLC during 2010 within the Towns of West Fairlee and Thetford. Blood Brook and Middle Brook contribute approximately 73 percent of the watershed area of Lake Fairlee and are the major streams within the watershed. This approach to assessing the two major tributaries to Lake Fairlee for the LWAP was discussed and agreed to at the Lake Fairlee LWAP project kick off meeting in November 2021.

There are twelve inlet streams to Lake Fairlee and the watershed contribution of each stream is provided in Table 4. The streams are listed in order from northeast of the Lake Fairlee outlet going in a clockwise direction around the Lake. StreamStats, a tool provided by the United States Geological Survey (USGS), was used to calculate drainage areas of each of the inlet streams and outlet of Lake Fairlee. The drainage area at the Lake Fairlee outlet is approximately 20.3 square miles. The watershed area of the twelve inlet streams sum to 18.6 square miles. This leaves about 1.7 square miles of watershed area that in not accounted for by the inlet streams.

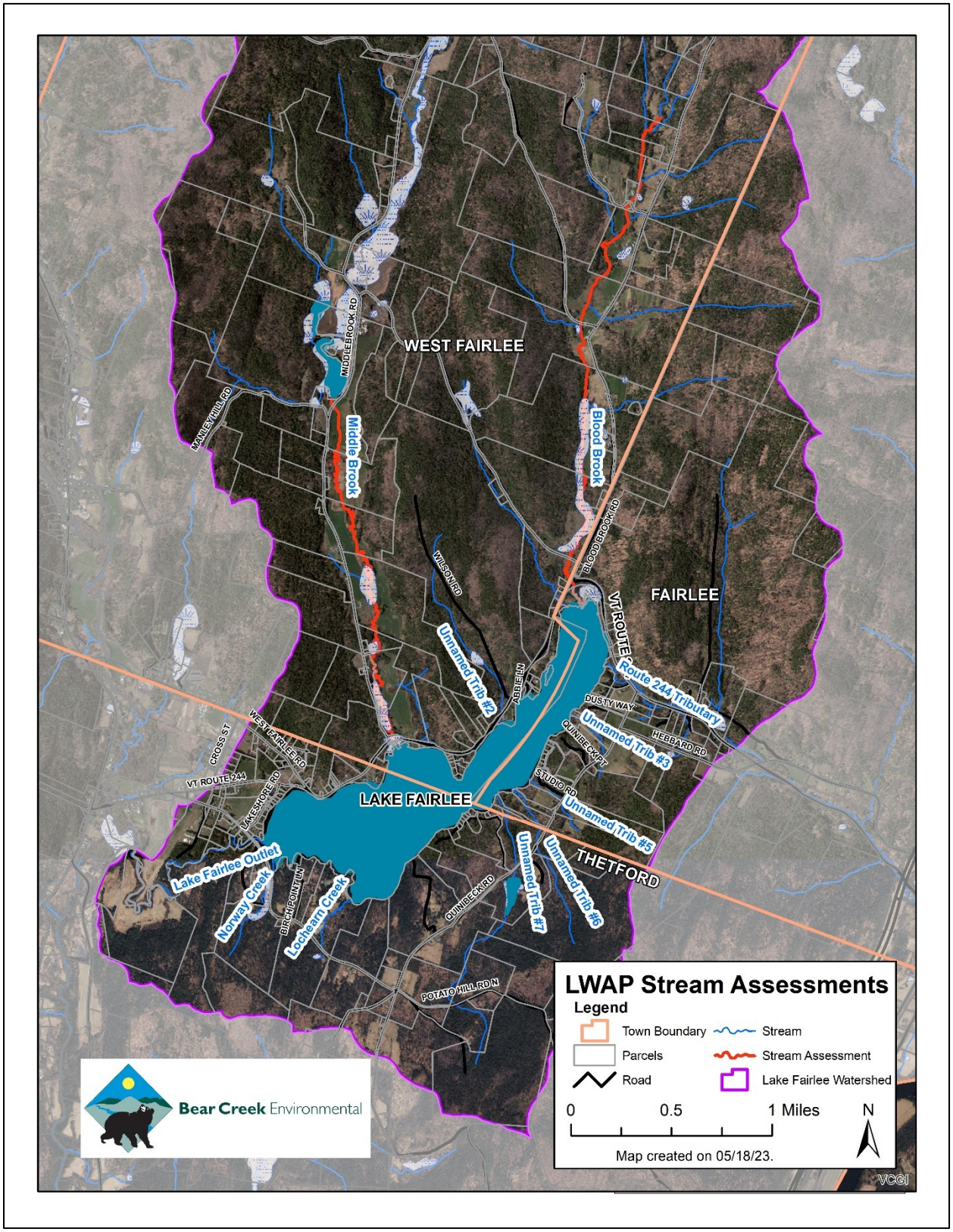


Figure 9. LWAP Stream Assessment Reaches and Major Tributaries

Table 4. Watershed Area Contribution of Inlet Streams to Lake Fairlee		
Inlet Stream Name	**Watershed Area (Sq. Mi.)**	**Percent Watershed Contribution**
Unnamed Tributary #1[1]	0.07	0.4%
Middle Brook	10.6	52.2%
Unnamed Tributary #2	0.32	1.6%
Blood Brook[2]	4.2	20.5%
Route 244 Tributary	1.4	7.0%
Unnamed Tributary #3	0.13	0.6%
Unnamed Tributary #4	0.08	0.4%
Unnamed Tributary #5	0.06	0.3%
Unnamed Tributary #6	0.26	1.3%
Unnamed Tributary #7	0.84	4.1%
Lochearn Creek	0.35	1.7%
Norway Brook	0.30	1.5%

Landowner Outreach

During May 2022, the White River Natural Resources Conservation District and Bear Creek Environmental, LLC mailed out post cards and letters to riparian landowners with property on the assessment reaches to provide information about the upcoming stream walks. Twenty-four landowners were contacted as part of this process. Two landowners within the study area mailed back post cards with their contact information and one landowner called Bear Creek Environmental to obtain additional information. No landowners within the target assessment reaches declined access.

Stream Walks

Blood Brook and Middle Brook: During the stream walks of Blood Brook and Middle Brook, which took place during mid-October 2022, points were collected with a handheld global positioning system (gps) unit to assist with project identification. Features, such as, bank erosion, areas with buffers less than 25 feet, culverts, ledge grade controls, and bridges and culverts were mapped in the field. The stream centerline was also mapped in locations where it was considerably different than the *Vermont Hydrography Dataset (i.e., Vermont stream layer)*.

[1] Unnamed tributaries 1 and 4 are not included in the Vermont Hydrography Dataset (VHD).
[2] The Vermont Hydrography Dataset (VHD) shows the tributary, which flows adjacent to King Hill Road, entering Lake Fairlee directly, while StreamStats indicates that tributary flows into Blood Brook upstream of Route 244. The watershed area of the unnamed tributary that is adjacent to King Hill Road has been included in the drainage area of Blood Brook.

Route 244 and Unnamed Tributary #7: In response to observations of sediment, a reconnaissance of two additional tributaries (Route 244 Tributary and Unnamed Tributary #7) took place during fall 2022.

- Route 244 Tributary: Sediment at the outlet of the Route 244 Tributary was noted during a boat tour of Lake Fairlee in June 2022. The Route 244 Tributary from the Route 244 crossing to the mouth of the stream was walked to investigate the source of sediment. No obvious problems were noted that could be remediated through a stream restoration/improvement project. Below the Route 244 crossing, the stream flows through a wetland and is *aggrading (i.e., filling in with sediment)*.

- Unnamed Tributary #7: During the road assessment of Quinibeck Road, sediment was noted in Unnamed Tributary #7, near the Potato Hill Road crossing. The source of the sediment was investigated by walking upstream of the stream crossing. The stream is braided in that location and considerable mobilized sediment was noted in the channel. The source of the sediment could not be determined.

It is recommended that additional funding be secured to assess additional inlet streams to Lake Fairlee, including the Route 244 Tributary and Unnamed Tributary #7.

5.3 Road Erosion Surveys

Study Area

A radius of one mile was buffered around Lake Fairlee to create a study area for road assessments (Figure 10). Municipal roads or state roads that were within this one-mile radius and appeared to be hydrologically connected to the lake were assessed. Anna Dodge Road, a private road, was included in the road assessment due to the concentration of homeowners on this road, who participated in the LakeWise program.

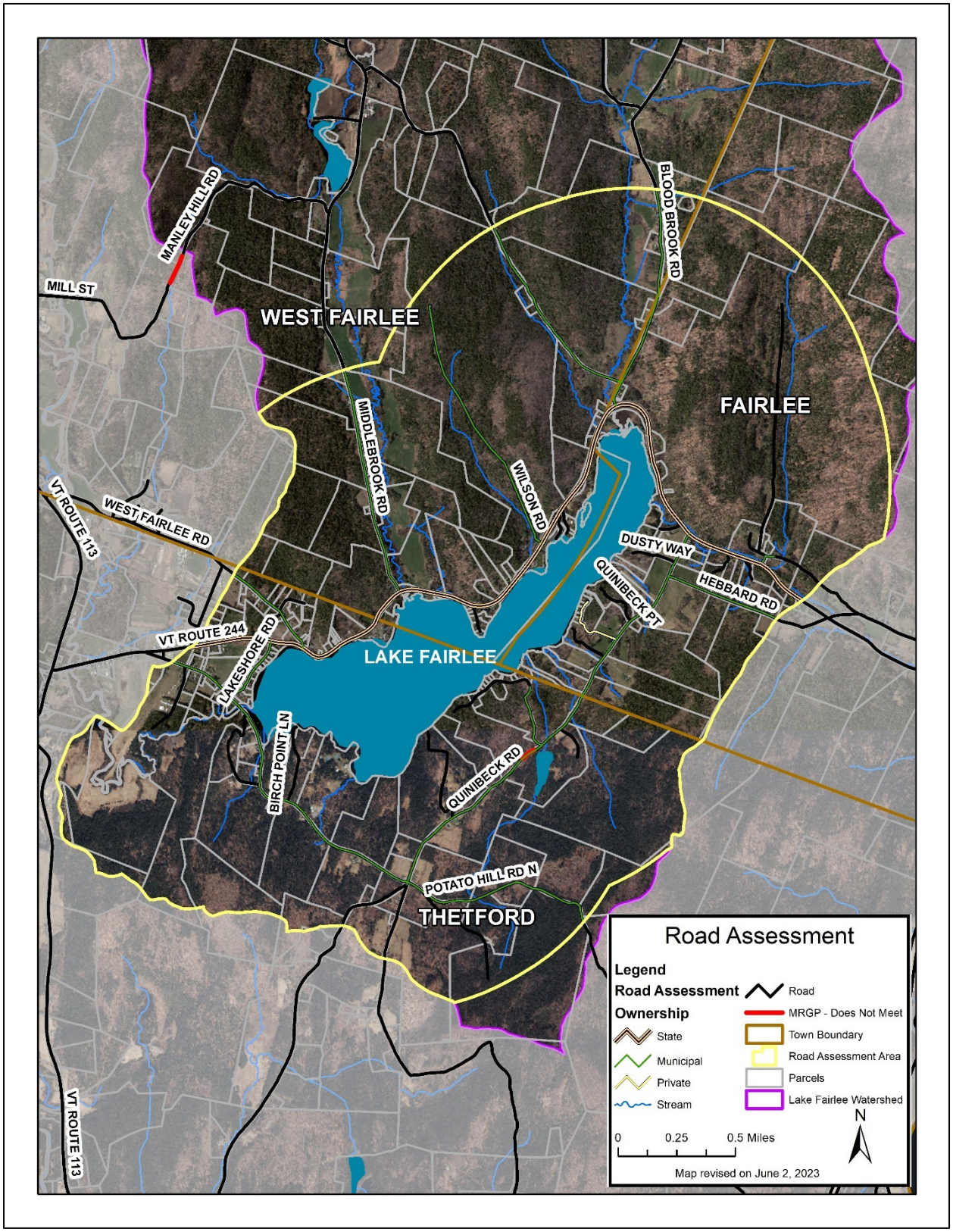


Figure 10. LWAP Road Assessment Study Area

Methodology

Hydrologically connected road segments were considered ones that were adjacent to Lake Fairlee or on roads with crossings on inlet streams. The existing MRGP data set was reviewed as a starting point to identify road problem areas. The MRGP data set only included one road segment within the one-mile study area with "Does Not Meet" the standards, and it appeared that this methodology was not fully capturing problem areas. For this reason, a more targeted approach to identifying sources of sediment and phosphorus was utilized. This included walking and or driving the road reach with a careful eye to where sediment from the road had the potential to enter either an inlet stream or the lake itself. Notes from a boat tour conducted in June 2022 was also used to identify delta bars at the mouth of the inlet streams, and where sediment/phosphorus could be potentially entering the lake.

6.0 PROJECT IDENTIFICATION

Information from the lakeshore, stream and road assessments was used to identify potential projects.

6.1 Lakeshore Project Identification

Eight lakeshore problem areas (Appendix B) were identified in the fall of 2022 using information from the boat tour, the LakeWise Assessments and additional site visits. A supplemental project at the Treasure Island parking lot was later added to the initial group of lakeshore projects. Lakeshore projects fall under three main categories: Stormwater Improvement, Buffer Improvement, and Retaining Walls.

Lakeshore projects offer many benefits. Stormwater improvement projects help by improving infiltration of runoff, which reduces erosion and decreases phosphorus and sediment loading to the lake. Lakeshore buffer planting projects stabilize the soil and provide for vegetation that takes up phosphorus and reduces nutrients loading. The replacement of deteriorated Lakeshore retaining walls with a bioengineered design offer stabilization of the bank with vegetation, filtering of contaminants, reduction in nutrients, shading to reduce thermal

warming, improved terrestrial and aquatic habitat, a greater connection between the littoral zone and land adjacent to the lake, as well as a source of organic matter for aquatic life. The identified lakeshore projects are provided below by category.

Stormwater Improvements:

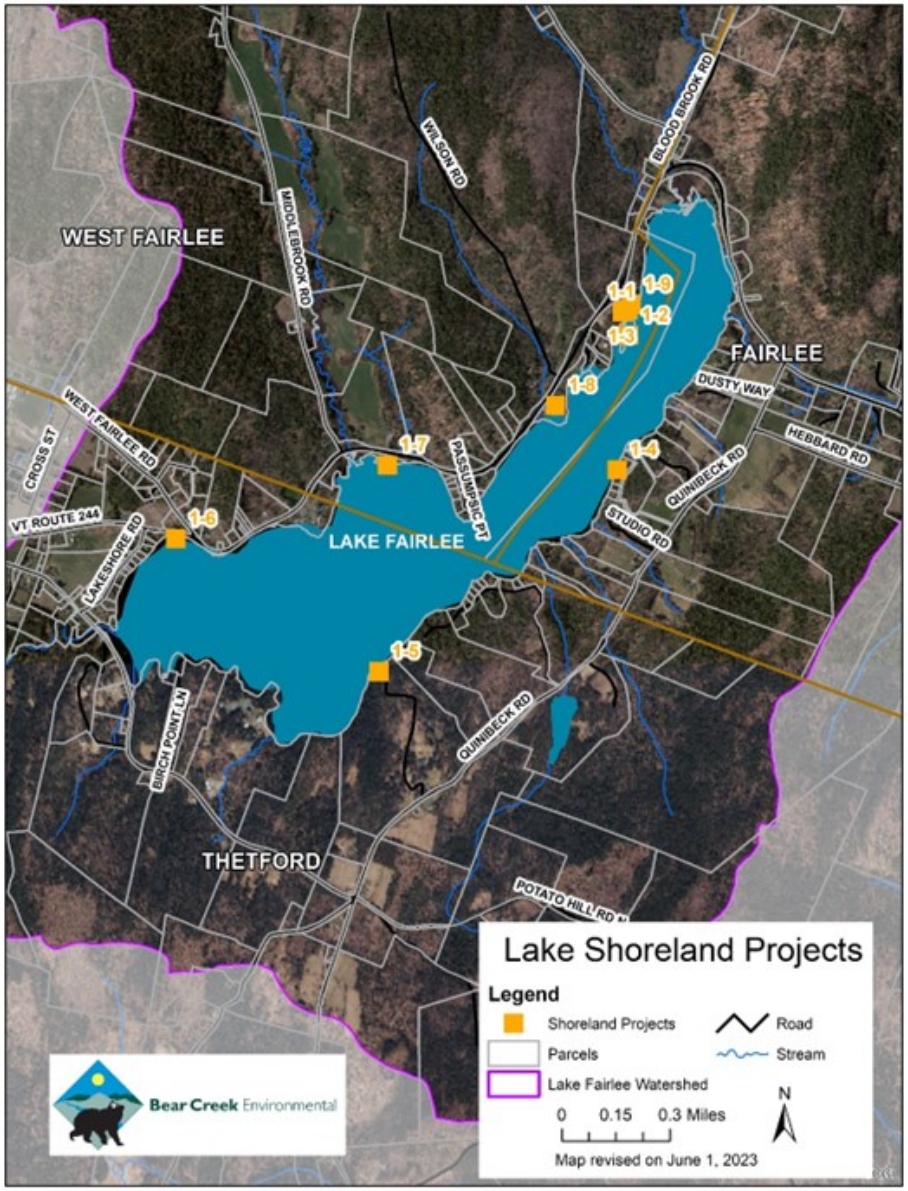
- Project 1-1 – Stabilization of eroding access road at Treasure Island (see 30% conceptual design in Appendix F)
- Project 1-3 – Rain Garden and improved French drain to contain sand on beach and treat runoff at Treasure Island (see 30% conceptual design)
- Project 1-5 – Installation of perforated pipe (French drain) around beachfront to treat runoff and reduce sand reaching Lake Fairlee at Ohana Family Camp (This project has been implemented)
- Project 1-8 – Infiltration steps to reduce erosion in the vicinity of a wash station that is close to the shoreline at Aloha Hive Camp.
- Project 1-9 – Installation or repair of water bars at Treasure Island parking lot to dissipate flow and provide surface infiltration (see 30% conceptual design)

Buffer Improvements:

- Project 1-2 – Widen buffers along lakeshore at Treasure Island
- Project 1-6 – Work with VTrans and possibly private landowners to improve riparian buffers between Route 244 and Lake Fairlee

Lakeshore Retaining Walls:

- Project 1-4 – Replace a deteriorated seawall at a camp off of Anna Dodge Road with a bioengineered solution that offers vegetation (see conceptual design).
- Project 1-7 – Replace deteriorated retaining wall at Horizons Day Camp with a bioengineered solution that offers vegetation (see conceptual design)



Lake Shoreland Projects

- 1-1 Treasure Island Stormwater Improvement of Access Drive
- 1-2 Treasure Island Lakeshore Buffer Improvement
- 1-3 Treasure Island Stormwater Improvement and Sand Containment
- 1-4 Lakeshore Retaining Wall at Private Camp
- 1-5 Beachfront Sand Containment at Ohana Camp
- 1-6 Route 244 Buffer Improvement
- 1-7 Lakeshore Retaining Wall at Horizons Day Camp
- 1-8 Aloha Hive Camp Stormwater Improvement at Wash Station
- 1-9 Treasure Island Stormwater improvement of Parking Area

6.2 Stream Project Identification

Four stream problem areas were identified using information from stream walks that took place during October 2022 (Appendix C). Two of the projects (Projects 2-1 and 2-2) focus on buffer improvement projects on Middle Brook. The other two projects (2-3 and 2-4), located on Blood Brook, involve livestock exclusion to reduce further erosion and increase buffers along the brook. All four of the projects are expected to reduce the amount of sediment reaching Lake Fairlee by providing vegetation to filter stormwater runoff and hold the soil in place.

Livestock Exclusion:

The Pasture and Surface Water Fencing (PSWF) Program (State of Vermont Agency of Food and Markets, 2023) provides financial assistance to Vermont farmers to improve water quality of surface waters through livestock exclusion. Some of the eligible practices are fencing, alternative water sources and stream crossings. A grant award up to $15,000 per farm is available for projects that exclude livestock from surface waters.

Buffer Plantings:

There are a number of programs available for riparian buffer plantings along streams including Trees for Streams and the Conservation Reserve Enhancement Program (CREP). Trees for Streams is a state-wide program that is funded through the Vermont Agency of Natural Resources and is implemented by the Vermont Natural Resources Conservation Districts. CREP is a voluntary program through the Vermont Agency of Agriculture, Food and Markets, which involves removing land from agricultural production and establishing riparian buffers.

6.3 Road Project Identification

Stormwater improvement projects were identified on Robinson Hill Road, Anna Dodge Road, and Quinibeck Road, and Bragg Road (Appendix D). In addition, a buffer improvement project (no mow zone) on Robinson Hill Road was identified, but has already been implemented by community members.

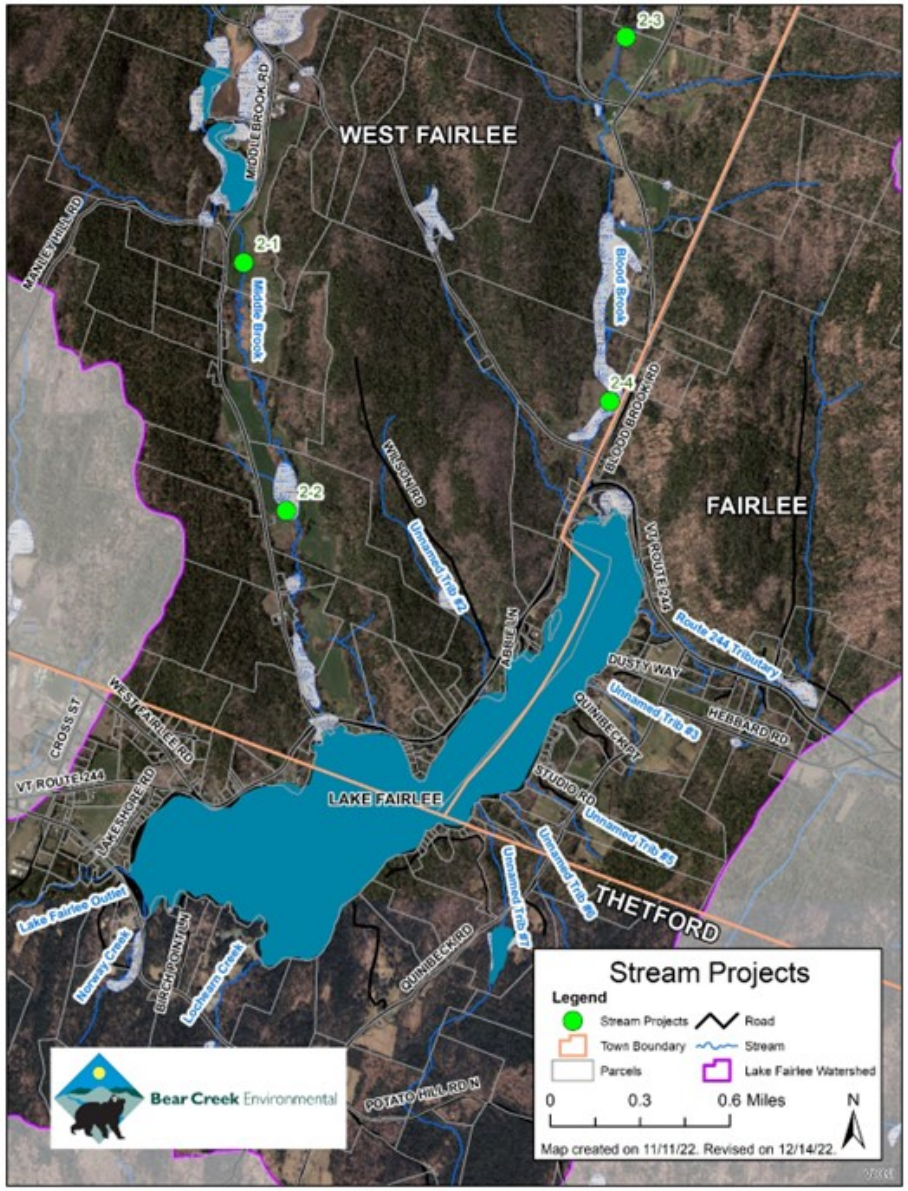
Robinson Hill Road is in close proximity to Lake Fairlee. The road can be muddy during the spring, and was particularly troublesome during the 2022 mud season when residents observed

sediment contribution from the road to Lake Fairlee. There are three primary components to the stormwater improvements on Robinson Hill Road to reduce sediment and phosphorus entering the lake (Projects 3-1 a-c). First, a 650 linear foot paving project is proposed from about 700 feet south of Lakeshore Road intersection (at the end of the existing pavement) to approximately 700 feet southeast of Birch Point Road. Installation of a cross culvert to improve drainage and reduce erosion is proposed in the vicinity of Norway Lane. The Town of Thetford issued a request for bids in 2020 for a more extensive road improvement project that included paving the section of gravel road. According to Bryan Gazda, Town Manager, no bids were received. The third improvement component is a structure to control debris at the outlet of an onstream pond. Conceptual designs for these three alternatives are included in Appendix F.

Anna Dodge Road has a steep section that is just upslope of a culvert that drains to Lake Fairlee. The roadside ditch is currently trapping some sediment where it flattens in slope. However, stormwater improvements are recommended to reduce the amount of sediment and phosphorus reaching Lake Fairlee. There are two possible means for achieving this goal. The preferred solution is to install a cross culvert to break up the runoff and reduce erosive forces. The second option is to install check dams to improve sediment retention. The check dams will require maintenance. The two options for Anna Dodge Road stormwater improvements are included in the conceptual design for project 3-2.

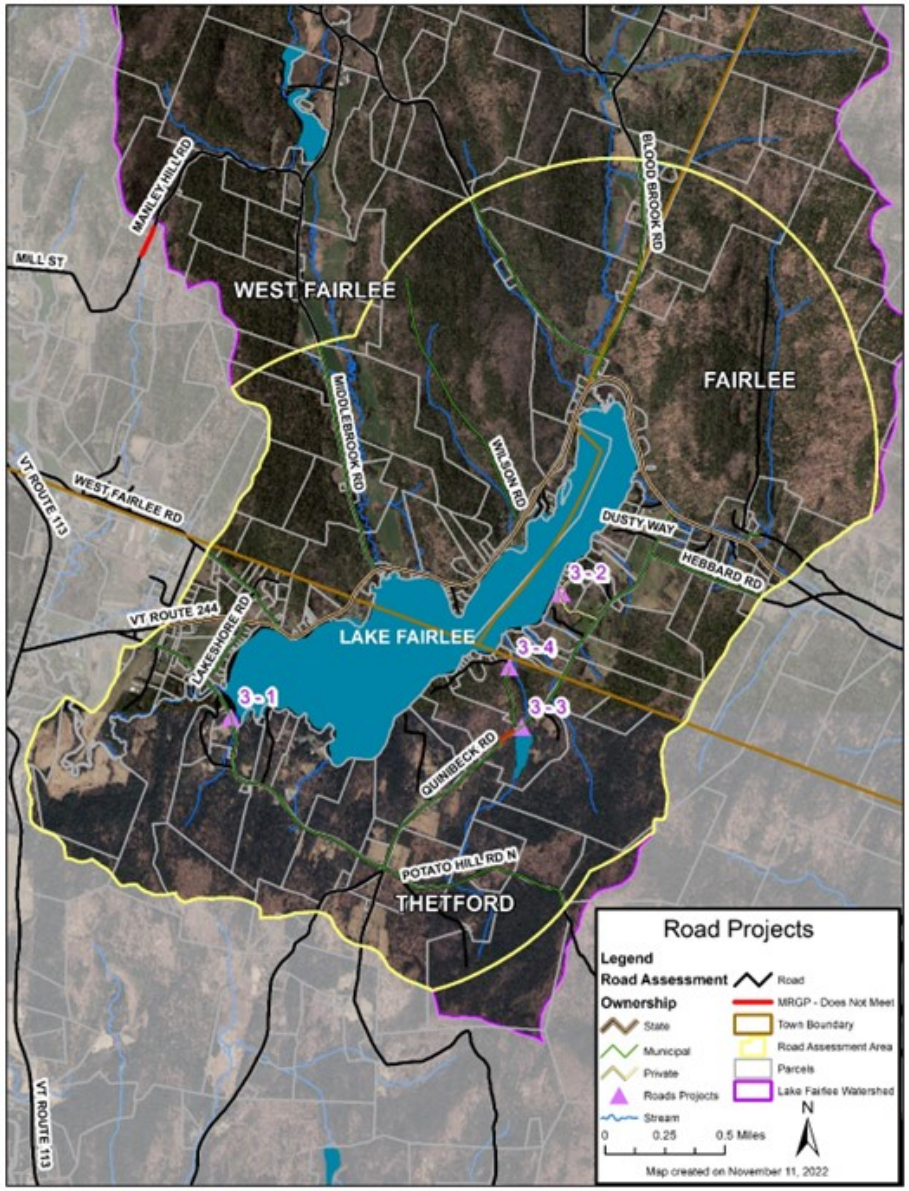
Quinibeck Road has developed berms at the edge of the road from grading operations. The berms have blocked the drainage of water off the road. Poking holes in the berms to provide turn outs is recommended as part of Project 3-3. This will disperse the runoff and reduce erosion.

Bragg Road is steep where the municipal road transitions to a private road. Water is concentrating in drainage ditches and contributing sediment to a nearby stream that drains into Lake Fairlee. A couple of alternatives are included in the conceptual design for project 3-4. These alternatives include installing a cross culvert or excavating a turnout to dissipate runoff and reduce erosion



Stream Projects

- 2-1 Increase buffers along Hayfield
- 2-2 Improve buffer in area with active stream bank erosion
- 2-3 Reduce animal crossings and improve buffers
- 2-4 Livestock exclusion



Road Projects

3-1: Robinson Hill Road

(a) Paving project
(b) Cross culvert to improve drainage
(c) Pond outlet debris control

3-2: Anna Dodge Road

- Install a cross culvert to dissipate runoff or as an alternative install check dams to improve sediment retention

3-3: Quinibeck Road

- Poke holes in berms to provide turn outs. Allows runoff to disperse.

3-4: Bragg Road

- Install a cross culvert or as an alternative excavate a turnout on steep section of road to reduce erosion and sedimentation of nearby stream

7.0 PROJECT PRIORITIZATION

Criteria were developed to prioritize the 20 projects that were identified within the Lake Fairlee watershed. A point system ranging from a score of zero to 3 was assigned to each of five categories. Two of the categories (Improves Water Quality and Cost effectiveness) rely on the use of the VTDEC's phosphorus reduction tool. The criteria are defined on page 1 of Appendix E and are summarized below. Each category was assessed a weighting that totals 100 percent for the five categories.

Five Categories (Score of 0 to 3)

1. **Improves Water Quality** (25%) – based on the amount estimated total phosphorus reduction in kilograms per year (kg/yr).
2. **Landowner Support** (25%) – ranges from lack of interest to having a landowner agreement
3. **Improves or Protects Riparian or Aquatic Habitat** (20%) - ranges from does not improve habitat to significantly improves habitat
4. **Cost Effectiveness** (20%) – based on the total cost, estimated phosphorus reduction and the estimated life span of the project (measured in $/kg/yr).
5. **Other Benefit** (10%) – 1 point per benefit for up to 3 points maximum
    - Improves or protects infrastructure
    - Demonstration project
    - Provides opportunity for education
    - Reduces peak flows and erosion
    - Reduces flooding

A map showing the location of the lake, stream and road projects is provided on page 2 of Appendix E. Information about each of these projects is listed by project number on pages 3 and 4 of Appendix E. First, a score was calculated using the criteria from the five categories listed above. A maximum score of 3 is possible.

Next, the projects were sorted by score from the highest score to the lowest score (pages 5 and 6 of Appendix E). The two lakeshore bioengineering projects, two buffer enhancement projects (adjacent to Robinson Hill Road and Route 244), and the four stream projects, resulted in the highest scores.

8.0 CONCEPTUAL DESIGNS

Ten of the projects were selected for 30% concept designs. Selection was based on the priority rating and written landowner interest. All of the conceptual design projects were rated as either high priority or moderate priority using the scoring criteria.

The conceptual designs were prepared by Ripple Natural Resources, LLC and Bear Creek Environmental, LLC. These designs are provided in Appendix F and include:

- A site plan with existing site features;
- Proposed design elements;
- Typical details for proposed practice;
- A preliminary cost estimate; and
- Expected permits.

The following projects were selected for the 30% conceptual designs:

1. Project 1-1: Treasure Island Stormwater Improvement of the Access Road
2. Project 1-3: Treasure Island French Drain on Beach
3. Project 1-4: Anna Dodge Lane Bioengineered Lakeshore
4. Project 1-7: Horizons Camp Bioengineered Lakeshore
5. Project 1-9: Treasure Island Stormwater Improvement of Parking Lot
6. Project 3-1a: Robinson Hill Road Paving Project
7. Project 3-1b: Robinson Hill Road Cross Culvert
8. Project 3-1c: Robinson Hill Road Pond Outlet Improvement
9. Project 3-2: Anna Dodge Lane Stormwater Improvements
10. Project 3-4: Bragg Road Stormwater Improvements

9.0 NEXT STEPS

The Lake Fairlee LWAP has many stakeholders, and a number of actions are required to implement the Plan. The LFA, WNRCD, and local conservations commissions, the VTDEC, and private landowners are all important partners in continuing outreach and project development within the Lake Fairlee watershed. The next step is to seek grants or other funding opportunities to move preliminary designs toward implementation. This will require collaboration between local organizations and the leveraging of local, state, and federal resources.

Funding for lake shoreland projects is available from the DEC Clean Water Initiative Program. https://dec.vermont.gov/watershed/lakes-ponds/lakeshores-lake-wise/LWAP. Available grant programs include:

- Project Development Block Grant – Funds to develop clean water projects;
- Design/Implementation Block Grant – Pass-through funds for preliminary design, final design, and implementation; and
- Woody Buffer Block Grant – Pass-through funds for design (planting plan) and implementation of native riparian buffers.

Funding for agricultural projects is available from the Vermont Agency of Agriculture. https://agriculture.vermont.gov/grants. Available programs include:

- Agricultural Clean Water Initiative Project – to support the improvement of water quality;
- Technical and financial assistance for improving best management practices on farms;
- Capital Equipment Assistance Program – financial assistance for new or innovative equipment; and
- Conservation Reserve Enhancement Program (CREP) – to improve water quality by removing land from agricultural production and establishing riparian buffers.

It is also recommended that additional funding be secured through Vermont Multi-sector Assessment grant program for further assessment work to identify and prioritize lake stressors and projects to improve lake and stream water quality. Two areas that would benefit from future funding including:

1. Additional LakeWise assessments
2. Walkovers of additional tributaries to identify sources of sediment and nutrients.

Landowners interested in pursuing projects to improve the water quality of Lake Fairlee or who would like to participate in the LakeWise program are encouraged to contact the White River Conservation District.

Lisa Niccolai
Conservation Specialist
White River Conservation District
28 Farmvu Drive
White River Junction, VT 05001
802-222-1293
Lisa.wrnrcd@gmail.com

White River Natural Resources Conservation District

10.0 REFERENCES

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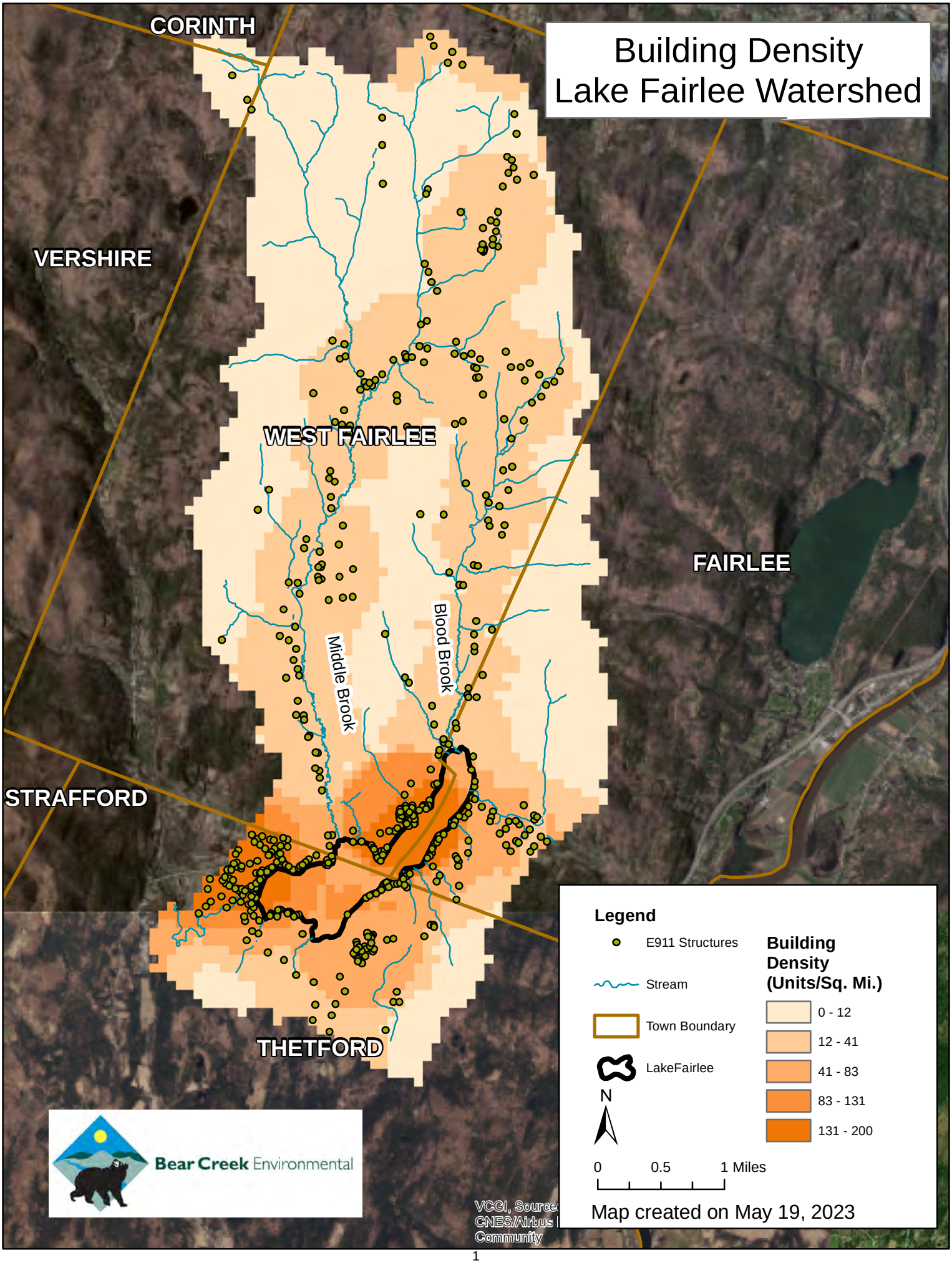
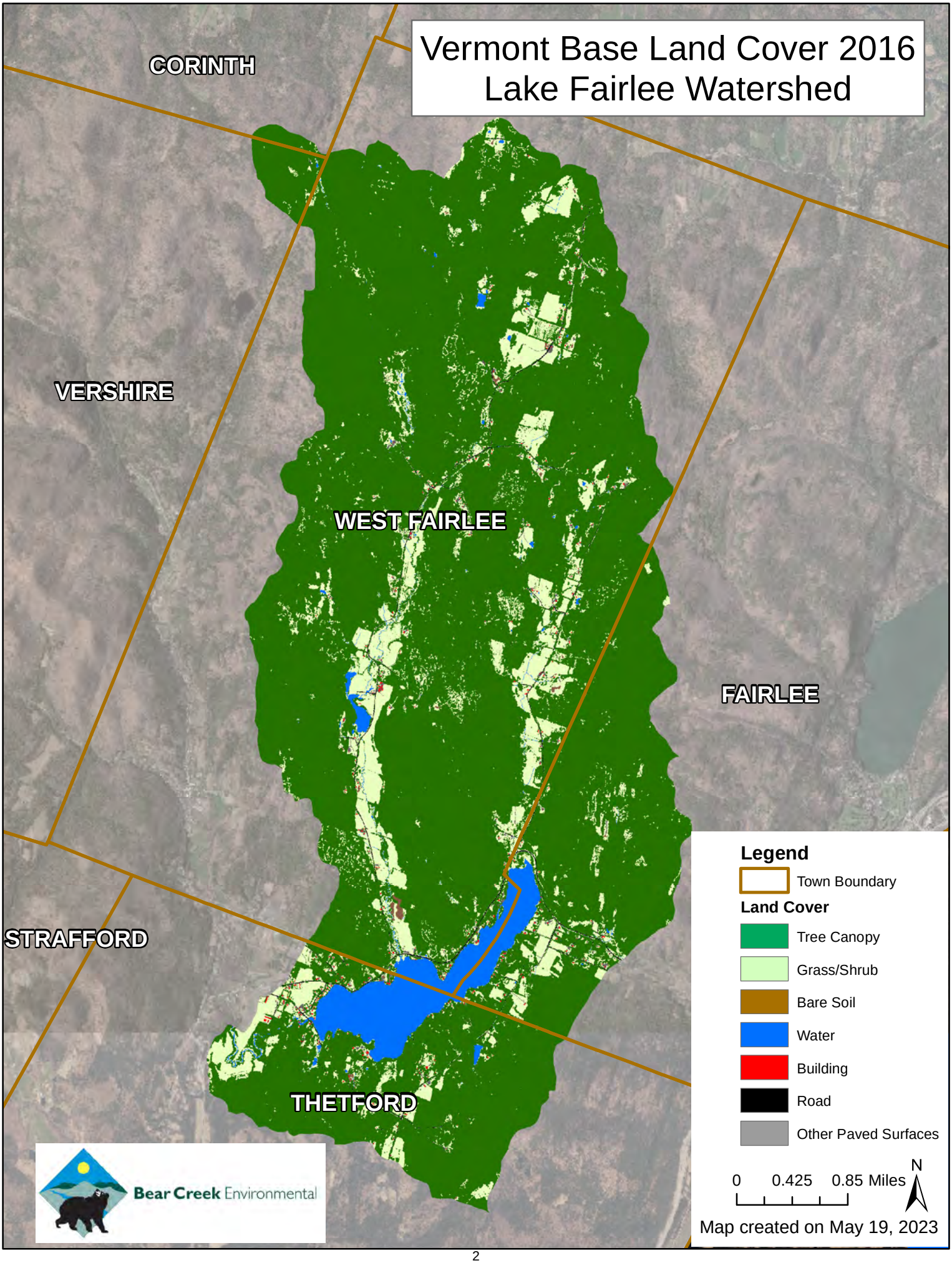
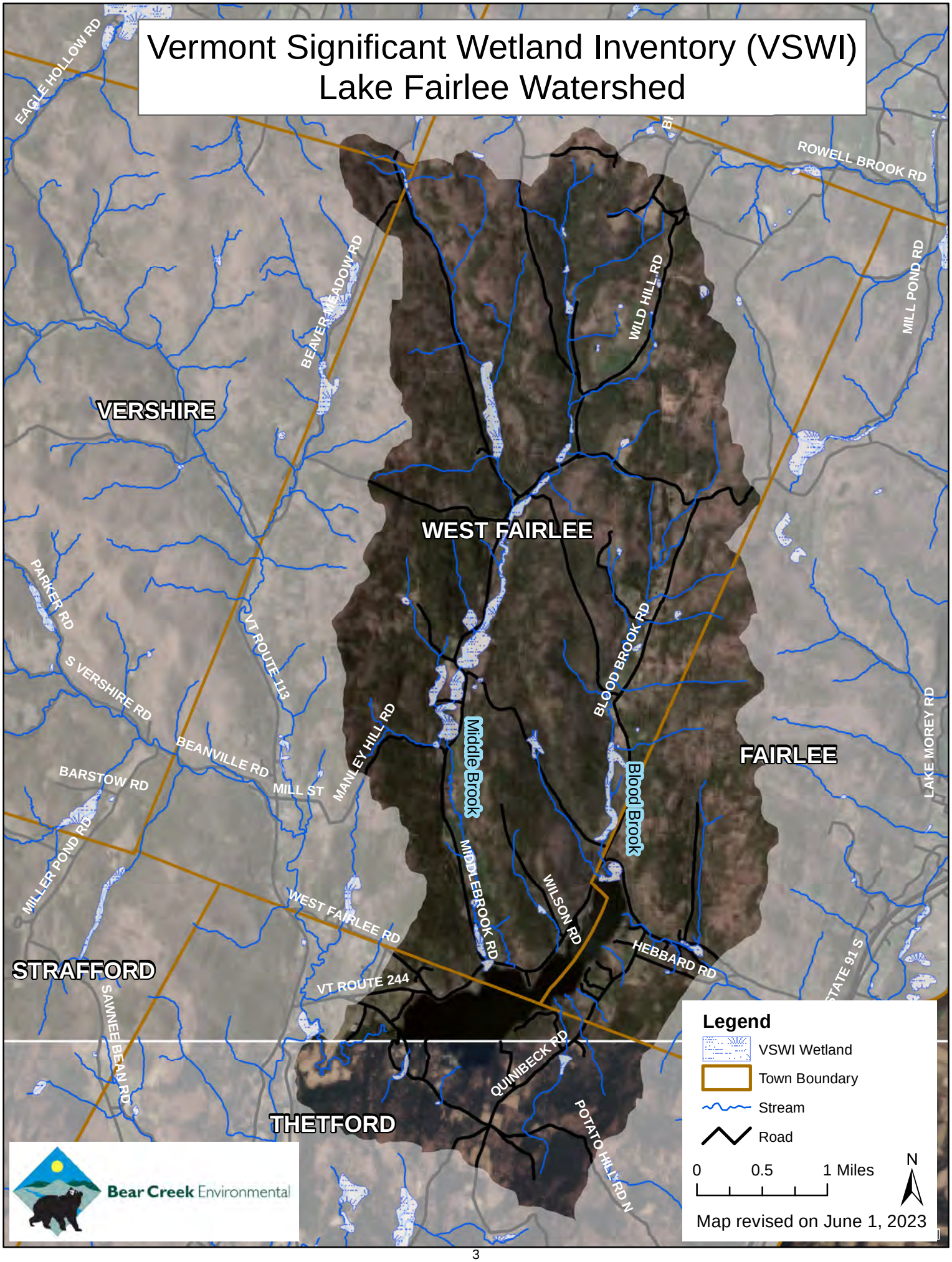
Vermont Integrated Watershed Information System (IWIS) https://anrweb.vt.gov/DEC/IWIS/

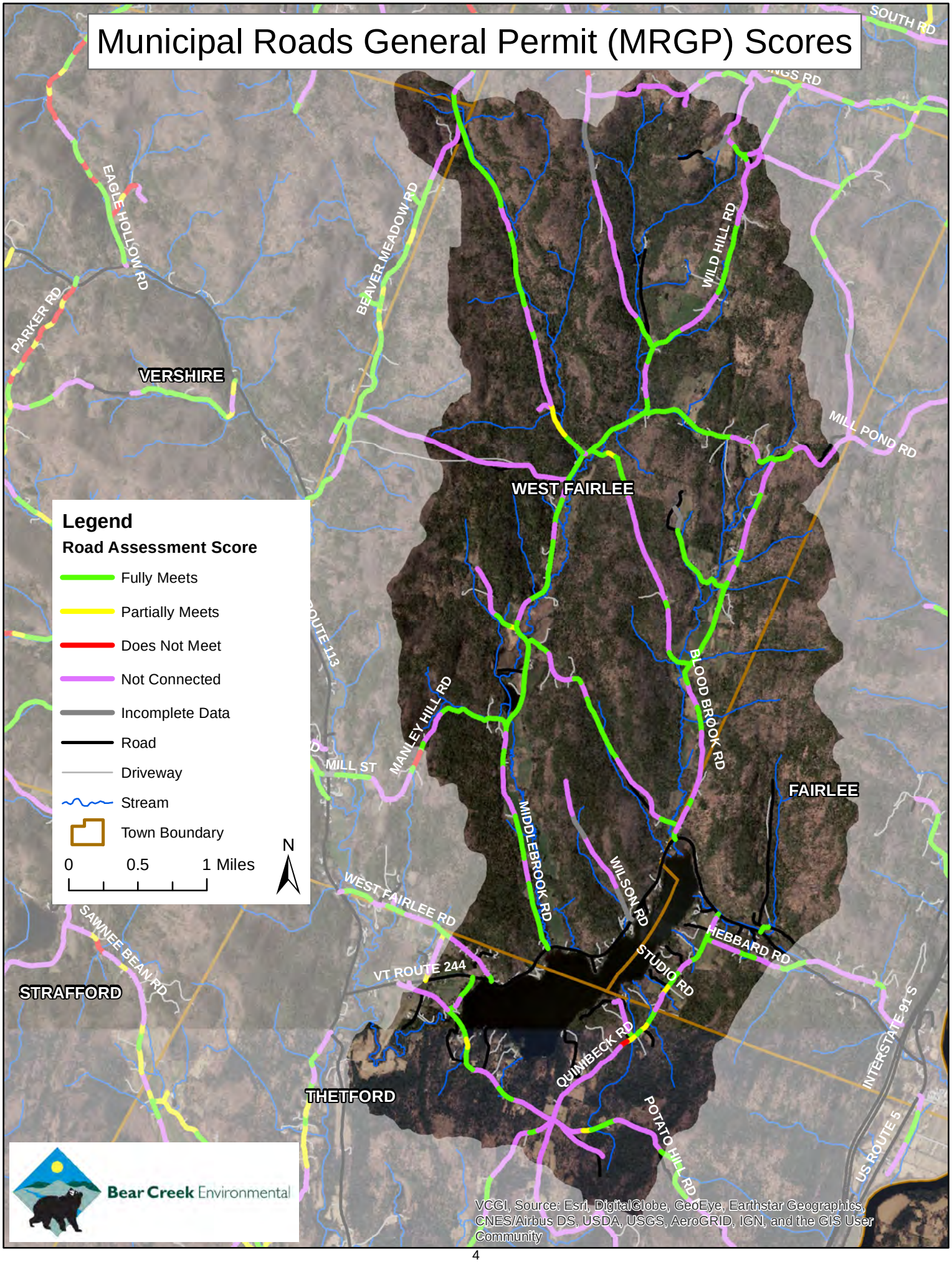
APPENDIX A

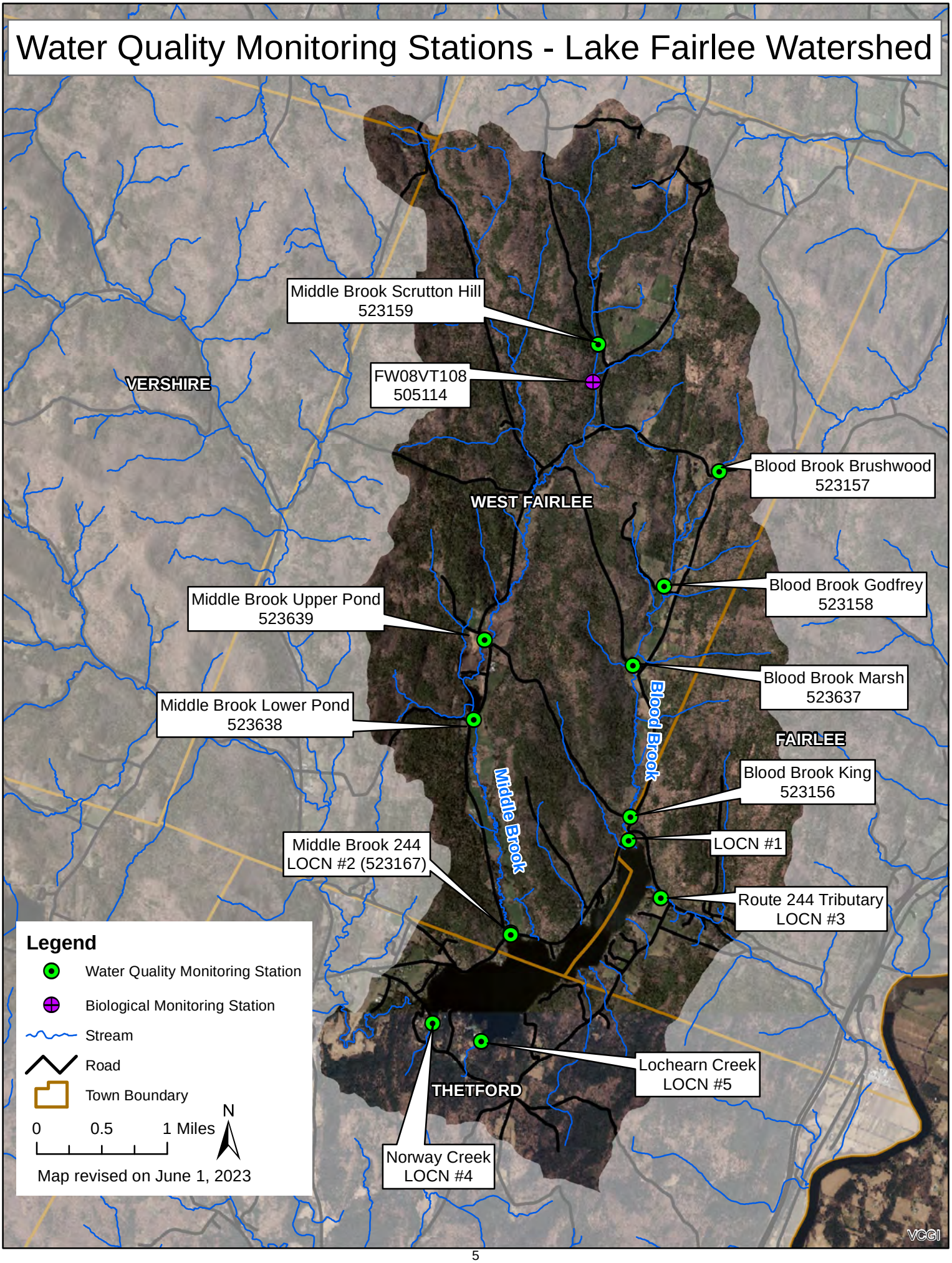
MAPS


Building Density
Lake Fairlee Watershed
CORINTH
VERSHIRE
WEST FAIRLEE
FAIRLEE
STRAFFORD
THETFORD
Middle Brook
Blood Brook
Legend
E911 Structures
Stream
Town Boundary
LakeFairlee
N
Building Density (Units/Sq. Mi.)
0 - 12
12 - 41
41 - 83
83 - 131
131 - 200
0
0.5
1 Miles
Map created on May 19, 2023
Bear Creek Environmental
VCGI, Source:
CNES/Airbus
Community


Vermont Base Land Cover 2016
Lake Fairlee Watershed
CORINTH
VERSHIRE
WEST FAIRLEE
FAIRLEE
STRAFFORD
THETFORD
Legend
Town Boundary
Land Cover
Tree Canopy
Grass/Shrub
Bare Soil
Water
Building
Road
Other Paved Surfaces
0 0.425 0.85 Miles
N
Map created on May 19, 2023
Bear Creek Environmental

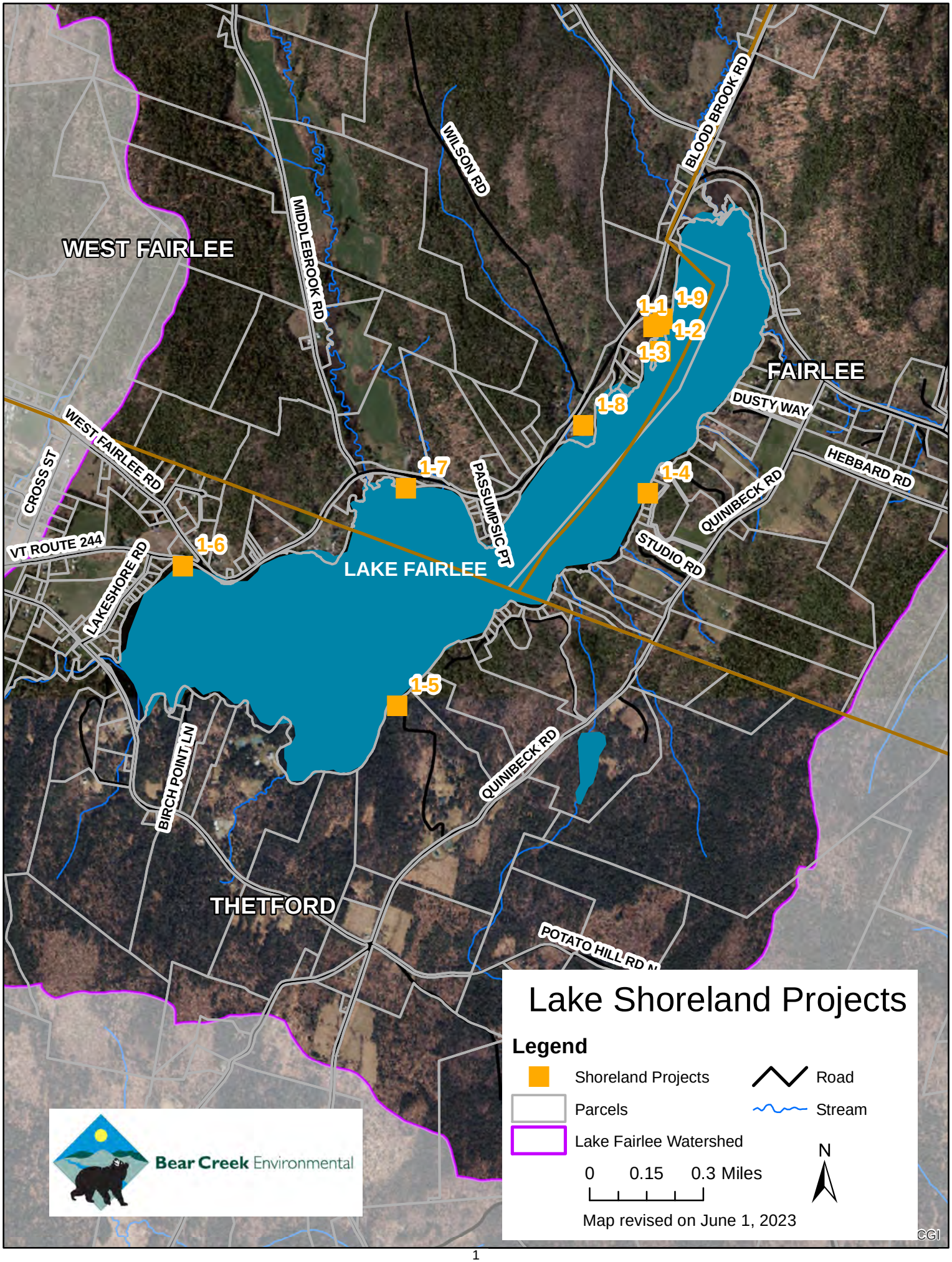

Vermont Significant Wetland Inventory (VSWI)
Lake Fairlee Watershed
VERSHIRE
WEST FAIRLEE
FAIRLEE
STRAFFORD
THETFORD
EAGLE HOLLOW RD
ROWELL BROOK RD
BEAVER MEADOW RD
WILD HILL RD
MILL POND RD
PARKER RD
S VERSHIRE RD
VT ROUTE 113
BEANVILLE RD
BARSTOW RD
MILL ST
MANLEY HILL RD
Middle Brook
BLOOD BROOK RD
Blood Brook
LAKE MOREY RD
MILLER POND RD
WEST FAIRLEE RD
MIDDLEBROOK RD
WILSON RD
HEBBARD RD
VT ROUTE 244
SAWNEE BEAN RD
QUINIBECK RD
POTATO HILL RD N
Legend
VSWI Wetland
Town Boundary
Stream
Road
0
0.5
1 Miles
N
Map revised on June 1, 2023
Bear Creek Environmental


Municipal Roads General Permit (MRGP) Scores
SOUTH RD
EAGLE HOLLOW RD
BEAVER MEADOW RD
WILD HILL RD
PARKER RD
VERSHIRE
MILL POND RD
WEST FAIRLEE
Legend
Road Assessment Score
Fully Meets
Partially Meets
Does Not Meet
Not Connected
Incomplete Data
Road
Driveway
Stream
Town Boundary
0
0.5
1 Miles
N
ROUTE 113
MANLEY HILL RD
BLOOD BROOK RD
MILL ST
FAIRLEE
MIDDLEBROOK RD
WILSON RD
WEST FAIRLEE RD
SAWNEE BEAN RD
HEBBARD RD
VT ROUTE 244
STUDIO RD
STRAFFORD
QUIMBECK RD
INTERSTATE 91 S
THETFORD
POTATO HILL RD
US ROUTE 5
Bear Creek Environmental
VCGI, Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community


Water Quality Monitoring Stations - Lake Fairlee Watershed
Middle Brook Scrutton Hill
523159
FW08VT108
505114
VERSHIRE
Blood Brook Brushwood
523157
WEST FAIRLEE
Blood Brook Godfrey
523158
Middle Brook Upper Pond
523639
Blood Brook Marsh
523637
Middle Brook Lower Pond
523638
Blood Brook
FAIRLEE
Blood Brook King
523156
Middle Brook
Middle Brook 244
LOCN #2 (523167)
LOCN #1
Route 244 Tributary
LOCN #3
Lochearn Creek
LOCN #5
THETFORD
Norway Creek
LOCN #4
Legend
Water Quality Monitoring Station
Biological Monitoring Station
Stream
Road
Town Boundary
0
0.5
1 Miles
N
Map revised on June 1, 2023
VCGI

APPENDIX B

LAKE SHORELAND PROJECT SUMMARY SHEETS


WEST FAIRLEE
MIDDLEBROOK RD
WILSON RD
BLOOD BROOK RD
FAIRLEE
DUSTY WAY
HEBBARD RD
QUINIBECK RD
STUDIO RD
WEST FAIRLEE RD
CROSS ST
VT ROUTE 244
LAKESHORE RD
PASSUMPSIC PT
LAKE FAIRLEE
BIRCH POINT LN
QUINIBECK RD
THETFORD
POTATO HILL RD
1-1
1-2
1-3
1-4
1-5
1-6
1-7
1-8
1-9
Lake Shoreland Projects
Legend
Shoreland Projects
Parcels
Lake Fairlee Watershed
Road
Stream
0 0.15 0.3 Miles
N
Map revised on June 1, 2023
Bear Creek Environmental
CGI

Lake Fairlee Watershed Action Plan - Project Identification
Fairlee, Thetford, and West Fairlee, Vermont
White River Natural Resources Conservation District
Revised June 1, 2023

Project Number Segment	Project Category	Project Type	Project Location	Town	Ownership	Project Location	Project Description	Environmental Benefits	Degree of Landowner Commitment
1-1	Lakeshore	Stormwater Improvement	Treasure Island Recreation Area	West Fairlee	Town of Thetford	-72.21525 43.89646	Stabilization of eroding access road	2	High
1-2	Lakeshore	Buffer Improvement	Treasure Island Recreation Area	West Fairlee	Town of Thetford	-72.21493 43.89553	Widen buffers along lakeshore	1,2	High
1-3	Lakeshore	Stormwater Improvement	Treasure Island Recreation Area	West Fairlee	Town of Thetford	-72.21493, 43.89654	Rain garden for beach outlet pipe; improved beach sand containment	1,2	High
1-4	Lakeshore	Lakeshore Retaining Wall	Private Landowner	Fairlee	Private	-72.21536 43.89007	Seawall has deteriorated. Replace with bioengineered solution.	1,2	High
1-5	Lakeshore	Beachfront - Sand Containment	Ohana Family Camp	Thetford	Aloha Foundation	-72.22880 43.88204	Install perforated pipe around beachfront to reduce sand reaching Lake Fairlee	1,2	High
1-6	Lakeshore	Buffer Improvement	Adjacent to Route 244	Fairlee	State of VT; private landowners	-72.24012 43.88745	Work with VTrans and possibly private landowners to improve buffers adjacent to Route 244	1,2	Unknown
1-7	Lakeshore	Lakeshore - Retaining Wall	Horizons Day Camp	West Fairlee	Aloha Foundation, Inc.	-72.22857 43.89038	Seawall has deteriorated. Replace with bioengineered solution.	1,2	High
1-8	Lakeshore	Stormwater Improvement	Aloha Hive Camp	Fairlee	Aloha Foundation, Inc.	-72.21906 43.89268	Stormwater is causing erosion in the vicinity of a building (wash station) that is close to the shoreline. Infiltration steps will help reduce erosion.	2	High
1-9	Lakeshore	Stormwater Improvement	Treasure Island Recreation Area	West Fairlee	Town of Thetford	-72.2147 43.89675	Existing water bars in parking area need to be reconstructed. The addition of a third water would help dissipate runoff and improve infiltration.	1,2	High

[1] Enhances or protects aquatic or riparian habitat
[2] Reduces sedimentation and phosphorus levels
[3] Moves the channel toward equilibrium where the water and sediment are in balance
[4] Reduces risk of flooding and erosion hazard

Lakeshore Problem Areas summary Sheet (Revised 1 June 2023)

Project Number and Name: 1-1 Treasure Island Stormwater Improvement of Access Drive

Land Ownership: Town of Thetford, Treasure Island Recreation Area

Site Location: -72.21525, 43.89646

Site Description: Access drive bank is eroding and needs to be stabilized. Bring in top soil and seed the area to reduce rilling and provide a vegetated filter strip.

Site Design Considerations: The bank below the access road is steep and is in close proximity to the shoreline.

Permitting Needs: No permits are required for this project.

Cost Estimate Range: $10,000 - $20,000

Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee

Level of Landowner Commitment: The Town of Thetford has expressed an interest in stabilizing the eroding access area.

Project Number and Name: 1-2 Treasure Island Lakeshore Buffer Improvement
Land Ownership: Town of Thetford, Treasure Island Recreation Area
Site Location: -72.21493, 43.89553

Site Description: Vegetative buffers are narrow along the Shoreline and could be improved through planting trees or implementing no mow zones.
 
Site Design Considerations: This area is used for recreation and picnicking. The land use needs to be balanced with the benefit of buffers filtering sediment and phosphorus.
Permitting Needs: No permits are required for this project.
Cost Estimate Range: $1,000 to $10,000
Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee and improve riparian habitat by improving buffers along the lakeshore
Level of Landowner Commitment: The Town of Thetford has expressed an interest in improving the buffer along the lakeshore.

Project Number and Name: 1-3 Treasure Island Stormwater Improvement at Outlet Pipe
Land Ownership (E911): Town of Thetford, Treasure Island Recreation Area
Site Location: -72.21493, 43.89654

Site Description: There is some minor beach erosion at the outlet pipe that carries water from the perforated pipe on the beach. A rain garden could be installed to provide a place for the water to dissipate and infiltrate. Some rilling of the sand was noted in October 2022.
 
Site Design Considerations: This area is used for recreation and space and aesthetics should be considered. Additional work is needed to determine if groundwater/surface water is circumventing the perforated pipe. The landscape pipe is perforated on all sides and water may not be reaching the outlet.
Permitting Needs: A lakeshore permit may be required for this project if work is performed within 250 feet of the mean water level of Lake Fairlee.
Cost Estimate Range: $10,000 - $20,000
Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee by reducing erosion and allowing infiltration.
Level of Landowner Commitment: The Town of Thetford has expressed an interest in reducing erosion on the beach.

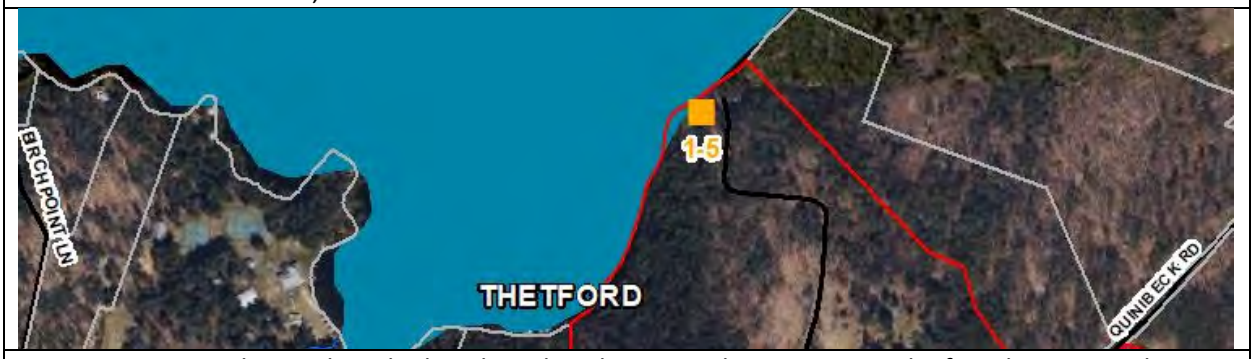
Project Number and Name: 1-4 Lakeshore Retaining Wall at Private Camp
Land Ownership: Private Camp in Fairlee, VT
Site Location: -72.21536, 43.89007

Site Description: The retaining wall along the lakefront at a private camp has deteriorated and could be replaced with a bioengineered retaining wall that provides a vegetated buffer and wildlife habitat.
 
Site Design Considerations: The camp and some large trees are in close proximity to the retaining wall. It may be difficult to secure funding for a project on private land.
Permitting Needs: A Vermont Shoreland permit and a 404 permit from the Army Corp of Engineers is required.
Cost Estimate Range: $40,000 - $60,000
Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee and improve riparian habitat by replacing wall with a bioengineered design
Level of Landowner Commitment: WRNRCD has had numerous conversations with the landowners about the restoration of the beachfront. They are committed to pursuing this project.

Project Number and Name: 1-5 Beachfront Sand Containment at Ohana Family Camp

Land Ownership: Aloha Foundation, Ohana Family Camp

Site Location: -72.22880, 43.88204



Site Description: The sand on the beach at the Ohana Family Camp is at risk of washing into Lake Fairlee. Perforated pipe could be installed to help contain the sand by creating a French drain.

Site Design Considerations: This is a high usage area.

Permitting Needs: A Vermont Shoreland Permit may be required if work is performed within 250 feet of the mean water level of Lake Fairlee.

Cost Estimate Range: $5,000 - $10,000

Restoration/Water Quality Improvement Objectives: Reduce sand reaching Lake Fairlee by containing the sand through improved stormwater management.

Level of Landowner Commitment: The Aloha Foundation supports this project. Restoration of the sand area has been an ongoing issue.

Project Number and Name: 1-6 Route 244 Buffer Improvement (Project Development)
Land Ownership: State of Vermont (Within road right-of-way), possibly private landowners
Site Location: -72.24012, 43.88745 (North side of Lake Fairlee along Vermont Route 244)

Site Description: Vegetated buffers are narrow or are lacking on the north side of the lake along VT Route 244. Complete a study to determine ownership of properties and willingness of landowners to improve buffers.
 
Site Design Considerations: There are multiple landowners and it is unclear whether the land is privately owned or within the right-of-way of Vermont Route 244.
Permitting Needs: No permits are required for project development
Cost Estimate Range: $1,000 - $5,000 (Does not include project implementation)
Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee and improve riparian habitat by providing vegetative buffers along the lakeshore.
Level of Landowner Commitment: Unknown

Project Number and Name: 1-7 Lakeshore Retaining Wall at Horizons Day Camp
Land Ownership: Aloha Foundation, Inc., Horizons Day Camp
Site Location: -72.22857, 43.89038

Site Description: The retaining wall along the lakefront at the Horizons Day Camp has deteriorated and could be replaced with a bioengineered retaining wall that provides a vegetated buffer and wildlife habitat.
 
Site Design Considerations: The boathouse and dock are in close proximity to the retaining wall. There are safety concerns about being able to see campers, who are swimming in this area.
Permitting Needs: A Vermont Shoreland permit and a 404 permit from the Army Corp of Engineers is required.
Cost Estimate Range: $60,000 - $80,000
Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee and improve riparian habitat by providing a bioengineered design
Level of Landowner Commitment: Ben Cole (Building and Grounds Director) and Stuart Fairbairn (Program Director at Horizons) are committed to pursuing the sea wall restoration. The landowner to the north is abroad and the WRNRCD has not been able to contact her. In preliminary conversations, the northern landowner expressed interest in learning if there was an advantage to piggybacking with the Horizons project.

Project Number and Name: 1-8 Aloha Hive Stormwater Improvement at Wash Station
Land Ownership: Aloha Foundation, Inc., Hive Camp
Site Location: -72.21906, 43.89268

Site Description: Stormwater is causing erosion in the vicinity of a building (wash station) that is close to the Lake Fairlee Shoreline. Infiltration steps (constructed with timbers and filled with crush stone) will help reduce erosion down a steep bank.

Site Design Considerations: This is a high usage area.

Permitting Needs: A permit will be needed if the infiltration steps are to be constructed within 250 feet of the mean water level of Lake Fairlee

Cost Estimate Range: $5,000 - $10,000

Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee by improving infiltration and reducing erosion.

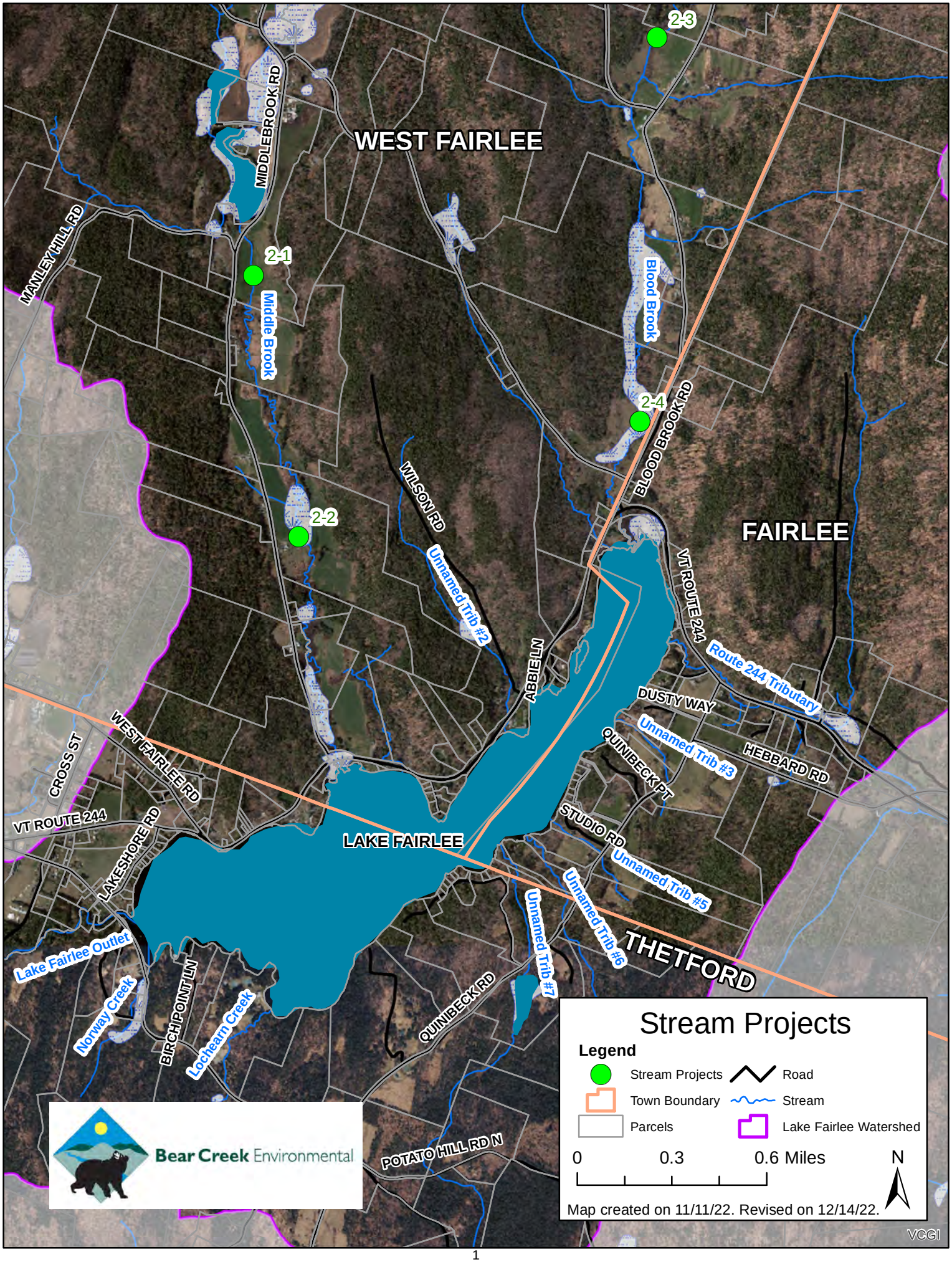
Level of Landowner Commitment: Ben Cole (Building and Groups Director) supports stabilizing this area due to being high use and in close proximity to the shoreline.

Project Number and Name: 1-9 Treasure Island Stormwater Improvement of Parking Lot
Land Ownership: Town of Thetford, Treasure Island Recreation Area
Site Location: -72.2147, 43.89675

Site Description: The parking lot is large and there are only two water bars to dissipate runoff. An improvement in infiltration could occur by reconstructing existing water bars and constructing a third water bar between the two existing ones.
 
Site Design Considerations: The parking lot is in close proximity to Lake Fairlee. There are two existing water bars that would be improved.
Permitting Needs: No permits are expected for this project
Cost Estimate Range: $10,000 - $20,000
Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee and by dispersing runoff on parking lot and improving surface infiltration below the lot.
Level of Landowner Commitment: The Town of Thetford has expressed an interest in supporting projects to improve the water quality of Lake Fairlee.

APPENDIX C

STREAM PROJECT SUMMARY SHEETS


WEST FAIRLEE
FAIRLEE
THETFORD
LAKE FAIRLEE
2-1
2-2
2-3
2-4
MIDDLEBROOK RD
MANLEY HILL RD
Middle Brook
Blood Brook
BLOOD BROOK RD
WILSON RD
Unnamed Trib #2
ABBIE LN
VT ROUTE 244
Route 244 Tributary
DUSTY WAY
Unnamed Trib #3
HEBBARD RD
QUINIBECK PT
STUDIO RD
Unnamed Trib #5
Unnamed Trib #6
Unnamed Trib #7
WEST FAIRLEE RD
CROSS ST
VT ROUTE 244
LAKESHORE RD
Lake Fairlee Outlet
Norway Creek
BIRCH POINT LN
Lochearn Creek
QUINIBECK RD
POTATO HILL RD N
Bear Creek Environmental
Stream Projects
Legend
Stream Projects
Town Boundary
Parcels
Road
Stream
Lake Fairlee Watershed
0
0.3
0.6 Miles
N
Map created on 11/11/22. Revised on 12/14/22.
VCGI

Lake Fairlee Watershed Action Plan - Project Identification
Fairlee, Thetford, and West Fairlee, Vermont
White River Natural Resources Conservation District
Nov. 18, 2022 (June 2, 2023)

Project Number Segment	Project Category	Project Type	Project Location	Town	Ownership	Project Location	Project Description	Environmental Benefits	Degree of Landowner Commitment
2-1	Streams	Buffer Improvement	Middle Brook	West Fairlee	Private	-72.23571 43.91317	Buffers along agricultural fields are narrow. Increase buffers along agricultural fields	1,2	None (Landowner has been approached by NRCS and the District and has indicated buffer plantings in this area are not practical)
2-2	Streams	Buffer Improvement	Middle Brook	West Fairlee	Private	-72.23291 43.90115	Create no mow zone where stream bank is eroding and is migrating toward backyard	1,2	None (Landowner has been approached by District and is not interested in tree plantings or increasing buffer in this area)
2-3	Streams	Buffer Improvement	Blood Brook	West Fairlee	Private	-72.21007 43.92401	Horses are crossing the stream and creating erosion in the stream and along the banks. Riparian buffers are absent or narrow. Reduce number of horse crossings and increase buffers along stream	1,2	Low
2-4	Streams	Livestock exclusion	Blood Brook	West Fairlee	Private	-72.21131 43.90638	Livestock have access to stream channel and banks and are creating erosion; Reduce number of animal crossings and exclude livestock	1,2	None

[1] Enhances or protects aquatic or riparian habitat
[2] Reduces sedimentation and phosphorus levels
[3] Moves the channel toward equilibrium where the water and sediment are in balance
[4] Reduces risk of flooding and erosion hazard

Lake Fairlee Watershed Action Plan

Stream Problem Areas summary Sheet

Project Number and Name: 2-1 Buffer Improvement Along Agricultural Fields
Land Ownership: Private
Site Location: -72.23571, 43.91317 Stream Name: Middle Brook

Site Description: Increase buffers along agricultural fields where there are currently narrow buffers with limited trees and shrubs growing.

Site Design Considerations: Agricultural land would need to be retired in order to expand buffer. Compensation for active farm land may be available through the Conservation Reserve Enhancement Program or a Vermont River Corridor Easement. The length of the project is about 1250 ft. each side.
Permitting Needs: No permits are required for this project.
Cost Estimate Range: $10,000 to $20,000
Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee. Improve riparian habitat.
Level of Landowner Commitment: None

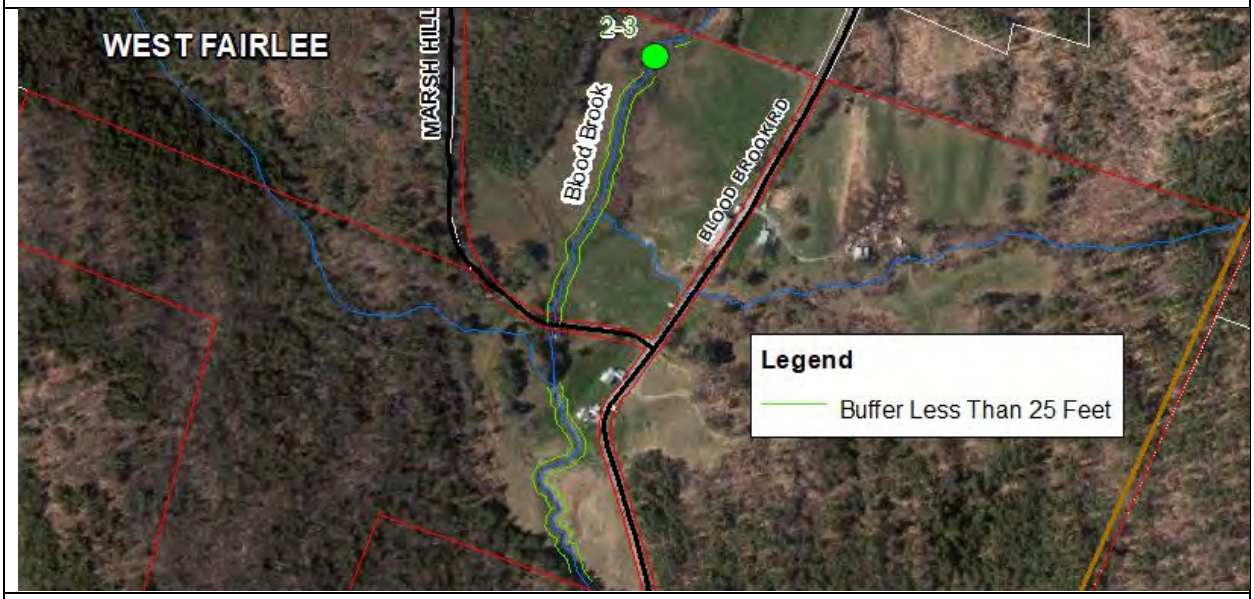
Project Number and Name: 2-2 Buffer Improvement
Land Ownership: Private
Site Location: -72.23291, 43.90115 Stream Name: Middle Brook

Site Description: Create no mow zone where stream bank is eroding and migrating toward backyard

Site Design Considerations: The landowner has declined additional plantings in this area.
Permitting Needs: No permits are required for this project.
Cost Estimate Range: $0 to $500
Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee. Improve riparian habitat.
Level of Landowner Commitment: None

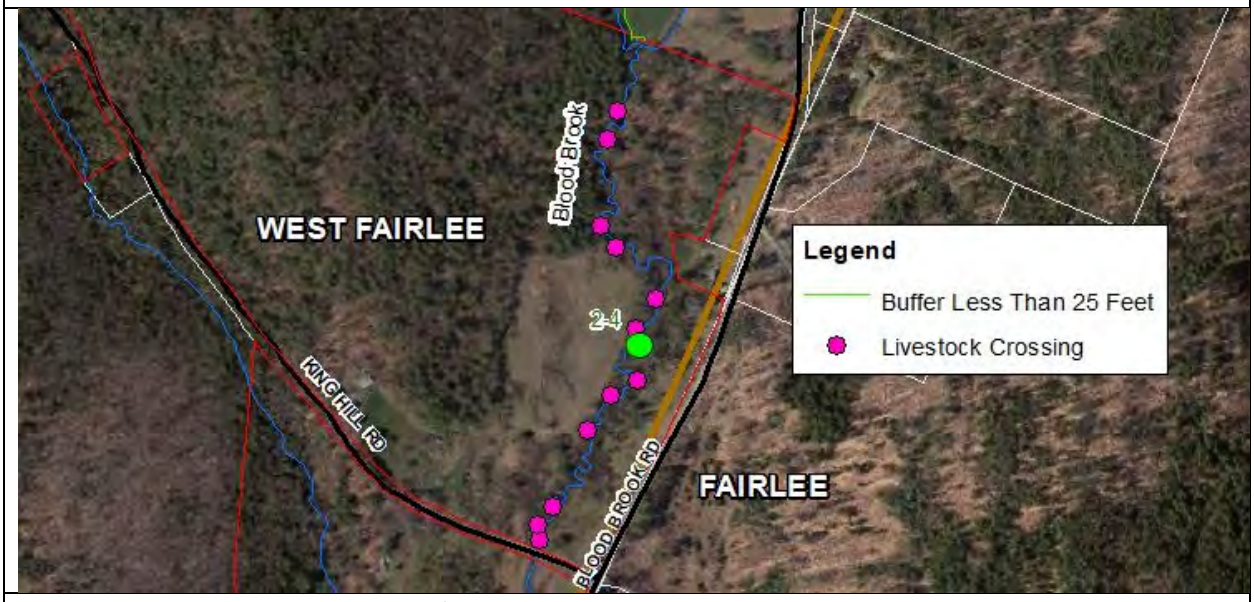
Lake Fairlee Watershed Action Plan

Stream Problem Areas summary Sheet

Project Number and Name: 2-3 Buffer Improvement and Reduce Animal Crossings
Land Ownership: Private
Site Location: -72.21007, 43.92401 Stream Name: Blood Brook

Site Description: Reduce number of horse crossings to prevent further erosion and increase buffers along stream.
 
Site Design Considerations: Horses will continue to access and use the fields. Funding may be available from the USDA NRCS for livestock exclusion and buffer plantings.
Permitting Needs: No permits are required for this project.
Cost Estimate Range: $10,000 to $20,000
Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee. Improve instream and riparian habitat.
Level of Landowner Commitment: Low

Bear Creek Environmental

Project Number and Name: 2-4 Livestock Exclusion
Land Ownership: Private
Site Location: -72.21131, 43.90638 Stream Name: Blood Brook



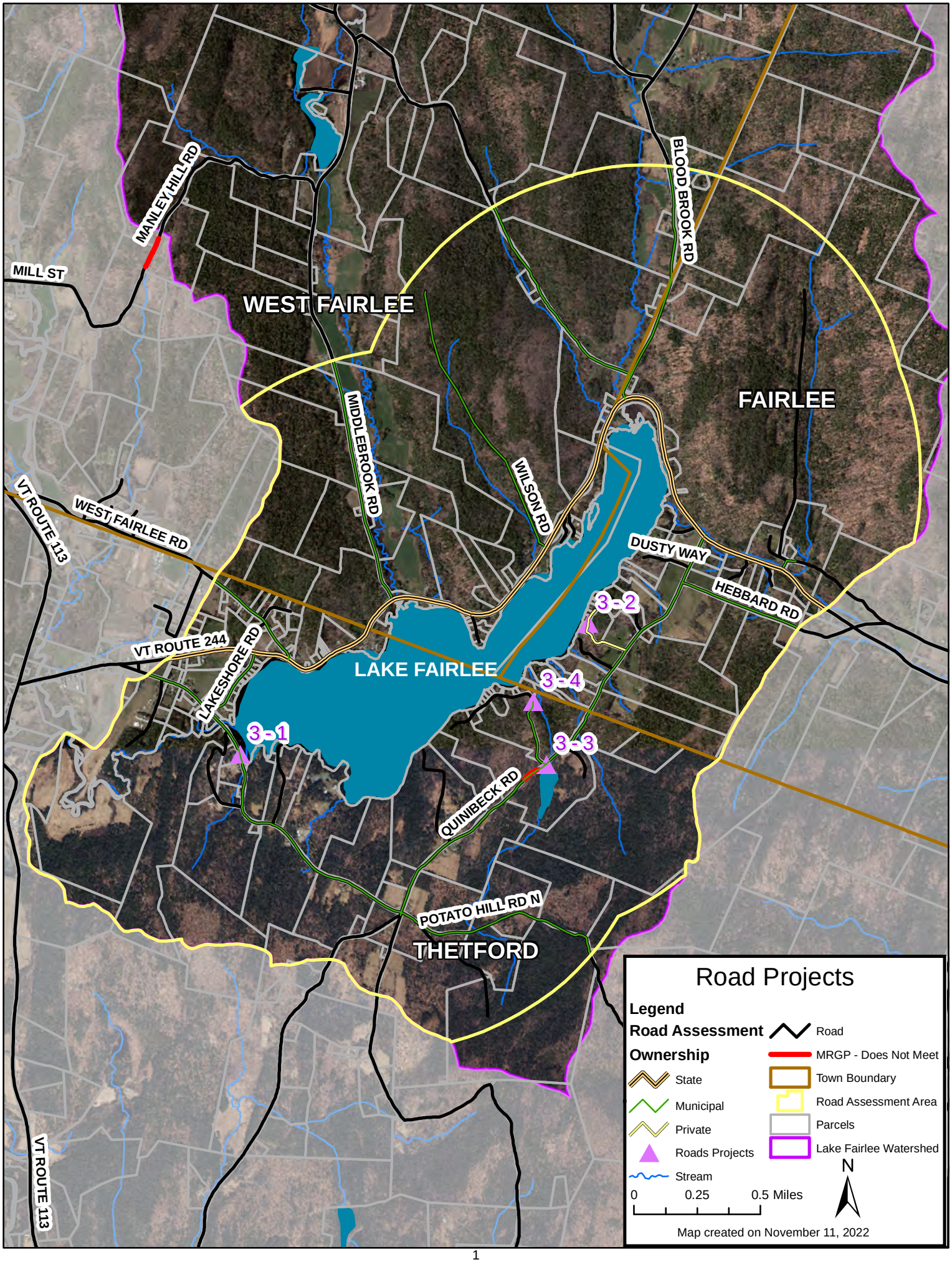
Site Description: Reduce number of livestock crossings in stream with livestock exclusion areas to reduce erosion.

Site Design Considerations: Programs may be available through USDA to provide a water source for livestock and to fence out the animals from the stream and stream buffer.
Permitting Needs: No permits are required for this project.
Cost Estimate Range: $10,000 to $20,000
Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee. Improve riparian habitat
Level of Landowner Commitment: None

Bear Creek Environmental

APPENDIX D

ROAD PROJECT SUMMARY SHEETS


MANLEY HILL RD
MILL ST
WEST FAIRLEE
BLOOD BROOK RD
FAIRLEE
MIDDLEBROOK RD
WILSON RD
VT ROUTE 113
WEST FAIRLEE RD
DUSTY WAY
HEBBARD RD
3-2
VT ROUTE 244
LAKESHORE RD
LAKE FAIRLEE
3-4
3-1
3-3
QUINIBECK RD
POTATO HILL RD N
THETFORD
VT ROUTE 113
Road Projects
Legend
Road Assessment
Ownership
State
Municipal
Private
Roads Projects
Stream
Road
MRGP - Does Not Meet
Town Boundary
Road Assessment Area
Parcels
Lake Fairlee Watershed
N
0
0.25
0.5 Miles
Map created on November 11, 2022

Lake Fairlee Watershed Action Plan - Project Identification
Fairlee, Thetford, and West Fairlee, Vermont
White River Natural Resources Conservation District
Nov. 20, 2022

Project Number Segment	Project Category	Project Type	Project Location	Town	Ownership	Project Location	Project Description	Environmental Benefits	Degree of Landowner Commitment
3-1a	Road	Stormwater Improvement	Robinson Hill Road	Thetford	Town of Thetford	Adjacent to Lake	Pave Road: Reduce sediment reaching the Lake by extending the pavement another 650 feet	2	High
3-1b	Road	Stormwater Improvement	Robinson Hill Road	Thetford	Town of Thetford	Adjacent to Lake	Cross Culvert: Reduce sediment reaching the Lake by reducing erosion in roadside ditch through installation of cross culvert	2	High
3-1c	Road	Stormwater Improvement	Robinson Hill Road	Thetford	Town of Thetford	Adjacent to Lake	Debris Control: Install debris control at outlet of pond to make 48 inch culvert inlet at pond more resistant to debris jams	2	High

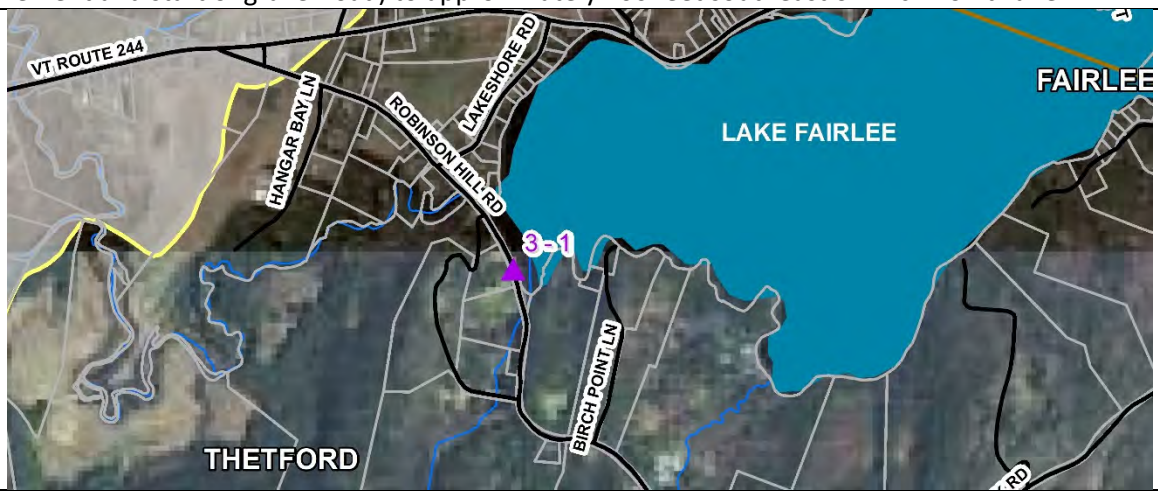
[1] Enhances or protects aquatic or riparian habitat
[2] Reduces sedimentation and phosphorus levels
[3] Moves the channel toward equilibrium where the water and sediment are in balance
[4] Reduces risk of flooding and erosion hazard

Lake Fairlee Watershed Action Plan - Project Identification
Fairlee, Thetford, and West Fairlee, Vermont
White River Natural Resources Conservation District
Nov. 20, 2022

Project Number Segment	Project Category	Project Type	Project Location	Town	Ownership	Project Location	Project Description	Environmental Benefits	Degree of Landowner Commitment
3-1d	Road	Stormwater and Riparian Zone Improvement	Robinson Hill Road	Thetford	Town of Thetford	Adjacent to Lake	No Mow Zone: Continue "no mow" zone adjacent to Lake to promote improved vegetation along lakeshore and filtering of stormwater contaminants	1,2	High
3-2	Road	Stormwater Improvement	Anna Dodge Road	Fairlee	Private	Lower end of road	Check dams: Install check dams to help trap sediment in roadside ditch prior to discharge to Lake Fairlee	2	Moderate
3-3	Road	Stormwater Improvement	Quinibeck Road	Thetford	Town of Thetford	Near intersection with Bragg Road	Turn outs: Berms have developed at the edge of the road and have blocked the drainage of water off road. Establish turn out to allow drainage off the road.	2	Undetermined
3-4	Road	Stormwater Improvement	Bragg Road	Thetford	Town of Thetford	Steep section of road adjacent to unnamed stream	Turn outs: Install turn outs or other erosion control measures to frequently divert water off road to reduce erosion and sedimentation.	2	Undetermined

[1] Enhances or protects aquatic or riparian habitat
[2] Reduces sedimentation and phosphorus levels
[3] Moves the channel toward equilibrium where the water and sediment are in balance
[4] Reduces risk of flooding and erosion hazard

Project Number and Name: 3-1 (a, b, c & d) Robinson Road Stormwater Improvements
Land Ownership: Town of Thetford
Site Location: Robinson Hill Road from about 700 feet south of Lakeshore Rd intersection (at end of pavement and start of gravel road) to approximately 700 feet southeast of Birch Point Lane



Site Description: The road is muddy during the spring, and is contributing sediment to Lake Fairlee. This project includes four components: a) paving of approximately 650 linear ft, b) installation of new cross culvert to improve drainage, c) debris control at outlet of pond, and d) continuing the "no mow" zone adjacent to the Lake.

Site Design Considerations: Robinson Hill Road is in close proximity to Lake Fairlee. Paving of the road is expensive.

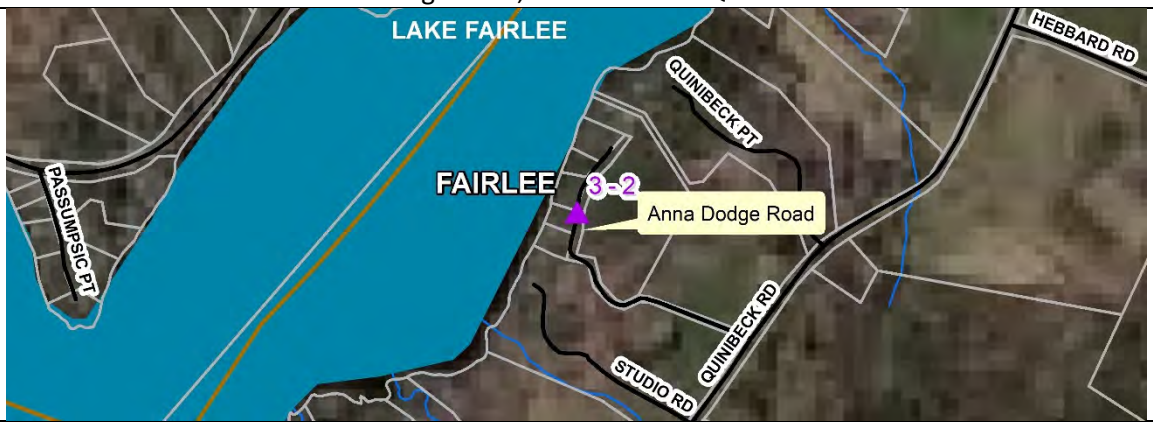
Permitting Needs: Permits from the ACOE and ANR may be required depending upon the design.

Cost Estimate Range: $100,000 - $150,000 for design and construction

Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee

Level of Landowner Commitment: There has been considerable communication between the Camp Norway Waterfront Association and the Thetford Select Board that dates back to 2010 about ways the Robinson Hill Road could be improved. The level of interest in this project is high.

Project Number and Name: 3-2 Anna Dodge Stormwater Improvement
Land Ownership: Private
Site Location: Lower end of Anna Dodge Road, which is off of Quinibeck Rd in Fairlee



Site Description: Road runoff is contributing sediment to a roadside ditch that discharges through a culvert into Lake Fairlee. The road side ditch is currently trapping sediment where it flattens in slope. The preferred alternative for the project is to install a cross culvert to dissipate the flow and reduce erosion of the ditch. An alternative solution, which would require maintenance, is to install check dams to aid in sediment retention.

Site Design Considerations: This is a private road and funding may be difficult to acquire.

Permitting Needs: No permits are required for this project.

Cost Estimate Range: $10,000 to $20,000

Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee

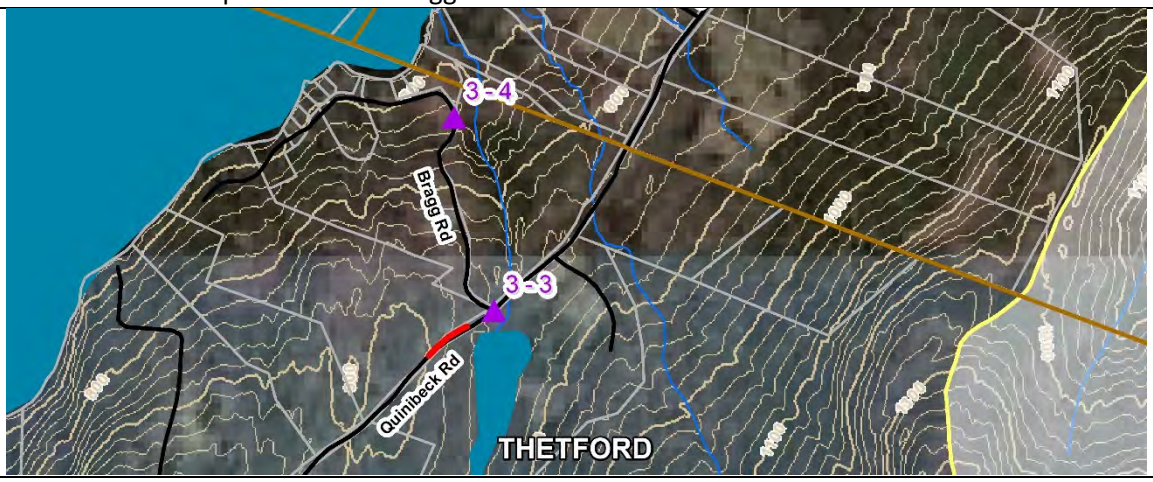
Level of Landowner Commitment: The level of commitment from the landowners along this private road is anticipated to be moderate.

Project Number and Name: 3-3 Quinibeck Road Stormwater Improvement
Land Ownership: Town of Thetford
Site Location: Quinibeck Road in the vicinity of Bragg Road

Site Description: Berms have developed at the edge of Quinibeck Road and have blocked the drainage of water off the road. Poking holes in the berms to provide turn outs is recommended. This will disperse the runoff and reduce erosion.

Site Design Considerations: A road segment (shown as red line above) to west of this area on Quinibeck Road had been previously rated as "Does not Meet" under the Municipal Road General Permit. Recent stone line ditching was observed on the north side of the road in this location.
Permitting Needs: No permits are required for this project
Cost Estimate Range: $500 - $1,000
Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee by dissipating road runoff.
Level of Landowner Commitment: The level of interest from the Town of Theford is unknown

Project Number and Name: 3-4 Bragg Road Stormwater Improvement
Land Ownership: Town of Thetford
Site Location: Municipal section of Bragg Road



Site Description: Water is concentrating in the drainage ditches and contributing sediment to a nearby stream. Install turn outs or determine other means of diverting water off of the road to reduce erosion and sedimentation.

Site Design Considerations: Bragg Road is steep (~13%) and the stream is close by.

Permitting Needs: No permits are required for this project.

Cost Estimate Range: $10,000 to $20,0000

Restoration/Water Quality Improvement Objectives: Reduce sediment and phosphorus reaching Lake Fairlee

Level of Landowner Commitment: Unknown

APPENDIX E

PROJECT PRIORITIZATION

Lake Fairlee LWAP

Prioritization of Problem Areas
Revised 5/24/23 by Mary Nealon of Bear Creek Environmental, LLC

Improves Water Quality (weight -25%) – Uses P reduction Calculation (kg/yr)

- 0 points – P reduction is 0 kg/yr to <0.2 kg/year
- 1 point - P reduction is 0.2 kg/yr to <1.0 kg/year
- 2 points – P reduction is 1 kg/yr to <2.0 kg/year
- 3 points – P reduction is ≥ 2 kg/yr

Landowner Support (weight – 25%)

- 0 points – Strong evidence of lack of interest
- 1 point - Uncertain, some evidence of lack of interest
- 2 points - Uncertain, some evidence of support
- 3 points - Written support – landowner agreement

Improves or Protects Riparian or Aquatic Habitat (weight 20%)

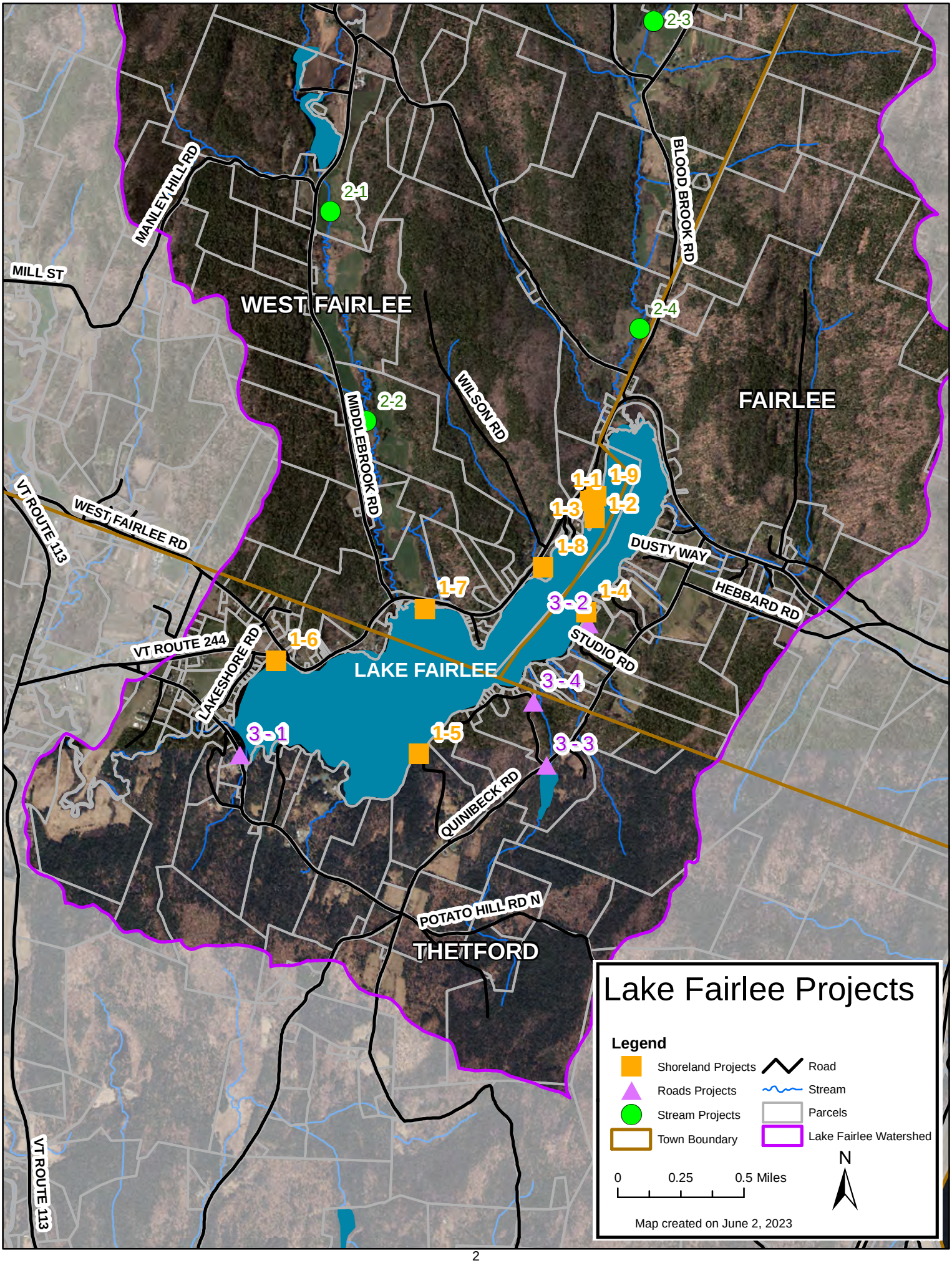
- 0 points – Does not improve habitat
- 1 points – offers Minor habitat enhancement
- 2 points – offers Moderate habitat enhancement
- 3 points - offers Significant habitat enhancement

Cost Effectiveness (weight 20%) **–** Uses P tool (total cost, P reduction, and estimated project life span)

- 0 points - >50,000 $/kg/yr
- 1 point - >25,000 to 50,000 $/kg/yr
- 2 points – >10,000 to 25,000 $/kg/yr
- 3 points – ≤10,000 $/kg/yr

Other Benefits (weight 10%) - 1 point per item up to 3 total points

- Improves or protects infrastructure
- Demonstration project
- Provides opportunity for education
- Reduces peak flows or erosion
- Reduces flooding


2-3
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1-2
1-8
1-7
1-4
3-2
1-6
3-4
1-5
3-1
3-3
MANLEY HILL RD
MILL ST
WEST FAIRLEE
BLOOD BROOK RD
FAIRLEE
WILSON RD
MIDDLEBROOK RD
VT ROUTE 113
WEST FAIRLEE RD
DUSTY WAY
HEBBARD RD
VT ROUTE 244
LAKESHORE RD
STUDIO RD
LAKE FAIRLEE
QUINIBECK RD
POTATO HILL RD N
THETFORD
VT ROUTE 113
Lake Fairlee Projects
Legend
Shoreland Projects
Roads Projects
Stream Projects
Town Boundary
Road
Stream
Parcels
Lake Fairlee Watershed
0
0.25
0.5 Miles
N
Map created on June 2, 2023

Lake Fairlee LWAP - Projects Listed by Project type
Fairlee, Thetford, and West Fairlee, Vermont
White River Natural Resources Conservation District
May 31, 2023

Project Number Segment	Project Order	Project Category	Project Type	Project Description	Project Location	Ownership	Improve Water Quality (P reduction Calculator)	Cost Effectiveness ($/kg/yr)	Landowner Support	Improves or Protects Habitat	Additional Benefits	Average Score (out of possible score of 3)	Priority	Project Completed	Comments
							25.0%	20.0%	25.0%	20.0%	10.0%				
1-1	1	Lakeshore	Stormwater Improvement	Stabilization of Eroding Access Road	Treasure Island Recreation Area	Town of Thetford	1	0	3	3	3	1.90	Moderate		The access road adjacent to the tennis courts is eroding and material is going over the bank into the Lake.
1-2	2	Lakeshore	Buffer Improvement	Widen Buffers Along Lakeshore	Treasure Island Recreation Area	Town of Thetford	0	0	3	2	2	1.35	Low		There are locations where buffers could be widened in the picnic area.
1-3	3	Lakeshore	Stormwater Improvement	Rain Garden and Sand Containment	Treasure Island Recreation Area	Town of Thetford	1	0	3	3	2	1.80	Moderate		The sand containment system is being outflanked. Improve sand containment and treat runoff.
1-4	4	Lakeshore	Bioengineering	Lakeshore Retaining Wall	Private Lakeshore Property Landowner	Private Landowner	2	1	3	3	3	2.35	High		Seawall has deteriorated. Replace with bioengineered solution. Site constraints include small yard and close proximity to house.
1-5	5	Lakeshore	Stormwater Improvement	Sand Containment	Ohana Family Camp	Aloha Foundation, Inc.	1	1	3	3	2	2.00	Moderate	√	Install perforated pipe around beachfront to reduce sand reaching Lake Fairlee
1-6	6	Lakeshore	Buffer Improvement	Widen and Enhance Buffers Along Lakeshore	Adjacent to Route 244	State of VT	3	3	1	2	1	2.10	High		This buffer improvement project is within the right-of-way along Route 244
1-7	7	Lakeshore	Bioengineering	Lakeshore Retaining Wall	Horizons Day Camp	Aloha Foundation, Inc.	3	1	3	3	3	2.60	High		The seawall has deteriorated. Replace with bioengineered solution. Site constraints include beach house and dock in close proximity. Design would not to consider safety of swimmers.
1-8	8	Lakeshore	Stormwater Improvement	Infiltration Steps	Aloha Hive Camp	Aloha Foundation, Inc.	0	0	3	2	2	1.35	Low		Stormwater is causing erosion in the vicinity of a building (wash station) that is close to the shoreline. Infiltration steps will help reduce erosion.
1-9	9	Lakeshore	Stormwater Improvement	Parking Lot Water Bars	Treasure Island Recreation Area	Town of Thetford	1	0	3	2	3	1.70	Moderate		Parking lot located upslope from Lake Fairlee requires stormwater improvement. Water bars in gravel parking lot need to be established. Parking lot would benefit from the installation of an additional water bar.
2-1	10	Stream	Buffer Improvement	Widen Stream Buffers Along Agriculture Fields	Middle Brook	Private Landowner	3	3	0	3	2	2.15	High		Buffers along agricultural fields are narrow. Landowner has indicated to NRCS an d NRCD that buffer plantings in this area are not practical.
2-2	11	Stream	Buffer Improvement	Widen Stream Buffers	Middle Brook	Private Landowner	1	3	0	3	2	1.65	Moderate		Stream bank is eroding and is migrating toward mowed back yard. Landowner has been approached by District and is not interested in tree plantings or increasing buffer in this area.
2-3	12	Stream	Forested Buffer/Live stock exclusion/Stream Crossings	Widen Stream Buffer and Reduce Animal Crossings	Blood Brook	Private Landowner	3	3	0	3	2	2.15	High		Horses are crossing the stream and creating erosion in the stream and along the banks. Riparian buffers are absent or narrow.
2-4	13	Stream	Livestock exclusion	Stream Exclusion/Fencing	Blood Brook	Private Landowner	3	3	0	3	2	2.15	High		Livestock have access to stream channel and banks and are creating erosion; Reduce number of animal crossings and exclude livestock with fencing.
3-1a	14	Road	Stormwater Improvement	Road surfacing/paving	Robinson Hill Road	Town of Thetford	1	0	3	3	2	1.80	Moderate		Sediment is entering the Lake when Robinson Hill Road becomes saturated and soft during mud season. Reduce sediment by extending pavement.

Lake Fairlee LWAP - Projects Listed by Project type
Fairlee, Thetford, and West Fairlee, Vermont
White River Natural Resources Conservation District
May 31, 2023

Project Number Segment	Project Order	Project Category	Project Type	Project Description	Project Location	Ownership	Improve Water Quality (P reduction Calculator)	Cost Effectiveness ($/kg/yr)	Landowner Support	Improves or Protects Habitat	Additional Benefits	Average Score (out of possible score of 3)	Priority	Project Completed	Comments
							25.0%	20.0%	25.0%	20.0%	10.0%				
3-1b	15	Road	Stormwater Improvement	Stormwater infrastructure/ BMPs	Robinson Hill Road	Town of Thetford	1	1	3	1	1	1.50	Moderate		Reduce erosion and sediment reaching the Lake by installing cross culverts to break up stormwater flow.
3-1c	16	Road	Stormwater Improvement	Stormwater infrastructure	Robinson Hill Road/Norway Brook	Town of Thetford	1	1	3	1	1	1.50	Moderate		Outlet of pond is susceptible to debris jams. Install debris control device at outlet to reduce the chance of the culvert blowing out.
3-1d	17	Road	Stormwater and Riparian Zone Improvement	No Mow Zone	Robinson Hill Road	Town of Thetford	1	3	3	2	2	2.20	High	√	Continue "no mow" zone adjacent to Lake to promote improved vegetation and filtering of stormwater contaminants.
3-2	18	Road	Stormwater Improvement	Stormwater infrastructure/ BMPs	Anna Dodge Road	Private Road	1	0	3	2	2	1.60	Moderate		Preferred project is to install cross culvert to dissipate flow to reduce erosion. Alternate project is to install check dams to help trap sediment . The project check dam project will require maintenance.
3-3	19	Road	Stormwater Improvement	Stormwater infrastructure/ BMP	Quinibeck Road	Town of Thetford	0	2	3	1	1	1.45	Low		Berms have developed at the edge of the road and have blocked the drainage of water off the road. Establish turn out to allow drainage off road.
3-4	20	Road	Stormwater Improvement	Stormwater infrastructure/ BMP	Bragg Road	Town of Thetford	1	0	3	3	1	1.70	Moderate		Install turn outs or other erosion control measures to frequently divert water off road to reduce erosion and sedimentation. Stream is adjacent to road and receives sediment.

Lake Fairlee LWAP - Project Prioritization by Score
Fairlee, Thetford, and West Fairlee, Vermont
White River Natural Resources Conservation District
May 31, 2023

Project Number Segment	Project Order	Project Category	Project Type	Project Description	Project Location	Ownership	Improve Water Quality (P reduction Calculator)	Cost Effectiveness ($/kg/yr)	Landowner Support	Improves or Protects Habitat	Additional Benefits	Average Score (out of possible score of 3)	Priority	Project Completed	Comments
							25.0%	20.0%	25.0%	20.0%	10.0%				
1-7	7	Lakeshore	Bioengineering	Lakeshore Retaining Wall	Horizons Day Camp	Aloha Foundation, Inc.	3	1	3	3	3	2.60	High		The seawall has deteriorated. Replace with bioengineered solution. Site constraints include beach house and dock in close proximity. Design would not to consider safety of swimmers.
1-4	4	Lakeshore	Bioengineering	Lakeshore Retaining Wall	Private Lakeshore Property Landowner	Private Landowner	2	1	3	3	3	2.35	High		Seawall has deteriorated. Replace with bioengineered solution. Site constraints include small yard and close proximity to house.
3-1d	17	Road	Stormwater and Riparian Zone Improvement	No Mow Zone	Robinson Hill Road	Town of Thetford	1	3	3	2	2	2.20	High	√	Continue "no mow" zone adjacent to Lake to promote improved vegetation and filtering of stormwater contaminants.
2-1	10	Stream	Buffer Improvement	Widen Stream Buffers Along Agriculture Fields	Middle Brook	Private Landowner	3	3	0	3	2	2.15	High		Buffers along agricultural fields are narrow. Landowner has indicated to NRCS an d NRCD that buffer plantings in this area are not practical.
2-3	12	Stream	Forested Buffer/Live stock exclusion/Stream Crossings	Widen Stream Buffer and Reduce Animal Crossings	Blood Brook	Private Landowner	3	3	0	3	2	2.15	High		Horses are crossing the stream and creating erosion in the stream and along the banks. Riparian buffers are absent or narrow.
2-4	13	Stream	Livestock exclusion	Stream Exclusion/Fencing	Blood Brook	Private Landowner	3	3	0	3	2	2.15	High		Livestock have access to stream channel and banks and are creating erosion; Reduce number of animal crossings and exclude livestock with fencing.
1-6	6	Lakeshore	Buffer Improvement	Widen and Enhance Buffers Along Lakeshore	Adjacent to Route 244	State of VT	3	3	1	2	1	2.10	High		This buffer improvement project is within the right-of-way along Route 244
1-5	5	Lakeshore	Stormwater Improvement	Sand Containment	Ohana Family Camp	Aloha Foundation, Inc.	1	1	3	3	2	2.00	Moderate	√	Install perforated pipe around beachfront to reduce sand reaching Lake Fairlee
1-1	1	Lakeshore	Stormwater Improvement	Stabilization of Eroding Access Road	Treasure Island Recreation Area	Town of Thetford	1	0	3	3	3	1.90	Moderate		The access road adjacent to the tennis courts is eroding and material is going over the bank into the Lake.
1-3	3	Lakeshore	Stormwater Improvement	Rain Garden and Sand Containment	Treasure Island Recreation Area	Town of Thetford	1	0	3	3	2	1.80	Moderate		The sand containment system is being outflanked. Improve sand containment and treat runoff.
3-1a	14	Road	Stormwater Improvement	Road surfacing/paving	Robinson Hill Road	Town of Thetford	1	0	3	3	2	1.80	Moderate		Sediment is entering the Lake when Robinson Hill Road becomes saturated and soft during mud season. Reduce sediment by extending pavement.
3-4	20	Road	Stormwater Improvement	Stormwater infrastructure/ BMP	Bragg Road	Town of Thetford	1	0	3	3	1	1.70	Moderate		Install turn outs or other erosion control measures to frequently divert water off road to reduce erosion and sedimentation. Stream is adjacent to road and receives sediment.
1-9	9	Lakeshore	Stormwater Improvement	Parking Lot Water Bars	Treasure Island Recreation Area	Town of Thetford	1	0	3	2	3	1.70	Moderate		Parking lot located upslope from Lake Fairlee requires stormwater improvement. Water bars in gravel parking lot need to be established. Parking lot would benefit from the installation of an additional water bar.
2-2	11	Stream	Buffer Improvement	Widen Stream Buffers	Middle Brook	Private Landowner	1	3	0	3	2	1.65	Moderate		Stream bank is eroding and is migrating toward mowed back yard. Landowner has been approached by District and is not interested in tree plantings or increasing buffer in this area.

Lake Fairlee LWAP - Project Prioritization by Score
Fairlee, Thetford, and West Fairlee, Vermont
White River Natural Resources Conservation District
May 31, 2023

Project Number Segment	Project Order	Project Category	Project Type	Project Description	Project Location	Ownership	Improve Water Quality (P reduction Calculator)	Cost Effectiveness ($/kg/yr)	Landowner Support	Improves or Protects Habitat	Additional Benefits	Average Score (out of possible score of 3)	Priority	Project Completed	Comments
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3-2	18	Road	Stormwater Improvement	Stormwater infrastructure/ BMPs	Anna Dodge Road	Private Road	1	0	3	2	2	1.60	Moderate		Preferred project is to install cross culvert to dissipate flow to reduce erosion. Alternate project is to install check dams to help trap sediment . The project check dam project will require maintenance.
3-1b	15	Road	Stormwater Improvement	Stormwater infrastructure/ BMPs	Robinson Hill Road	Town of Thetford	1	1	3	1	1	1.50	Moderate		Reduce erosion and sediment reaching the Lake by installing cross culverts to break up stormwater flow.
3-1c	16	Road	Stormwater Improvement	Stormwater infrastructure	Robinson Hill Road/Norway Brook	Town of Thetford	1	1	3	1	1	1.50	Moderate		Outlet of pond is susceptible to debris jams. Install debris control device at outlet to reduce the chance of the culvert blowing out.
3-3	19	Road	Stormwater Improvement	Stormwater infrastructure/ BMP	Quinibeck Road	Town of Thetford	0	2	3	1	1	1.45	Low		Berms have developed at the edge of the road and have blocked the drainage of water off the road. Establish turn out to allow drainage off road.
1-2	2	Lakeshore	Buffer Improvement	Widen Buffers Along Lakeshore	Treasure Island Recreation Area	Town of Thetford	0	0	3	2	2	1.35	Low		There are locations where buffers could be widened in the picnic area.
1-8	8	Lakeshore	Stormwater Improvement	Infiltration Steps	Aloha Hive Camp	Aloha Foundation, Inc.	0	0	3	2	2	1.35	Low		Stormwater is causing erosion in the vicinity of a building (wash station) that is close to the shoreline. Infiltration steps will help reduce erosion.

Lake Fairlee LWAP - Project Prioritization by Score (Landowner Support Not Considered in Score)
Fairlee, Thetford, and West Fairlee, Vermont
White River Natural Resources Conservation District
May 31, 2023

Project Number Segment	Project Order	Project Category	Project Type	Project Description	Project Location	Ownership	Improve Water Quality (P reduction Calculator)	Cost Effectiveness ($/kg/yr)	Landowner Support	Improves or Protects Habitat	Additional Benefits	Average Score (out of possible score of 3)	Priority	Project Completed	Comments
							25.0%	20.0%	0.0%	20.0%	10.0%				
2-1	10	Stream	Buffer Improvement	Widen Stream Buffers Along Agriculture Fields	Middle Brook	Private Landowner	3	3	0	3	2	2.87	High		Buffers along agricultural fields are narrow. Landowner has indicated to NRCS an d NRCD that buffer plantings in this area are not practical.
2-3	12	Stream	Forested Buffer/Live stock exclusion/Stream Crossings	Widen Stream Buffer and Reduce Animal Crossings	Blood Brook	Private Landowner	3	3	0	3	2	2.87	High		Horses are crossing the stream and creating erosion in the stream and along the banks. Riparian buffers are absent or narrow.
2-4	13	Stream	Livestock exclusion	Stream Exclusion/Fencing	Blood Brook	Private Landowner	3	3	0	3	2	2.87	High		Livestock have access to stream channel and banks and are creating erosion; Reduce number of animal crossings and exclude livestock with fencing.
1-7	7	Lakeshore	Bioengineering	Lakeshore Retaining Wall	Horizons Day Camp	Aloha Foundation, Inc.	3	1	3	3	3	2.47	High		The seawall has deteriorated. Replace with bioengineered solution. Site constraints include beach house and dock in close proximity. Design would not to consider safety of swimmers.
1-6	6	Lakeshore	Buffer Improvement	Widen and Enhance Buffers Along Lakeshore	Adjacent to Route 244	State of VT	3	3	1	2	1	2.47	High		This buffer improvement project is within the right-of-way along Route 244
2-2	11	Stream	Buffer Improvement	Widen Stream Buffers	Middle Brook	Private Landowner	1	3	0	3	2	2.20	High		Stream bank is eroding and is migrating toward mowed back yard. Landowner has been approached by District and is not interested in tree plantings or increasing buffer in this area.
1-4	4	Lakeshore	Bioengineering	Lakeshore Retaining Wall	Private Lakeshore Property Landowner	Private Landowner	2	1	3	3	3	2.13	High		Seawall has deteriorated. Replace with bioengineered solution. Site constraints include small yard and close proximity to house.
3-1d	17	Road	Stormwater and Riparian Zone Improvement	No Mow Zone	Robinson Hill Road	Town of Thetford	1	3	3	2	2	1.93	Moderate	√	Continue "no mow" zone adjacent to Lake to promote improved vegetation and filtering of stormwater contaminants.
1-5	5	Lakeshore	Stormwater Improvement	Sand Containment	Ohana Family Camp	Aloha Foundation, Inc.	1	1	3	3	2	1.67	Moderate	√	Install perforated pipe around beachfront to reduce sand reaching Lake Fairlee
1-1	1	Lakeshore	Stormwater Improvement	Stabilization of Eroding Access Road	Treasure Island Recreation Area	Town of Thetford	1	0	3	3	3	1.53	Moderate		The access road adjacent to the tennis courts is eroding and material is going over the bank into the Lake.
1-3	3	Lakeshore	Stormwater Improvement	Rain Garden and Sand Containment	Treasure Island Recreation Area	Town of Thetford	1	0	3	3	2	1.40	Moderate		The sand containment system is being outflanked. Improve sand containment and treat runoff.
3-1a	14	Road	Stormwater Improvement	Road surfacing/paving	Robinson Hill Road	Town of Thetford	1	0	3	3	2	1.40	Moderate		Sediment is entering the Lake when Robinson Hill Road becomes saturated and soft during mud season. Reduce sediment by extending pavement.
3-4	20	Road	Stormwater Improvement	Stormwater infrastructure/ BMP	Bragg Road	Town of Thetford	1	0	3	3	1	1.27	Moderate		Install turn outs or other erosion control measures to frequently divert water off road to reduce erosion and sedimentation. Stream is adjacent to road and receives sediment.
1-9	9	Lakeshore	Stormwater Improvement	Parking Lot Water Bars	Treasure Island Recreation Area	Town of Thetford	1	0	3	2	3	1.27	Moderate		Parking lot located upslope from Lake Fairlee requires stormwater improvement. Water bars in gravel parking lot need to be established. Parking lot would benefit from the installation of an additional water bar.

Lake Fairlee LWAP - Project Prioritization by Score (Landowner Support Not Considered in Score)
Fairlee, Thetford, and West Fairlee, Vermont
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3-1b	15	Road	Stormwater Improvement	Stormwater infrastructure/ BMPs	Robinson Hill Road	Town of Thetford	1	1	3	1	1	1.00	Moderate		Reduce erosion and sediment reaching the Lake by installing cross culverts to break up stormwater flow.
3-1c	16	Road	Stormwater Improvement	Stormwater infrastructure	Robinson Hill Road/Norway Brook	Town of Thetford	1	1	3	1	1	1.00	Moderate		Outlet of pond is susceptible to debris jams. Install debris control device at outlet to reduce the chance of the culvert blowing out.
3-3	19	Road	Stormwater Improvement	Stormwater infrastructure/ BMP	Quinibeck Road	Town of Thetford	0	2	3	1	1	0.93	Low		Berms have developed at the edge of the road and have blocked the drainage of water off the road. Establish turn out to allow drainage off road.
1-2	2	Lakeshore	Buffer Improvement	Widen Buffers Along Lakeshore	Treasure Island Recreation Area	Town of Thetford	0	0	3	2	2	0.80	Low		There are locations where buffers could be widened in the picnic area.
1-8	8	Lakeshore	Stormwater Improvement	Infiltration Steps	Aloha Hive Camp	Aloha Foundation, Inc.	0	0	3	2	2	0.80	Low		Stormwater is causing erosion in the vicinity of a building (wash station) that is close to the shoreline. Infiltration steps will help reduce erosion.

APPENDIX F

CONCEPTUAL DESIGNS

Project 1-1: Treasure Island Stormwater Improvement - Access Road

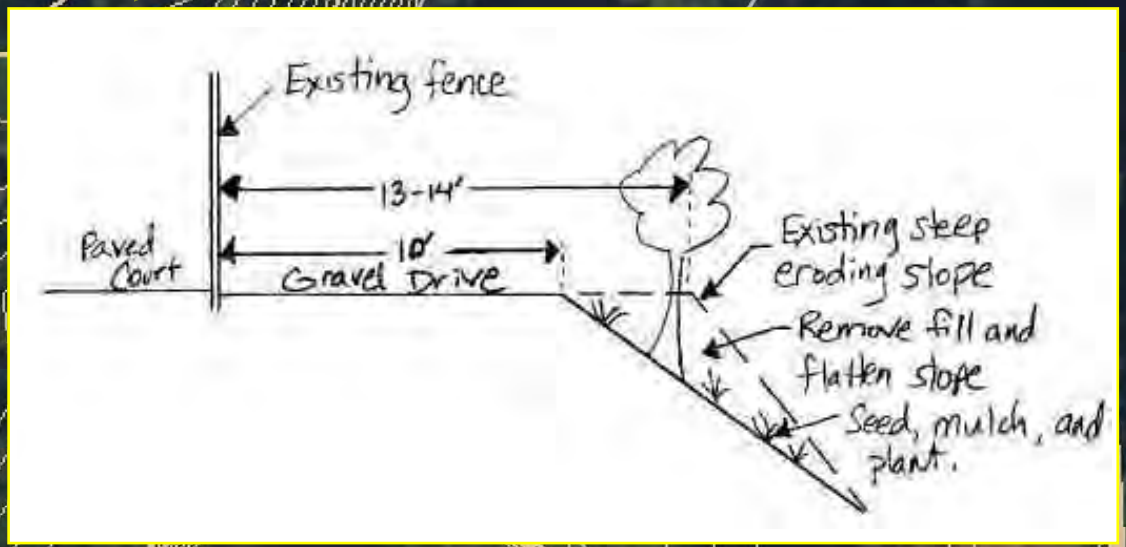
Existing fence around court

GRAVEL DRIVE. REDUCE WIDTH TO 10'

REMOVE FILL AND CREATE FLATTER SIDE SLOPE
* Currently steep and eroding
* Seed, mulch, and plant the new flatter slope

BLEND TO MATCH EXISTING AT BOTH ENDS

WEST FAIRLEE



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RIPPLE Natural Resources LLC

Bear Creek Environmental

Conceptual Design
Lake Fairlee Watershed Action Plan
White River NRCD

Drawn by Matthew Murawski, PE
and Mary Nealon, CPESC
4/18/2023

N

0 10 20 40 Feet

Project 1-3: Treasure Island French Drain - Sand Containment

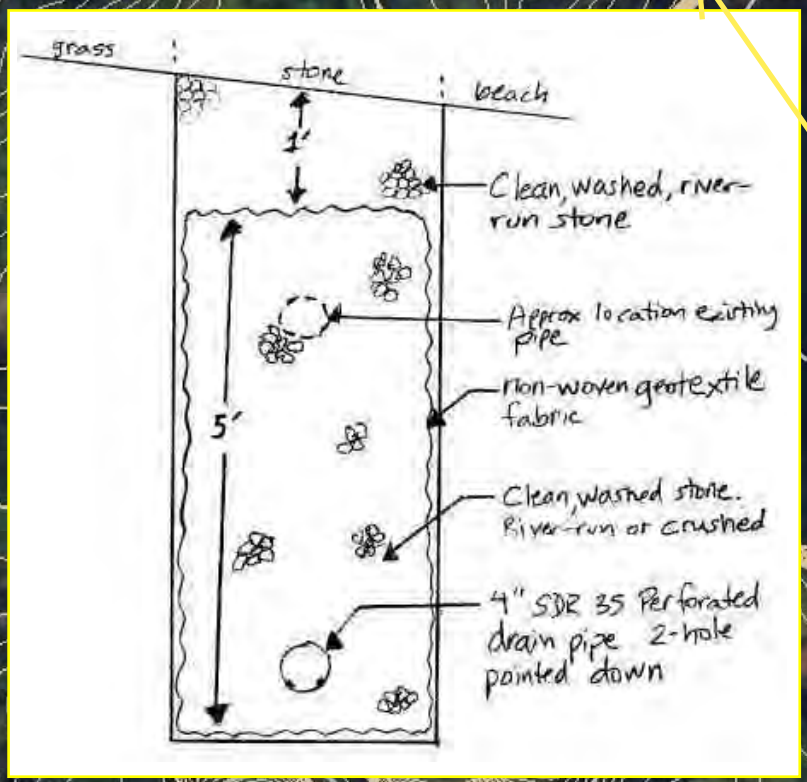
1.25-acre contributing drainage area

RE-ROUTE OUTLET PIPE
* Shallow ledge limits depth
* Route under gazebo deck (above grade, but concealed) and outlet on lake side.
* Eliminates beach erosion at existing outlet

RECONSTRUCT FRENCH DRAIN
*Intended to catch groundwater flowing under or through existing drain and eroding beach.
* Install deeper than existing system
* Use perforated PVC drain pipe with holes down.

RAIN GARDEN AT OUTLET
* grade to facilitate infiltration and disperse high flows
* plant with native species

WEST FAIRLEE



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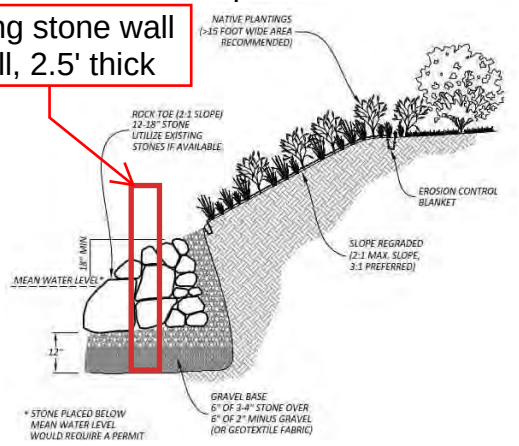
N

0 12.5 25 50 Feet

Project 1-4: Anna Dodge Lane Bioengineered Lakeshore

BETWEEN STAIRS: STONE TOE WITH NATIVE PLANTINGS (78 +/-)
* Remove existing mortared stone wall and blend with imported larger stone.
* Slope bank back and plant

Existing stone wall 3.5' tall, 2.5' thick



Source: Vermont Bioengineering Manual, Vermont DEC, January 2022

MAINTAIN EXISTING STEPS
* For water access

Existing mortared stone

MAINTAIN EXISTING STEPS
* For water access

Existing house

IN FRONT OF HOUSE: NEW STONE AT WALL TOE (32 +/-)
* Place stone at base of existing wall for wave break and habitat
* Leave wall intact

13.5' from house to wall

FAIRLEE

Anna Dodge Ln

VCGI

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Bear Creek Environmental

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White River NRCD

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4/18/2023

N

0 12.5 25 50 Feet

Project 1-7: Horizons Camp Bioengineered Lakeshore

VT ROUTE 244

WEST FAIRLEE

Existing boathouse

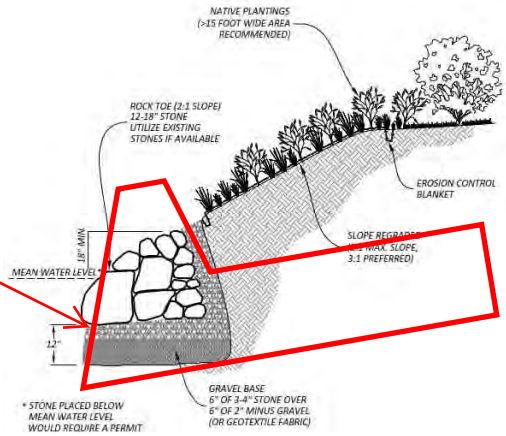
Existing failed concrete wall

NEW STONE TOE +/- 215 LF

Subject to ANR clearance, place stone toe lakeward of existing wall where clearance to building requires.

NEW STONE TOE WITH NATIVE PLANTINGS (+/-215 LF)
* Remove and dispose of existing concrete wall.
* Construct Stone Toe.
* Slope bank back.
* Plant bank where camp use allows.

Existing concrete wall. 3' tall. Sloped faces (1.5H:1V). 1' top width. 7' heal extending back into earth. Wall is rotated, pushing soil up.



Source: Vermont Bioengineering Manual, Vermont DEC, January 2022

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4/18/2023

N

0 12.5 25 50 Feet

Project 1-9: Treasure Island Stormwater Improvement - Parking Lot

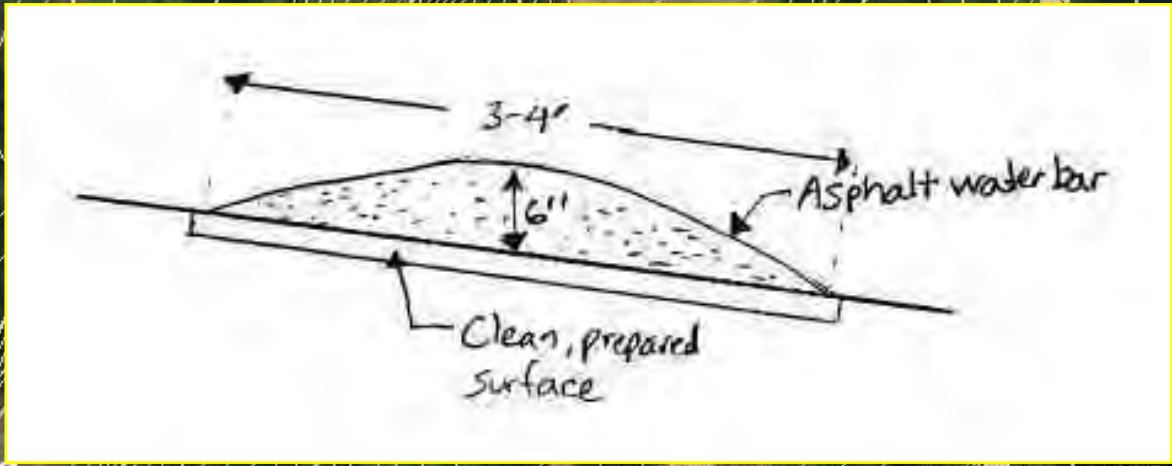
VT ROUTE 244

EXISTING UPPER WATERBAR. 51+/- LF. **Reconstruct** to ensure diversion of water.

NEW MIDDLE WATERBAR. 93+/- LF. **Add** to reduce runoff to lower waterbar and improve infiltration at downstream end.

EXISTING LOWER WATERBAR. 60+/- LF. **Reconstruct** to ensure diversion of water.

Grade outlet of each waterbar as needed to ensure dispersion of water and encourage infiltration.



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N

0 12.5 25 50 Feet

Project 3-1a: Robinson Hill Road Stormwater Improvements - Paving

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Bear Creek Environmental

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White River NRCD

Drawn by Matthew Murawski, PE
and Mary Nealon, CPESC
4/18/2023

N

0 75 150 300 Feet

Project 3-1b: Robinson Hill Road Stormwater Improvements - Cross Culvert

NEW 18" CROSS CULVERT
* Located immediately below Norway Ln.
* Captures runoff from 1.5 ac+/-
* Intended to reduce flow and erosion in lower ditch that discharges directly to lake

THETFORD

Norway Ln

ROBINSON HILL RD

IMPROVE DITCH on culvert approach to accommodate installation of culvert

Start of flow toward new culvert

New Culvert Location

bing

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White River NRCD

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4/18/2023

N

0 50 100 200 Feet

Project 3-1c: Robinson Hill Road Pond Outlet Improvement

NEW POND OUTLET STRUCTURE
* Located at entrance to existing culvert
* Avoids flushing of water, sediment, and nutrients that accompanies clearing of debris
* Avoids fluctuating pond levels that increase shore erosion
* Reduces beaver debris blockage and local flooding
* Facilitates removal of debris

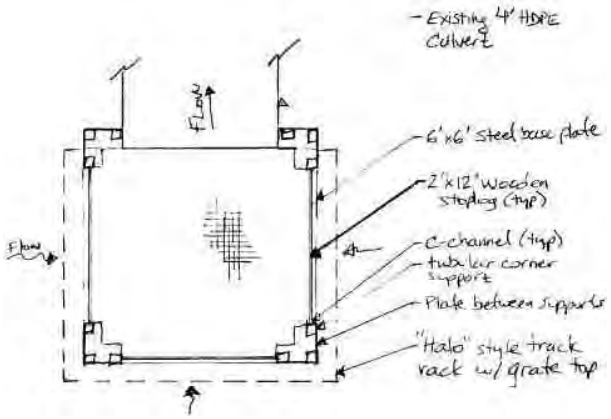
Robinson Hill Rd

THETFORD

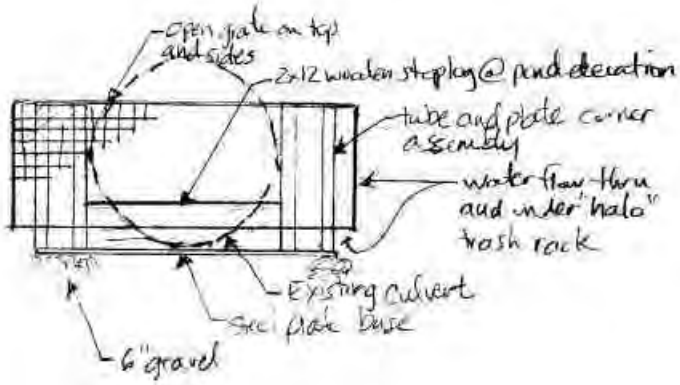
Existing 48-inch Culvert

hdpe 48 in

OUTLET STRUCTURE DETAILS



PLAN VIEW



ELEVATION VIEW

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Bear Creek Environmental

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White River NRCD

Drawn by Matthew Murawski, PE
and Mary Nealon, CPESC
4/18/2023

N

0 25 50 100 Feet

Project 3-2: Anna Dodge Lane Stormwater Improvements

Alternate Project:
INSTALL THREE STONE CHECK DAMS
* In ditch 250' - 300' below existing culvert
* Intended to slow water and accumulate sediment
* Remove sediment annually or as necessary

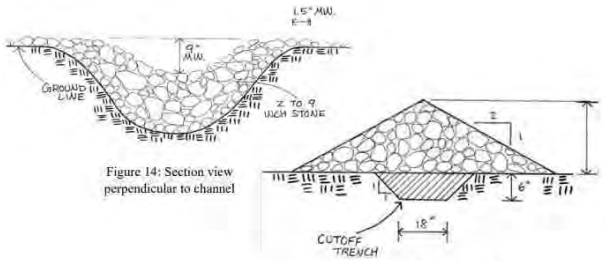

Figure 14: Section view perpendicular to channel

Figure 15: Section view parallel to channel

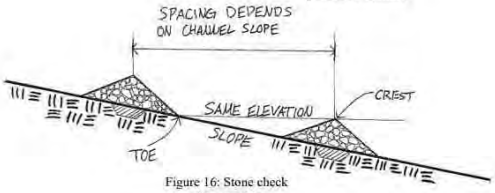

Figure 16: Stone check dam spacing

Source: Vermont Better Back Roads Manuals, VTrans 2019

Existing Culvert

Preferred Project:
NEW 18" CROSS CULVERT
* Located 250'+/- ft below existing culvert.
* Intended to reduce flow and erosion in lower ditch

Anna Dodge Ln

Existing wooded flowpath

FAIRLEE

Preferred Project:
MINOR GRADING
* to ensure water flows away from building
* Seed and mulch to match existing site character

New Culvert Location

Existing Culvert

Anna Dodge Ln

VCGI

RIPPLE Natural Resources LLC

Bear Creek Environmental

Conceptual Design
Lake Fairlee Watershed Action Plan
White River NRCD

Drawn by Matthew Murawski, PE and Mary Nealon, CPESC
4/17/2023

N

0 25 50 100 Feet

Project 3-4: Bragg Road Stormwater Improvements

Alternate Project:
NEW TURNOUT
* Intended to reduce flow and erosion at outlet of existing ditch.
* Turnout provides location for water to infiltrate and sediment to deposit.

Preferred Project:
NEW 18" CROSS CULVERT
* Intended to reduce flow and erosion at outlet of existing ditch.

FAIR

IETFORD

Existing Culvert

Bragg Rd

VCGI

RIPPLE Natural Resources LLC

Bear Creek Environmental

Conceptual Design
Lake Fairlee Watershed Action Plan
White River NRCD

Drawn by Matthew Murawski, PE
and Mary Nealon, CPESC
4/18/2023

N

0 25 50 100 Feet

Lake Fairlee Watershed Action Plan
Construction Cost Estimates

Project 1-1: Treasure Island Access Road

Item	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization/Demob	1	Lump	$ 1,100	$ 1,100
2	Erosion Control	1	Lump Sum	$ 1,000	$ 1,000
3	Excavation and Hauling	108	Cubic Yards	$ 50	$ 5,400
4	Plantings	1	Lump	$ 5,000	$ 5,000
5	Survey, Engineering, and Permitting	1	Lump	$ 3,000	$ 3,000
6	Contingency			25%	$ 3,900
	TOTAL				$ 19,400
				USE	$ 20,000

Project 1-3: Treasure Island French Drain

Item	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization/Demob	1	Lump	$ 2,000	$ 2,000
2	Erosion Control	1	Lump	$ 2,000	$ 2,000
3	Excavation and Hauling	30	Cubic Yards	$ 50	$ 1,500
4	Materials	1	Lump	$ 5,000	$ 5,000
5	Survey, Engineering, and Permitting	1	Lump	$ 3,000	$ 3,000
6	Contingency			25%	$ 3,400
	TOTAL				$ 16,900
				USE	$ 17,000

Project 1-4: Anna Dodge Lane Bioengineered Lakeshore

Item	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization/Demob	1	Lump	$ 2,400	$ 2,400
2	Erosion Control	1	Lump	$ 3,000	$ 3,000
3	Excavation and Hauling	15	Cubic Yards	$ 100	$ 1,500
4	Imported Stone	30	Cubic Yards	$ 300	$ 9,000
5	Plantings	1	Lump	$ 5,000	$ 5,000
6	Site Restoration	1	Lump	$ 5,000	$ 5,000
6	Survey, Engineering, and Permitting	1	Lump	$ 7,500	$ 7,500
7	Contingency			25%	$ 8,400
	TOTAL				$ 41,800
				USE	$ 42,000

Project 1-7: Horizons Camp Bioengineered Lakeshore

Item	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization/Demob	1	Lump	$ 4,500	$ 4,500
2	Erosion Control	1	Lump	$ 3,000	$ 3,000
3	Excavation and Hauling	108	Cubic Yards	$ 100	$ 10,800
4	Imported Stone	72	Cubic Yards	$ 300	$ 21,600
5	Plantings	1	Lump	$ 5,000	$ 5,000
6	Site Restoration	1	Lump	$ 5,000	$ 5,000
7	Survey, Engineering, and Permitting	1	Lump	$ 7,500	$ 7,500
8	Contingency			25%	$ 14,400
	TOTAL				$ 71,800
				USE	$ 72,000

Project 1-9: Treasure Island Parking Lot Stormwater Improvements

Item	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization/Demob	1	Lump	$ 2,000	$ 2,000
2	Erosion Control	1	Lump	$ 1,000	$ 1,000
3	Excavation and Hauling	8	Cubic Yards	$ 75	$ 600
4	Asphalt Waterbars	15.3	Tons	$ 350	$ 5,355
6	Site Restoration	1	Lump	$ 1,000	$ 1,000
7	Survey, Engineering, and Permitting	1	Lump	$ 3,000	$ 3,000
8	Contingency			25%	$ 3,200
	TOTAL				$ 16,155
				USE	$ 17,000

Project 3-1a: Robinson Hill Road Paving

Item	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization/Demob	1	Lump	$ 6,900	$ 6,900
2	Erosion Control	1	Lump	$ 1,000	$ 1,000
3	Excavation and Hauling	30	Cubic Yards	$ 40	$ 1,200
4	Roadway Paving	312.5	Tons	$ 202	$ 63,125
5	Traffic Control	1	Lump	$ 3,000	$ 3,000
6	Site Restoration	1	Lump	$ 1,000	$ 1,000
7	Survey, Engineering, and Permitting	1	Lump	$ 11,000	$ 11,000
8	Contingency			25%	$ 21,800
	TOTAL				$ 109,025
				USE	$ 110,000

Project 3-1b: Robinson Hill Road New Culvert

Item	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization/Demob	1	Lump	$ 2,000	$ 2,000
2	Erosion Control	1	Lump	$ 1,000	$ 1,000
3	Excavation and Hauling	45	Cubic Yards	$ 40	$ 1,800
4	Gravel	53	Cubic Yards	$ 50	$ 2,650
5	Culvert	1	Lump	$ 1,500	$ 1,500
6	Traffic Control	1	Lump	$ 1,000	$ 1,000
7	Site Restoration	1	Lump	$ 1,000	$ 1,000
8	Survey, Engineering, and Permitting	1	Lump	$ 3,000	$ 3,000
9	Contingency			25%	$ 3,500
	TOTAL				$ 17,450
				USE	$ 18,000

Project 3-1c: Robinson Hill Road Pond Outlet Improvements

Item	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization/Demob	1	Lump	$ 2,000	$ 2,000
2	Erosion Control	1	Lump	$ 1,000	$ 1,000
3	Excavation and Hauling	15	Cubic Yards	$ 40	$ 600
4	Crushed Stone	5	Cubic Yards	$ 50	$ 237
5	Outlet Structure Fabrication	1	Lump	$ 6,000	$ 6,000
6	Outlet Structure Install	1	Lump	$ 3,500	$ 3,500
7	Site Restoration	1	Lump	$ 1,000	$ 1,000
8	Survey, Engineering, and Permitting	1	Lump	$ 3,000	$ 3,000
9	Contingency			25%	$ 4,300
	TOTAL				$ 21,637
				USE	$ 22,000

Project 3-2: Anna Dodge Lane Stormwater New Culvert

Item	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization/Demob	1	Lump	$ 2,000	$ 2,000
2	Erosion Control	1	Lump	$ 1,000	$ 1,000
3	Excavation and Hauling	30	Cubic Yards	$ 40	$ 1,200
4	Gravel	53	Cubic Yards	$ 50	$ 2,650
5	Culvert	1	Lump	$ 1,500	$ 1,500
6	Traffic Control	1	Lump	$ 1,000	$ 1,000
7	Site Restoration	1	Lump	$ 1,000	$ 1,000
8	Survey, Engineering, and Permitting	1	Lump	$ 3,000	$ 3,000
9	Contingency			25%	$ 3,300
	TOTAL				$ 16,650
				USE	$ 17,000

Project 3-4: Bragg Road Stormwater New Culvert

Item	Description	Quantity	Units	Unit Cost	Total Cost
1	Mobilization/Demob	1	Lump	$ 2,000	$ 2,000
2	Erosion Control	1	Lump	$ 1,000	$ 1,000
3	Excavation and Hauling	30	Cubic Yards	$ 40	$ 1,200
4	Gravel	53	Cubic Yards	$ 50	$ 2,650
5	Culvert	1	Lump	$ 1,500	$ 1,500
6	Traffic Control	1	Lump	$ 1,000	$ 1,000
7	Site Restoration	1	Lump	$ 1,000	$ 1,000
8	Survey, Engineering, and Permitting	1	Lump	$ 3,000	$ 3,000
9	Contingency			25%	$ 3,300
	TOTAL				$ 16,650
				USE	$ 17,000

NOTES:

1. This is our opinion of probable construction cost based on conceptual designs.
2. The costs assume projects are advanced through design and construction as stand-alone efforts. Economies of scale that may be achieved by lumping projects together are not reflected.
3. Ripple has no control over the cost or availability of labor, equipment or materials, market conditions, or the Contractor's method of pricing, and we can make no warranty, express or implied, with respect to the accuracy of this cost estimate relative to actual costs. Actual costs will differ.

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Permits Expected for Conceptual Design Projects

June 2, 2023

The table below provides preliminary information about which permits will likely be needed for the conceptual design projects. As projects move through the final design phase, it is recommended a request for a project review sheet be submitted to an ANR permit specialist. This project review is intended to assist the applicant with a list of potential permits that will be required.
https://fpr.vermont.gov/sites/fpr/files/Recreation/Recreation_Grants/Requesting%20a%20PR%20sheet.pdf

Project	No Permits Required	Vermont Shoreland Permit	Vermont Wetlands Permit	Vermont Stream Alteration Permit	Section 404 Permit
1-1: Treasure Island Access Rd	X				
1-3: Treasure Island French Drain and Rain Garden		X			
1-4: Anna Dodge Lane Bioengineered Lakeshore		X			X
1-7: Horizons Camp Bioengineered Lakeshore		X			X

Project	No Permits Required	Vermont Shoreland Permit	Vermont Wetlands Permit	Vermont Stream Alteration Permit	Section 404 Permit
1-9: Treasure Island Parking Lot Improvement	X				
3-1a: Robinson Hill Road Paving	X				
3-1b: Robinson Hill Road Cross Culvert	X				
3-1c: Robinson Hill Road Pond Outlet Improvement		X (by registration)		X	X
3-2: Anna Dodge Lane Stormwater Improvements	X				
3-4: Bragg Road Stormwater Improvements	X				