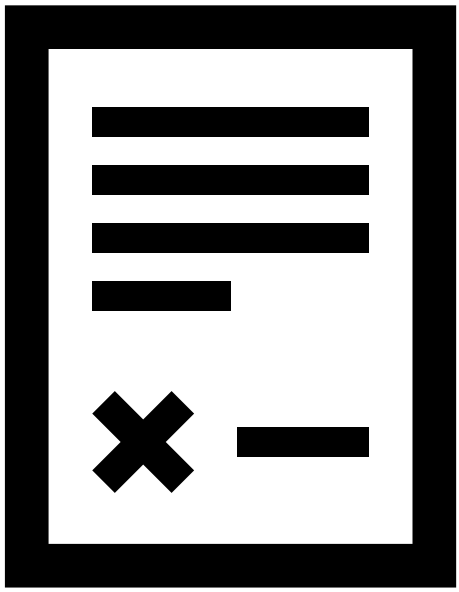
Upper Connecticut River Direct Tributaries

Basin 16 Tactical Basin Plan

Connecticut River, Maidstone Vermont

January 2021 | Draft for Management Review

Tactical Basin Plan was prepared in accordance with 10 VSA § 1253(d), the Vermont Water Quality Standards[1], the Federal Clean Water Act and 40 CFR 130.6, and the Vermont Surface Water Management Strategy.



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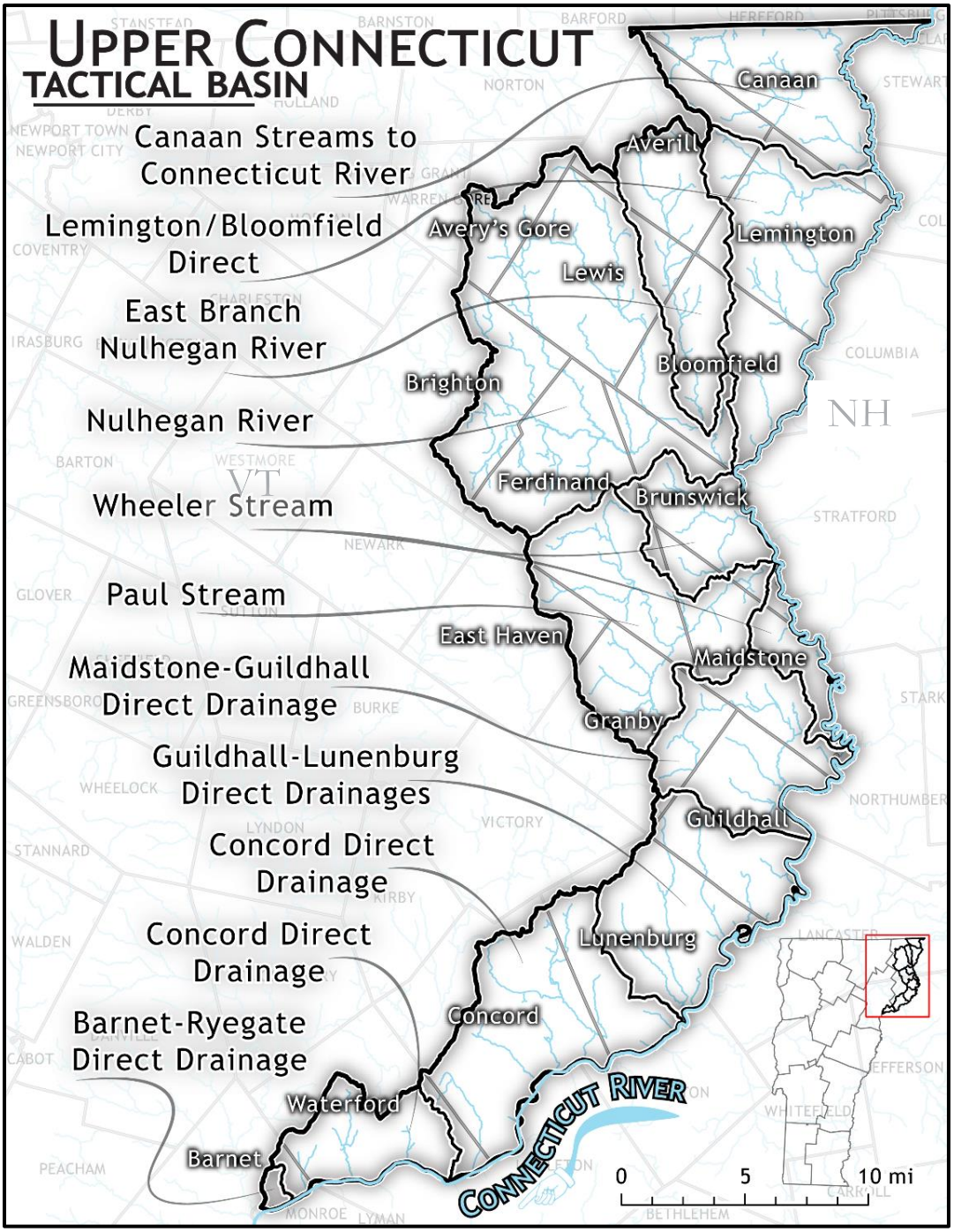
List of Basin 16 Towns

Averill	Brunswick	Granby	Maidstone
Avery's Gore	Canaan	Guildhall	Waterford
Barnet	Concord	Lemington	
Bloomfield	East Haven	Lewis	
Brighton	Ferdinand	Lunenburg	

Basin 16 Watershed Boundary and Towns



Basin 16 Tactical Plan Overview

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Executive Summary

Basin 16 comprises multiple sub-basins that drain to the Connecticut River north of the Passumpsic River confluence. The basin stretches from Canaan to Barnet draining portions of Caledonia, and Essex counties and covers significant areas of 17 individual towns and gores. The Basin 16 Tactical Basin Plan (TBP) provides a detailed description of current watershed condition and identifies water quality focused strategies to protect and restore the basin's surface waters.

The goal of the Tactical Basin Plan is to "Protect the Best and Restore the Rest" when it comes to surface waters of the State of Vermont.

Adapting how we manage and use our surface waters in the face of climate change is one of the chief overarching challenges for Basin 16, and beyond (State of Vermont, 2015). In Vermont, climate change is causing increases in storm intensity and total precipitation (Betts, 2011) (National Oceanic and Atmospheric Administration, 2013). These increases will likely lead to a rise in flooding, water quality and ecosystem impairments, and reduced water-based recreational availability to Vermonters (Pealer & Dunnington, 2011).

Protective measures, such as strategic land acquisition and limitations on development in riparian areas, may be the most economical solution to address the challenges presented by climate change and to achieve healthy surface waters (Watson, Ricketts, Galford, Polasky, & O'Niel-Dunne, 2016) (Weiskel, 2007). But where pollution from historic and current land use occurs, strategies are identified in this plan that will complement protective measures, such as river corridor easements, riparian area plantings, floodplain and wetland restoration, dam removals, and agriculture, silviculture and stormwater best management practices. To implement these strategies, a significant investment in time by federal, state, and local stakeholders is required. These coordination efforts are ongoing.

The information from monitoring events over the last 10 years have been incorporated in Chapters 1, 2, and 3, which cover the condition of surface waters, protection priorities, and restoration priorities, respectively. Overwhelmingly, the waters in Basin 16 meet or exceed water quality standards.

In Chapter 2, a total of 52 river segments, lakes, ponds, and wetlands are identified for protection or additional monitoring. Of the 52 waters, 22 river segments and two lakes and ponds meet criteria for enhanced protection for fishing, aesthetics, or aquatic biota. Eleven river segments and 15 lakes and ponds are identified for additional monitoring to determine if they meet reclassification criteria. Two wetlands are identified as potential Class I candidates and are recommended for further study to determine if they meet Class I wetland criteria. Target areas for protection are outlined in Table 1 and Figure 10.

Table 1. Focus areas and priority strategies for restoration and protection in Basin 16.

Focus Areas	Priority Strategies
Agriculture	
Mink Brook, Dean Brook and Willard Stream watersheds	• Connect farmers with the Connecticut River Watershed Farmers Alliance. • Continue biannual meetings of the Caledonia and Essex County Agricultural Workgroup. • Support workshops, outreach, and technical assistance necessary to support the implementation of nutrient management plans, soil health practices, agricultural best management practices. (BMPs), to reduce nitrogen and *E. coli* runoff. • Develop a basin specific trial to support the advancement of interseeding. • Provide technical and financial support to farmers to acquire equipment necessary for effective implementation of BMPs such as cover cropping and no/minimal tillage. • Identify a process and priorities for including floodplain and wetland restoration projects as farms transition ownership or are conserved.
Developed Lands - Stormwater	
Canaan, Bloomfield, Guildhall, Lunenburg	• Develop a Stormwater Master Plan for Canaan and Beecher Falls. • Implement priority stormwater projects identified in Stormwater Mapping Reports.
Developed Lands - Roads	
Maidstone Lake, Miles Pond, Wallace Pond watersheds.	• Complete Road Erosion Inventories (REIs) and implement BMPs on high priority road segments. • Provide and support training for road crews on using REI results to prioritize projects, to update road segment status in the MRGP database as well as the installation and maintenance of road BMPs to meet MRGP standards. • Provide support for towns to apply for better roads grants, shared hydroseeder program, and to reduce invasive species spread.
Wastewater	
Maidstone Lake, Miles Pond, Wallace Pond.	• Promote septic system maintenance through local outreach and education programs, such as a septic social.
Natural Resources - Rivers	
Connecticut River and lowest reaches of tributaries. Upland tributaries for strategic wood addition and culvert replacements.	• Develop and prioritize potential floodplain restoration and river corridor easement locations and implement these in coordination with basin partners. • Expand local sources of native tree species as sources for riverine buffer planting. • Target strategic wood additions and culvert replacements to restore Brook Trout habitat. • Provide support to towns to strengthen floodplain and river corridor protections in local flood hazard bylaws.
Natural Resources - Lakes	
Maidstone Pond, Miles Pond, Wallace Pond	• Complete and implement a Lake Watershed Action Plan for Maidstone Lake. • Complete outreach to the Miles and Wallace Pond communities around increasing nutrient trends and opportunities to support Lake Wise assessments and implementation. • Support aquatic invasive species spread prevention efforts.
Natural Resources - Wetlands	
Connecticut River floodplain and lowest reaches of tributaries.	• Complete site visits and/or location specific restoration maps for potential wetland restoration locations. • Increase wetland restoration opportunities by developing a funding model for smaller wetland restoration projects and for partners to acquire and steward wetlands. • Estimate nitrogen reduction potential for wetland restoration projects.
Natural Resources - Forests	
Existing & Prospective A(1) & B(1) watersheds	• Implement forest infrastructure restoration projects on state-owned forest lands. • Provide outreach, technical assistance, and workshops to private forestland owners, foresters, and loggers on Acceptable Management Practices and Use Value Appraisal (Current Use) Program, use of skidder bridges, and voluntary harvesting guidelines. • Support forestland conservation and skidder bridge loan program.

Although most surface waters monitored in Basin 16 meet or exceed water quality standards, there are waters in need of restoration. In Chapter 3, a total of 17 lakes, ponds, or river segments are identified for restoration. Fourteen of these segments are on the Connecticut River and are listed as impaired by the State of New Hampshire. Three lakes are considered impaired due to elevated mercury and acid concentrations as shown in Figure 11.

Chapters 4 and 5 outline sector-based strategies to meet protection and restoration goals, by providing a list of 47 detailed strategies and 43 monitoring priorities for the next five years.

The 2014 Basin 15/16 plan identified 31 strategies to address protection and restoration of surface waters in Basin 16. Of the 31 strategies identified, nine are complete, 15 are in progress, five are awaiting action, and two are discontinued (Figure 1). Seventy-seven percent of the strategies identified in the 2014 TBP are active or complete[1]. The Basin 16 report card in Appendix A includes the 2014 list of strategies with detailed updates on progress.

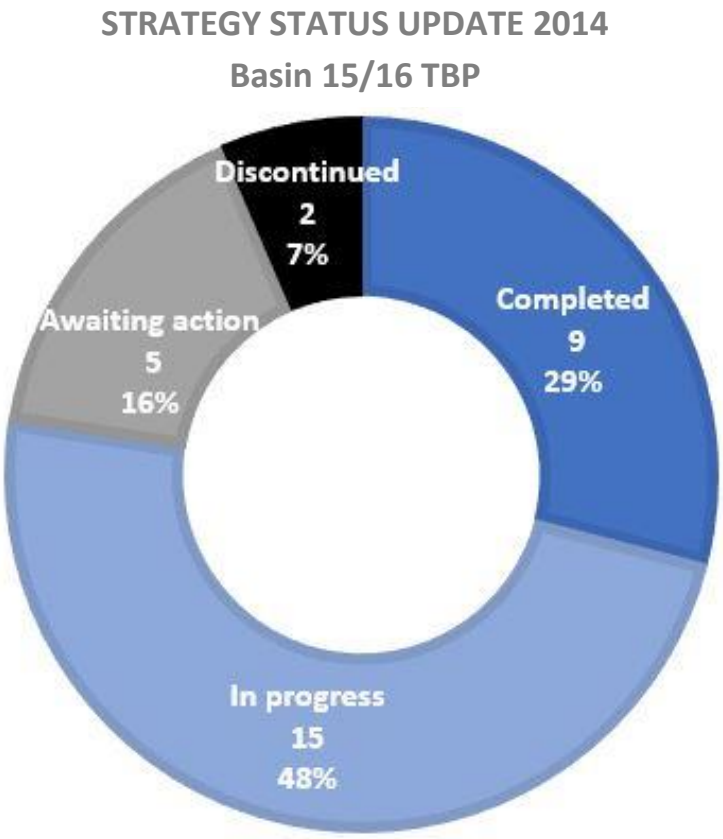


Figure 1. Status of 31 strategies from the 2014 Basin 15/16 TBP.

While water quality improvements are being made in Basin 16, limited capacity, resources, and interest are primary challenges to implementation. The 47 priority strategies identified in this plan reflect input from the public, state and federal water quality staff, watershed groups, and regional planning commissions. During the basin planning process partners expressed that outreach, technical support and training on how to best protect and maintain our natural resources, in addition to continued financial and technical support is critical in order to meet water quality goals.

[1] Complete = strategies with an explicit start and end point. In progress = strategies actively being pursued. Discontinued = strategies that have not been initiated and are no longer being pursued. Awaiting action = strategies that have not been initiated for various reasons such as a lack of resources or local support, or low priority (i.e., other projects need to be completed first) but are still a priority.

What is a Tactical Basin Plan?

A Tactical Basin Plan (TBP) is a strategic guidebook produced by the Vermont Agency of Natural Resources (ANR) to "protect the best and restore the rest" of Vermont's surface waters.

Tactical basin planning is carried out by the Water Investment Division (WID) in collaboration with the Watershed Management Division (WSMD) and in coordination with other state agencies and watershed partners. Tactical Basin Plans (TBPs) are integral to meeting a broad array of both state and federal requirements (see Figure 2) including the U.S Environmental Protection Agency's (EPA) 9-element framework for watershed plans (Environmental Protection Agency, 2008) and state statutory obligations including those of the Vermont Clean Water Act, and Act 76 of 2019 and 10 V.S.A. § 1253.

The basin-specific water quality goals, objectives, strategies, and projects described in the TBPs aim to protect public health and safety and ensure public use and enjoyment of Vermont waters and their ecological health as set forward in the Vermont Surface Water Management Strategy (VSWMS) and the Vermont Water Quality Standards (VWQS), and as identified in Total Maximum Daily Loads. The TBP process (Figure 3) allows for the issuance of plans for Vermont's fifteen basins every five years, as required by statute 10 V.S.A. § 1253.

The basin planning process includes:

1. Monitoring water quality as described in the Water Quality Monitoring Program Strategy
2. Assessing and analyzing water quality data
3. Identifying strategies and projects to protect and restore waters
4. Seeking public comment and finalizing the plan
5. Implementing and tracking plan priorities (ongoing).

Figure 3. Steps to the basin planning process on a 5-year schedule.

Chapters 1-4 in the TBP provide an overview of the basin, protection and restoration priorities and efforts to protect and restore water quality for each sector. Together this information supports the targeted strategies listed in the implementation table in Chapter 5 as outlined in Figure 4.

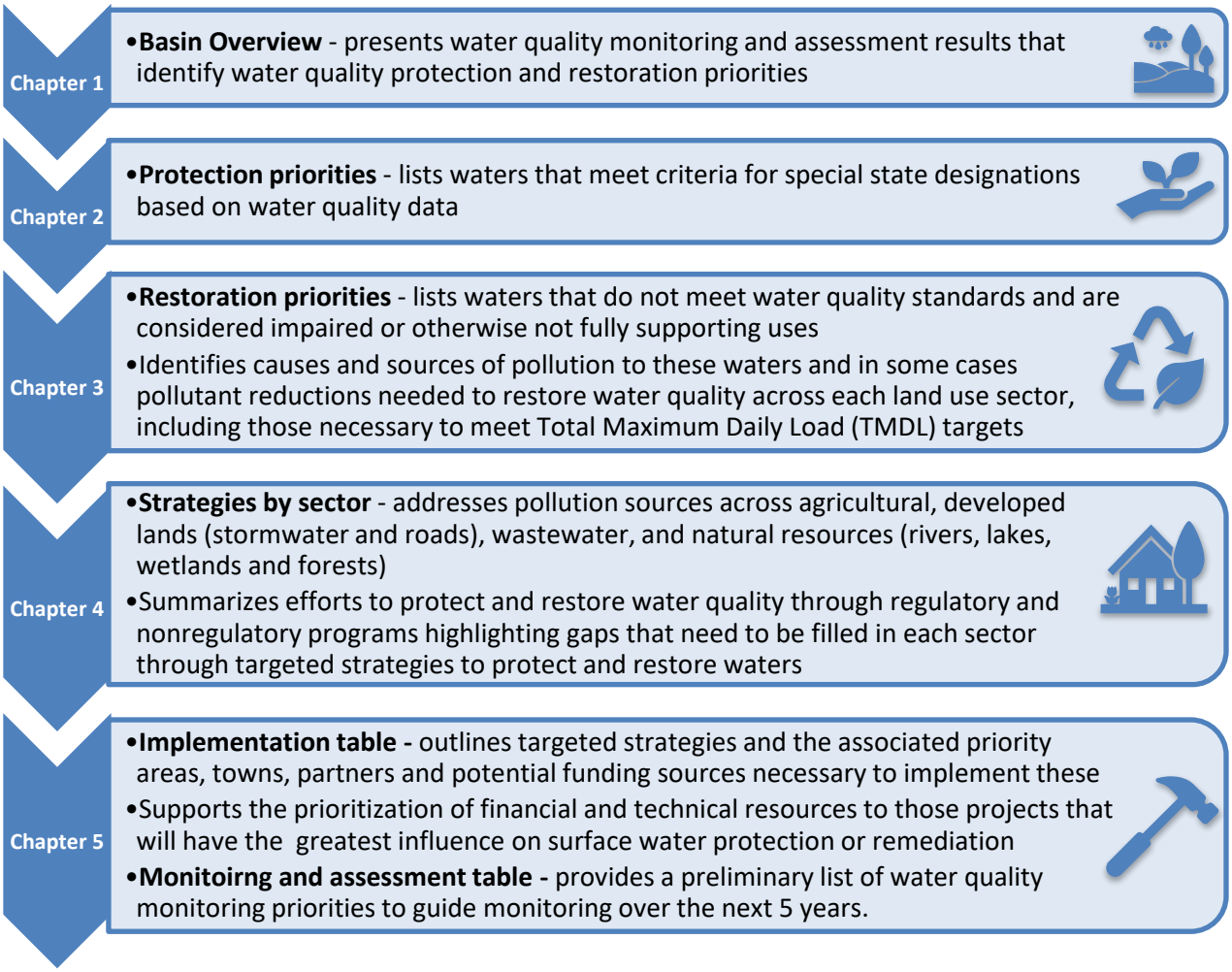


Figure 4. The five chapters of Vermont Tactical Basin Plans.

The tactical basin planning process engages water quality partners in building on the 2014 Basin Plan as highlighted in the Basin 16 Report Card located in Appendix A that provides status updates for strategies identified in the previous basin plan. This plan identifies strategies that serve as the next five-year game plan for the Agency and partners that targets individual projects that are tracked via its online counterpart, the Watershed Projects Database (WPD). The WPD is found on ANR's Clean Water Portal and is continuously updated to capture project information from the TBP process, on the ground assessments, and emerging projects due to natural and anthropogenic events. ANR's Clean Water Portal is an online platform that houses a variety of clean water tools to assist with project planning, searching existing projects, funding opportunities, and more. The Clean Water Portal links to the Annual Performance Report that outlines progress in implementing clean water practices for each basin in Appendix A and the Clean Water Cashboard that provides funding levels for each basin.

Chapter 1 – Basin Description and Conditions

A. Basin 16 Overview

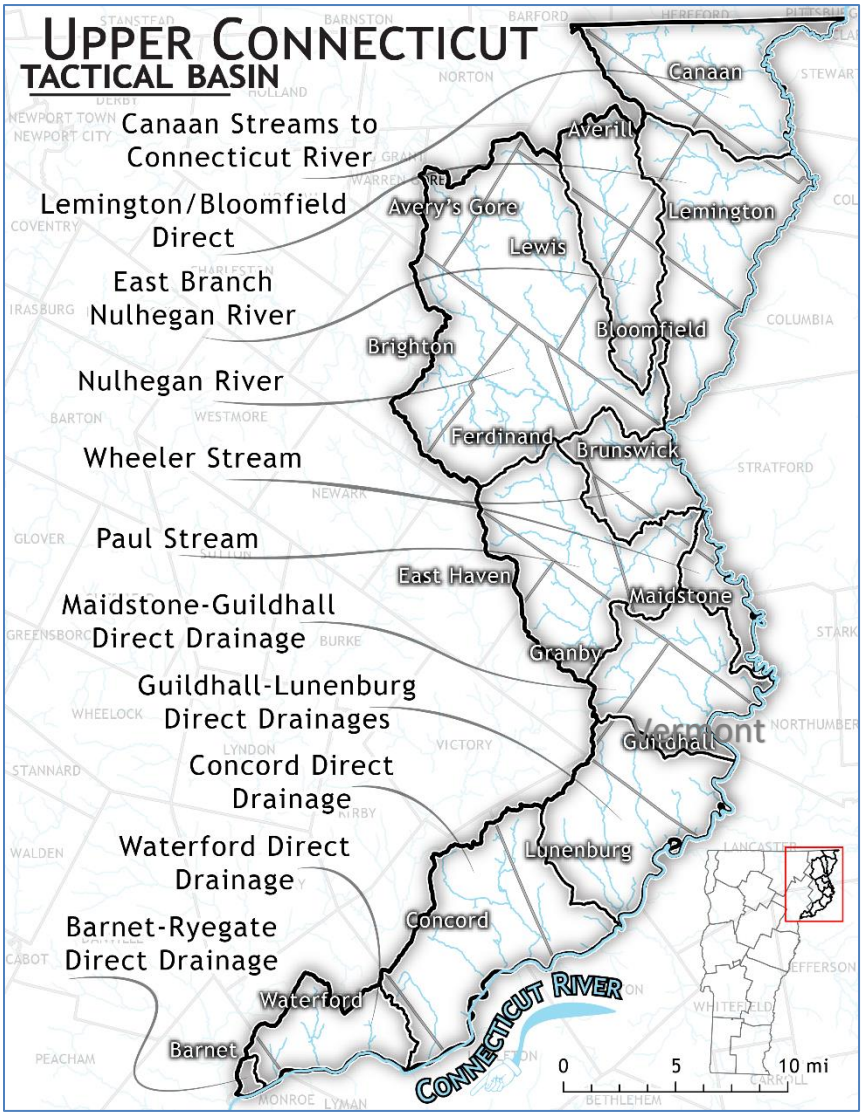


Figure 5. Basin 16 is located in Northeast VT and is a 482 square mile watershed.

Basin 16 encompasses 482 square miles in Vermont, draining a small portion of Caledonia, and nearly all of Essex Counties. The watershed[2] comprises 11 sub-watersheds (Figure 5) which include the Leach Stream, Willard Stream, Nulhegan River, Paul Stream, and many other smaller Connecticut River tributaries.

The northern most point of the basin originates in Canaan around the headwaters of Leach Stream and covers the drainages to the Connecticut River south to the Passumpsic River confluence. All waters in each of the sub-watersheds flow southeast towards the Connecticut River. Detailed information about each of these rivers can be found in the individual basin assessment reports for Basin 16.

Lakes and ponds are not abundant in the Basin, but a few large and popular lakes are found here, including Maidstone Lake, Miles Pond, Shadow Lake, and Wallace Pond. On the other hand, Basin 16 has large areas of wetlands (Figure 6).

[2] A river basin is an area of land drained by a river and its tributaries. The terms 'basin' and 'watershed' are used interchangeably in this report. The Upper Connecticut River Basin is also referred to as Basin 16.

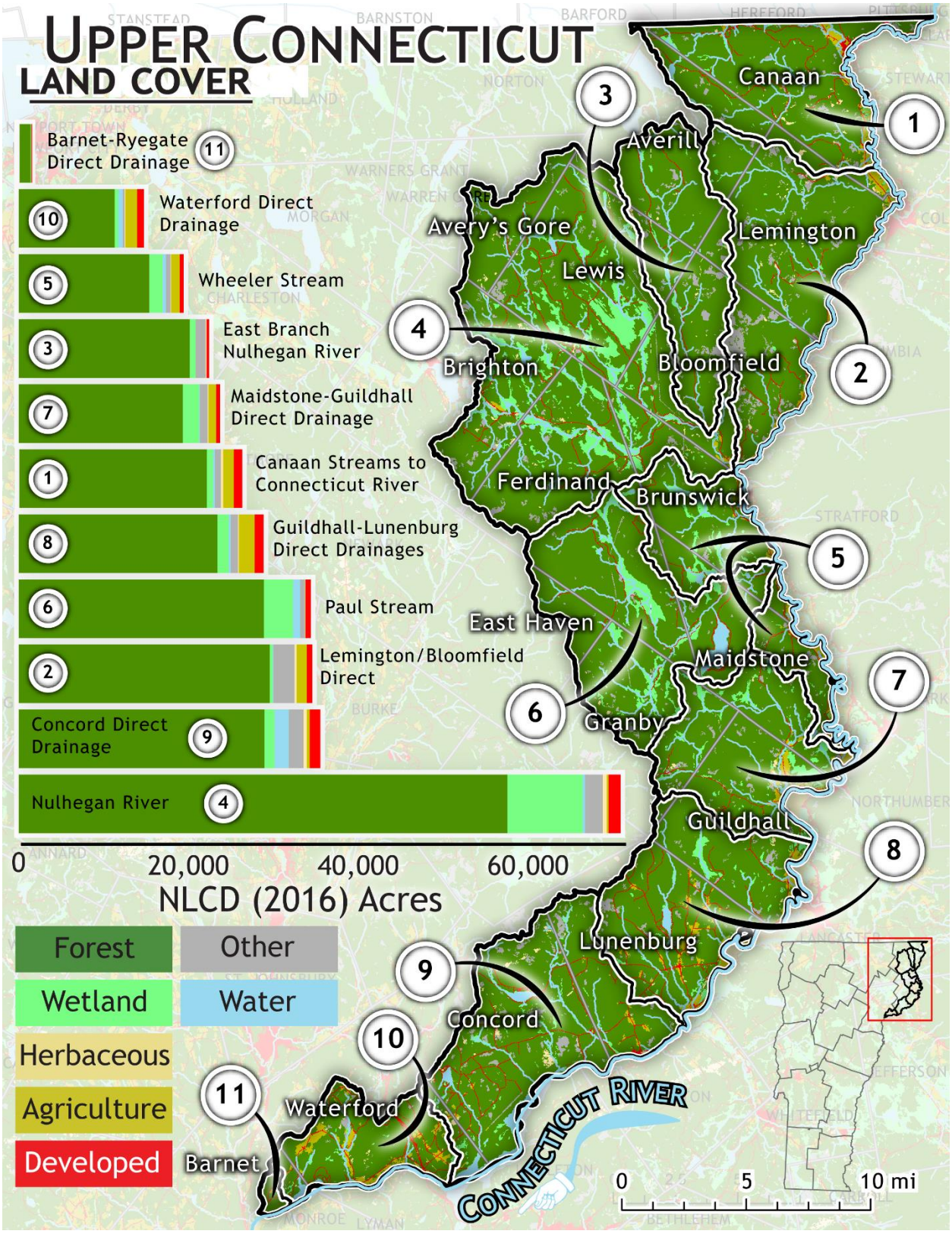


Figure 6. Land cover estimates by acreage for the eleven sub-basins of Basin 16. (Source: 2016 LULC data)

Land Use and Land Cover

The Upper Connecticut River Basin is a predominantly forested landscape covering 83% of the basin while more than six percent is wetlands. Developed and agriculture land use each cover about 2.5% of the basin (Figure 6). A basin wide analysis of land use change from 2001 to 2016 showed significant differences in several land use categories. Forest land cover decreased by around 3,000 acres (1.2%) and herbaceous land cover decreased by 1,950 acres (50%). The latter was largely offset by an increase in shrub/scrub land cover of about 5,400 acres (96%). This suggests that most of the loss in forest land cover is related to logging operations, where regrowth is occurring, not conversion to agricultural or developed lands. About half of this loss in forest land cover was mapped in the Lyman Brook, headwaters of the Nulhegan River, and East Branch of the Nulhegan River watersheds with losses of 729, 760 and 759 acres, respectively. In agricultural lands, there has been a loss of 525 acres (8%) of hay/pasture lands, but an increase in cultivated crops of nearly 60 acres (3%), most of which (35 acres) are within the Willard Stream watershed. Developed land cover increased by 2.4 acres during this timeframe. Wetland and water acreage varied inversely, which is likely related to water levels when mapping was done.

The forested landscape and wetlands are largely responsible for the good water quality in headwaters areas of the basin. The areas in Basin 16 that are experiencing degraded water quality trends are near concentrated residential and road development (Maidstone Lake, Wallace Pond, Miles Pond), or concentrated agriculture along the Connecticut River. Managing land use to reduce discharge of polluted runoff and allowing adequate space for treatment can both improve and protect water quality. Good existing management practices and quality local stewardship may also be responsible for the overall superior water quality of this basin.

Climate Change and Implications for Basin 16

Climate is defined by long-term weather patterns, which in turn, influence human and natural systems. The 2014 Vermont Climate Assessment established state-level, climate change information with implications for local surface waters. Since 1941, Vermont average temperatures have increased 2.7° F with warming occurring twice as fast in winter (Galford, 2014). The latter results in earlier thaw dates for rivers, lakes and ponds, and mountain snowpack. Average annual stream flows are increasing, which is expected to continue in the future. High flows now happen more frequently, leading to increased inundation flooding and fluvial erosion (stream-related erosion) all of which can be exacerbated or alleviated by land-use management decisions.

The impact of increased runoff and streamflow in a watershed depends on local land use and land cover. In developed areas, more precipitation can increase stormwater volume and velocity thereby mobilizing larger pollutant loads (Galford, 2014). In addition, increased streamflow will increase bed and bank erosion and deliver more sediments downstream. In areas where non-point source pollution is a concern more runoff can increase sediment, nutrient, and pathogen loading to surface waters (Galford, 2014). Changes in climate increasingly require watershed restoration projects to preserve natural sediment attenuation locations and incorporate stormwater and non-point source

runoff controls to counteract pollutant transport as well as consider the potential for higher peak flows. Restoring floodplain connectivity along streams is essential to provide space for sediment, debris, and nutrients to settle and store naturally and to maintain ecosystem resilience as the climate changes.

Aquatic habitats affected by increased runoff and streamflow could experience increases in sediment mobilization, nutrients and scouring in addition to increased water temperature. In response, local freshwater plant and animal species may shift their geographic ranges and seasonal activities and alter their abundance (Stamp J, 2020). Maintaining habitat connectivity, river and lake riparian buffers, and stream equilibrium conditions will help reduce the impacts of climate change on Vermont's rivers, lakes and ponds, and wetlands.

Streamflow is influenced by several environmental factors with precipitation being the most important. Daily precipitation data for the basin is available from the PRISM climate dataset (http://prism.oregonstate.edu/) for the period 1981-2018. DEC analysis showed that, during this time, trends in annual average precipitation, annual maximum 1-day precipitation, and number of days per year with one or more inches of precipitation increased for all watersheds. When comparing the beginning and end of this period, trends show an increase of more than two days per year of 1+ inches of precipitation (from around six days to more than eight) and more than five additional inches of total annual precipitation in this region from less than 40 to more than 45 inches per year.

Monitoring data also indicate changing drought conditions in the region. A decrease in drought severity is reflected in trends for the Standardized Precipitation Index (SPI), the most used drought index worldwide. Long-term rainfall records (125 years) from nearby St. Johnsbury show significant positive (wetter) trends in the SPI for each of the four seasons, suggesting that droughts have become less severe on a seasonal basis. It is important to note these trends reflect what has been observed in the past, and in some cases these trends may or may not persist into the future. For example, many models and the information in the 2014 Vermont Climate Assessment suggest an increased frequency and severity of low-flow, drier conditions for Vermont due to predictions of longer periods between heavy rainfall events in future decades. Additional information on climate change in Vermont can be found at: https://climatechange.vermont.gov.

B. Water Quality Conditions in Basin 16

There is a wide variety of water quality monitoring and assessment work that is supported by DEC and its partners which are described in detail in the Water Quality Monitoring Program Strategy. The results of this work provide a window into the condition of a Basin's waters.

Several monitoring programs are active in this basin, most of which are led by programs in the WSMD. These include the Biological and Aquatic Studies Section (BASS)that focuses on biological monitoring of macroinvertebrate and fish communities as well as targeted chemistry sampling around Wastewater Treatment Facilities (WWTF) or other pollution concerns. BASS also supports

the LaRosa volunteer water quality monitoring program that has supported an annual one day sampling event which has included Halls Stream, the Nulhegan River and Paul Stream to evaluate nutrient and chloride levels across the Connecticut River watershed across Vermont, New Hampshire, Massachusetts and Connecticut. The Rivers Program supports stream geomorphic assessments that evaluate geomorphic and habitat conditions of rivers. The Lakes and Ponds Management and Protection Program supports the Spring Phosphorus and Lay Monitoring Programs, which evaluate nutrient conditions and trends on lakes, as well as shoreland condition, and in-depth lake assessments in addition to surveys for aquatic invasive species. Additionally, the Wetlands Program conducts chemical and biological assessments of wetlands.

In addition to the WSMD programs, a network of streamflow gages is funded and operated in partnership among DEC, Vermont Agency of Transportation (AOT), and Vermont Department of Public Service (VDPS). The Vermont Fish and Wildlife Department (FWD) conducts fishery assessments and temperature monitoring to understand recreational fish populations and evaluates streams for strategic wood addition to restore habitat.

Condition of Rivers and Streams

Bioassessment on Streams

The Watershed Management Division (WSMD) in DEC assesses the health of a waterbody using biological, chemical and physical criteria as described in the Vermont Water Quality Monitoring Program Strategy 2011-2020 which was updated in 2015. Most of these data can be accessed through the Vermont Integrated Watershed Information System (IWIS) online data portal. The biological assessment of streams in VT is carried out by the WSMD using biological indices that measure the health of streams by looking at multiple structural and functional aspects of the macroinvertebrate and fish communities. Biomonitoring is best used for detecting aquatic life impairments and assessing their relative severity, and for recognizing streams at or near a reference level condition that may be suitable to higher levels of protection through reclassification. The ratings for the community assessments range from *Poor* - not meeting Vermont's water quality standards (VWQS) - to *Excellent* - exceeding water quality standards. The monitoring information below was collected in Basin 16 from 2010 to 2019.

Macroinvertebrate Monitoring Results

A total of 55 macroinvertebrate assessments were completed between 2010 and 2019 at 36 sites in Basin 16. Results of these assessments are described below. In addition, to ensure a comprehensive understanding of water quality basin wide, a gap analysis was conducted by DEC to identify sites without current monitoring data. These will be prioritized for the 2022 monitoring season and can be found in Chapter 5 in the Basin 16 Monitoring and Assessment Table.

From the most recent assessment, 33 streams (92%) exhibited *Very Good* or better condition. Of these, 15 were found to be *Excellent* meaning at reference or natural condition.

In the most recent assessments, the East Branch of the Nulhegan River was rated as *Good-Very Good* and *Good* at river mile 0.7 and 4.2 respectively, suggesting that this stream meets VWQS. Only one site, Paul John Stream, was rated as Fair/*Good* condition back in 2012.

Fish Monitoring Results

Twenty-one individual sites were sampled for fish in Basin 16 from 2010 through 2019. Five sampling events (events are dates when a site was sampled – and several sites were sampled on multiple dates) were unable to be assessed due to Brook Trout being the only species present, significant wetlands upstream, or unsafe sampling conditions. On the most recent sampling dates, six sampling sites exhibited fish communities in *Excellent* condition and seven sampling sites exhibited fish communities in *Very Good* condition which indicate the fish communities at these sites exceed VWQS. Two sampling sites exhibited fish communities in *Good* condition at Keyer Brook and Mill Brook, which were likely related to a low density of Brook Trout and increased prevalence of non-native Rainbow and Brown Trout in both streams. More information about the results of these sampling sites and events can be found in the Vermont Integrated Watershed Information System (IWIS).

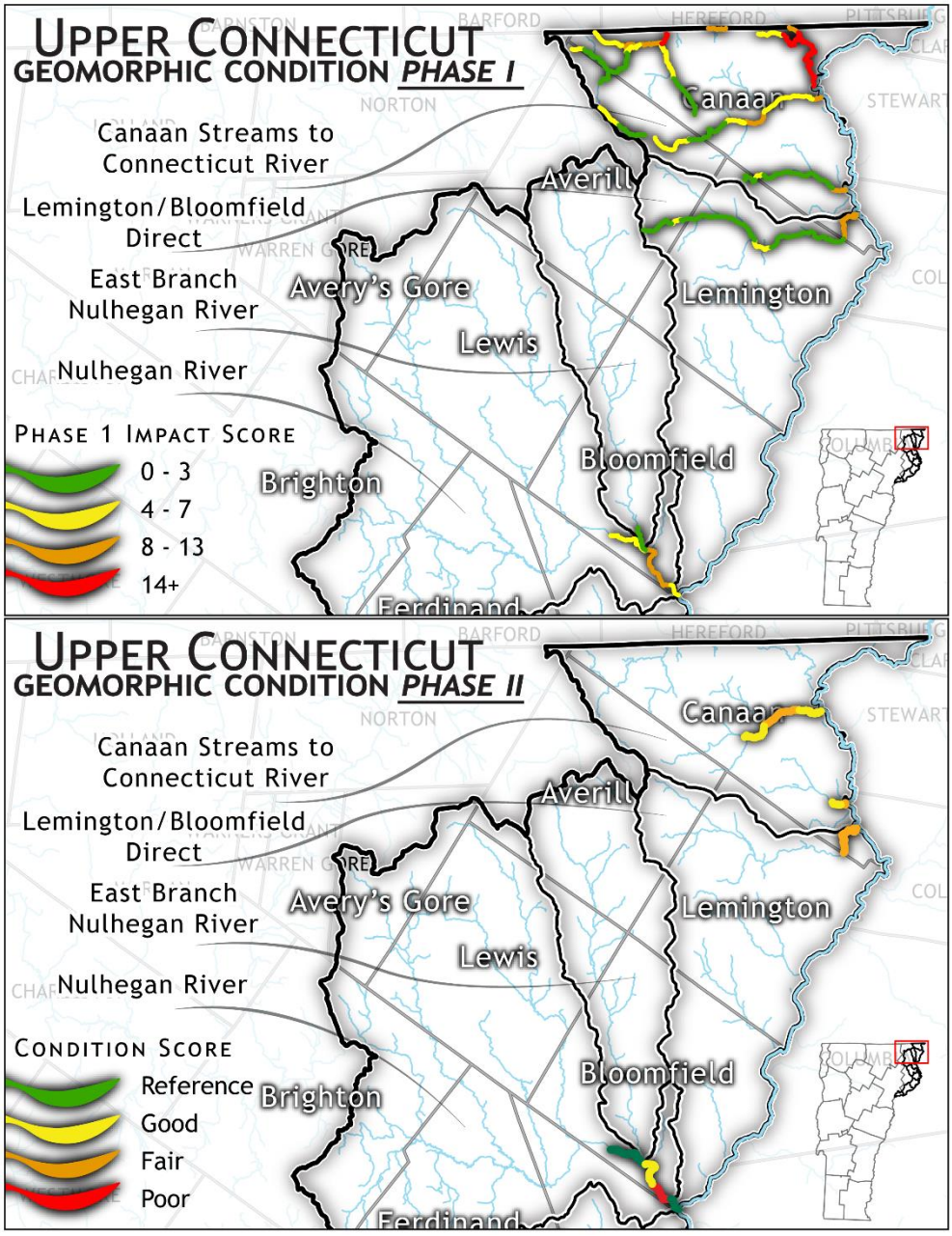


Figure 7. Geomorphic condition of assessed streams in Basin 16 from reference to poor condition based on Phase I and Phase II assessments.

Stream Geomorphic Assessments

There is limited coverage of Phase I or Phase II Stream Geomorphic

Assessments (SGAs) in Basin 16 (Figure 7). With the exception of the Nulhegan River, streams in this basin are primarily in confined valleys and are particularly sensitive where these steeper streams reach the broad Connecticut River floodplain. The Phase I and 2 SGAs show areas of *Poor* to *Fair* geomorphic condition along most of the lowest reaches of streams as they cross the Connecticut River floodplain. This plan recommends that additional Phase II SGA's or SGA lite assessments be conducted for Leach Stream and portions of the Nulhegan River watershed where there is a sentinel monitoring site or where significant strategic wood addition has been done or is planned. In addition, spot checks of previous SGA work on Keyer Brook, Willard Stream, Bolter Brook, and Capon Brooks could be done as part of project development efforts in these watersheds. Final SGAs can be accessed at: https://anrweb.vt.gov/DEC/SGA/finalReports.aspx.

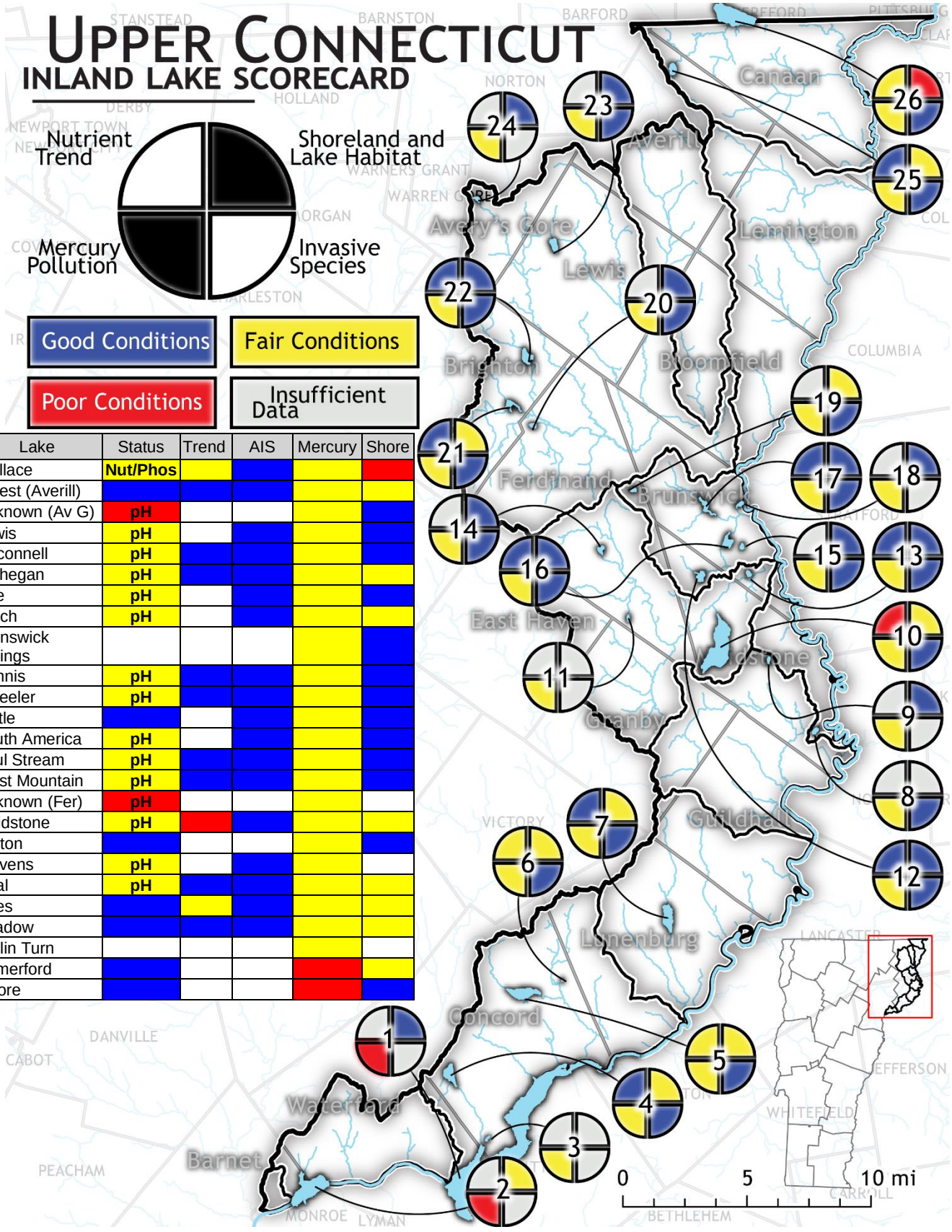
In 2004, a fluvial geomorphology assessment of the Connecticut River noted large areas of historical straightening, ongoing channel adjustments, and significant erosion related to these modifications as well as the loss of riparian vegetation and sediment inputs from some tributaries. This assessment covered the Connecticut River mainstem from Pittsburg downstream as far as Gilman and the backwater of the Moore Reservoir and was completed by Field Geology Services for the Connecticut River Joint Commissions. The state of New Hampshire has listed a reach of the Connecticut River as impaired due to substrate alteration in Lemington likely related to the sedimentation from tributaries and eroding streambanks of the Connecticut River. The DEC Rivers program plans to provide River Corridor mapping for the Connecticut River.

Condition of Lakes and Ponds

There are twenty-six lakes and ponds in Basin 16 that are ten acres or greater. Two of the largest are Moore (3181 acres) and Comerford (1029 acres) reservoirs on the Connecticut River, which are shared between Vermont and New Hampshire and are used to support hydropower generation. Maidstone Lake is the second largest lake in the basin at over 756 acres, followed by Neil Pond (188 acres), and Shadow Lake (Concord) (132 acres). Lakes that are ten acres or greater should be in accordance with the Vermont Hydrology Policy and meet the Hydrology Criteria (§29A-304) in the 2017 VT Water Quality Standards.

Lakes in Vermont are scored on the VT Inland Lakes Scorecard (Figure 8), which is a user-friendly interface developed by the Vermont Lakes and Ponds Management and Protection Program (VLPP). The VT Inland Lakes Scorecard provides available data on overall lake health by providing a rating of a waterbody's nutrient trend, shoreland and lake habitat, atmospheric pollution, and aquatic invasive species. Lake-specific water quality and chemistry data can be accessed online through the VT Lay Monitoring Program webpage.

Of the twenty-six lakes monitored in Basin 16, only Wallace Pond has poor conditions for shoreland and lake habitat although eight other waterbodies scored as fair. Maidstone lake has the only *poor* condition rating for nutrient trends while Wallace Pond and Miles Pond are scored as fair.



#	Lake	Status	Trend	AIS	Mercury	Shore
26	Wallace	Nut/Phos				
25	Forest (Averill)					
24	Unknown (Av G)	pH				
23	Lewis	pH				
22	Mcconnell	pH				
21	Nulhegan	pH				
20	Mile	pH				
19	Notch	pH				
18	Brunswick Springs					
17	Dennis	pH				
16	Wheeler	pH				
15	Tuttle					
14	South America	pH				
13	Paul Stream	pH				
12	West Mountain	pH				
11	Unknown (Fer)	pH				
10	Maidstone	pH				
9	Dutton					
8	Stevens	pH				
7	Neal	pH				
5	Miles					
4	Shadow					
3	Joslin Turn					
2	Comerford					
1	Moore					

Figure 8. Scorecard information for lakes and ponds in Basin 16.

There are three main airborne pollution types that affect lakes and ponds in Vermont: sulfur oxides, nitrogen oxides, and mercury. Mercury contamination has resulted in fish consumption advisories in nearly every lake in Vermont and those of nearby states as well, so all lakes in Basin 16 get a fair condition score for mercury except for Comerford and Moore reservoirs which are rated as poor condition and considered impaired for mercury (Figure 8). Due to the way reservoirs are managed for hydroelectrical production, dramatic shifts in water level cause the release of bio-available mercury that is otherwise sequestered in the sediments and this mercury is more easily transferred up the food web to fish and loons.

Sulfur and nitrogen oxides are largely transported to Vermont from out of state air emissions. As part of the Vermont acid lake impaired TMDL, the State of Vermont urged USEPA to enforce the Clean Air Act and its amendments to meet emission reduction targets. Vermont joined the USEPA, 7 states and 13 citizen groups to sue a major emitter of air borne pollutants and won a settlement in 2007. Nationwide emissions and deposition of acid forming pollutants have declined. As a result, Vermont's in-lake acid concentrations have declined, resulting in less acidic conditions. Achieving pre-industrial conditions will be unlikely, but the improvements are significant.

Lakes and ponds in Basin 16 are regularly monitored for low pH (high acidity), which impacts biological communities. Two ponds in the basin both called "Unknown", one in Avery's Gore and one in Ferdinand, are considered impaired for acidity because of their low pH. The majority of other lakes and ponds in the basin also show low pH and are considered acid stressed by the VLPP. These ponds are monitored periodically. More information about long-term monitoring of VT's acid lakes can be found at: https://dec.vermont.gov/watershed/map/monitor/acid-rain

Several lakes in the basin have been surveyed in the past demonstrating "good" scores for the lack of aquatic invasive species (AIS). A "poor" score indicates that there is at least one invasive species present, regardless of its abundance or 'nuisance' level. New introductions occur mainly in waterbodies that have access for watercraft (mainly motorboats), and the incoming boat traffic is from AIS infested waters. Boat access areas are present at five locations in the basin, which provide light use by boaters including Maidstone, Miles, Neal, Shadow, and the main channel of the CT River. Maidstone and Miles have active and successful VT Public Access Greeter Programs, checking hundreds of boats annually. Their results show that the majority of incoming boats have not visited regional or local waterbodies containing AIS. A small number of incoming boats did previously visit AIS infested waterbodies including Lake Champlain, some regional Vermont waterbodies, and the Atlantic Ocean. Other access locations are smaller and are limited to personal watercraft, mainly kayaks and canoes, which provide less of a threat to potential AIS introductions. As more AIS waterbodies and threats are in close proximity, and incoming boat traffic is expected to increase, implementing a basinwide AIS Spread Prevention Program will limit the threat of the introduction of AIS in the basin lakes and ponds. More information about how these lakes are managed is found in the Natural Resources – Lakes section of Chapter 4.

Those wishing to better understand the scoring process are encouraged to read the 'How Lakes Are

Scored' sections and watch the recorded webinar on the YouTube channel for the DEC Watershed Management Division.

Condition of Wetlands

Wetland Monitoring

The Vermont Wetlands Program uses its Bioassessment Project to gather data about the health of Vermont wetlands. Based on a 2017 analysis of bioassessment data, the principal factors that correlate with poor wetland condition are:

- presence of invasive species,
- disturbance to the wetland buffer or surrounding area,
- disturbance to wetland soils, and
- disturbance to wetland hydrology (how water moves through a wetland) through ditching (e.g., agricultural), filling (e.g., roads) and draining (e.g., culverts).

Wetlands in remote areas and at high elevations tend to be in good condition, with the most threatened wetlands occurring in areas of high development pressure and exhibiting habitat loss. The wetlands program has 12 surveys in this basin with an average score that is higher than all the other basins in Vermont. While the wetlands surveyed may not be representative of the entire basin, this suggests that the basin has many wetlands with the best conditions in the state.

The State of Vermont also uses the Vermont Rapid Assessment Method (VRAM) to rapidly assess both wetland condition and function. Scores can range from 4 to 100. This basin is relatively under-sampled, with 12 VRAM wetland assessments. The assessments are concentrated in and near the Nulhegan Basin area. Scores range from 71 to 95 with a mean of 83. While these assessments cannot be directly used to infer wetland condition in this watershed compared with others, this mean score is much higher than the overall state average of 64 and does likely represent an overall tendency towards good-condition wetlands in this basin. Factors that impact wetlands in other areas of the state such as urban development and agriculture are very limited in extent in this watershed and mostly limited to the immediate Connecticut River floodplain.

Interested organizations and citizens can help build the dataset of wetlands in Basin 16 by conducting VRAM analysis. Individuals or groups interested in learning the VRAM protocol should contact Wetlands Scientist Charlie Hohn at Charlie.Hohn@vermont.gov for further information.

Condition of Fisheries

Flowing Water Fisheries

Brook Trout are the most widespread fisheries resource in Basin 16. Self-sustaining populations of Brook Trout exist in nearly all of the cold streams in the basin, and they are joined by naturally reproducing populations of Brown and Rainbow Trout in some of the small direct tributaries to the

Connecticut River. While connectivity exists between the Connecticut River and larger basins, very few naturalized Brown Trout are found in the Paul Stream and Nulhegan Basin and at this point pose little threat to native Brook Trout populations. Bedrock geology and extensive stream electrofishing throughout the basin suggest that Basin 16 streams are chemically less productive than those in other parts of the state. A Basin 16 stream is expected to support a lower abundance of trout than a stream of similar habitat quality in a more productive part of the state. There are also many stream reaches in Basin 16 that are too warm for salmonids in summer because they are below ponds or one of the many large wetlands found in the basin.

The Northeast Kingdom of Vermont has some of the most intact Brook Trout habitat throughout the native range of Eastern Brook Trout (Eastern Brook Trout Joint Venture, 2006). Many watersheds in this area are secure strongholds, because of habitat integrity and resilience (Fesenmyer, 2017). Despite these exceptional conditions, the lack of in-stream wood is one of the main factors limiting Brook Trout biomass in northeastern Vermont (Kratzer J. F., 2013). Historically, rivers in the northeast were filled with natural wood pieces, jams, and rafts that shaped the structure and function of rivers and resulted in high floodplain connectivity (Pike, 1999) (Wohl, 2014). Extensive logging and log-drives denuded the landscape and severely degraded the rivers. To drive logs, numerous splash-dams were built along the rivers, long stretches were straightened, side channels were blocked, and boulders, trees, and other instream obstructions were removed to prevent logjams. Repeated cycles of clear-cutting ended in the 1980's, and since then, many watersheds have become reforested. But many rivers in the Northeast Kingdom have entered an alternative stable state of single-thread channels with substantially reduced overbank flow, sedimentation, and avulsions (Wohl, 2014) and it will be decades before riparian trees reach sizes and ages capable of restoring wood recruitment and retention to historic, natural rates. In addition, large boulders that were removed to aid log drives are very unlikely to come back naturally.

Despite the large proportion of forested, undeveloped land in Basin 16 and despite extensive electrofishing by FWD in Basin 16, relatively few streams qualify as B(1) fishing waters (Table 2). This is believed to be mostly a result of the low productivity of streams in this basin. In streams with sufficiently cool water temperatures and the right size and slope to hold large woody material, adding large wood could increase Brook Trout abundance enough to meet B(1) fishing standards.

There may be opportunities for classifying many Basin 16 streams as A(1) for fishing, as many small streams have little to no ongoing human activity. However, past logging practices eliminated the "natural condition" of these streams by reducing the age of the riparian forest and decreasing wood loading. While only time can restore the age of the riparian forests and the natural wood recruitment process, strategic wood addition can be used to help restore natural wood loadings in the meantime.

Lakes & Ponds Fisheries

The pond-dwelling Brook Trout populations of Basin 16 represent a rare fisheries resource for the state. There are only eight ponds in the state that are known to support naturally reproducing populations of Brook Trout that are robust enough to provide quality angling opportunities without

additional stocking. Two of these ponds, Unknown Pond (Avery's Gore) and West Mountain Pond, are in Basin 16. Additionally, Unknown Pond (Ferdinand) has a modest population of wild Brook Trout, which are supplemented with stocking of triploid (sterile) Brook Trout, and Lewis Pond has a small population of wild Brook Trout that continue to persist despite the recent establishment of Smallmouth Bass. While it is poorly documented, it is very likely that there were self-sustaining populations of Brook Trout in many more Vermont ponds before European settlement. Habitat degradation and the introduction of non-native fish species has eliminated them from most of these habitats. Therefore, protecting existing pond-dwelling, self-sustaining Brook Trout populations is a high priority. Listing the tributaries of these ponds as A(1) waters may be appropriate, although all of these ponds and their tributaries are on conserved lands, and so they are already protected.

Maidstone Lake supports a self-sustaining population of Lake Trout. Within the last 20 years, Smallmouth Bass were illegally introduced and have become established in Maidstone Lake and Lewis Pond.

Summary

Most surface waters in Basin 16 meet or exceed water quality standards. However, both restoration and protection efforts are required to maintain and improve water quality in Basin 16 as well as to address downstream water quality concerns on the Connecticut River and Long Island Sound. The following chapters provide an overview of priority waters for protection and restoration and identify sector specific strategies to meet our water quality goals.

Chapter 2 – Priority Areas for Surface Water Protection

In order to protect Vermont surface waters and their designated uses, the VWQS establish water quality classes and associated management objectives. In addition to the pathways provided by the VWQS, Tactical Basin Plans identify opportunities to increase protection of high-quality waters through land stewardship programs, local protection efforts, conservation easements, and land acquisition.

As specified in the VWQS, all surface waters are managed to support designated uses valued by the public at a level of Class B(2) (i.e., good condition) or better. Designated uses include: swimming, boating, fishing, aquatic biota, aquatic habitat, aesthetics, public water source, and irrigation. This section of the plan identifies surface waters where monitoring data indicate conditions may meet or exceed the VWQS management objectives and criteria for A(1) and B(1) designated uses. These high-quality waters may be protected by the anti-degradation policy of the VWQS or by upward reclassification through one of the following pathways:

- Reclassification of surface waters
- Class I Wetland designation
- Outstanding Resource Waters designation
- Designation of waters as cold-water fisheries

- Identification of existing uses

In Basin 16, two waters meet criteria for A(1) aquatic biota, three waters meet criteria for B(1) aquatic biota, one lake meets criteria for A(1) aesthetics and another for B(1) aesthetics, seventeen waters meet criteria for B(1) fishing, and two wetlands are identified for further study as Class I wetland candidates. One abandoned A(2) public water source is identified for evaluation for reclassification, and many rivers and lakes have been identified as potential reclassification candidates in need of additional monitoring. These are highlighted in the monitoring and assessment table in Chapter 5.

Figure 9. Surface water protection highlights in Basin 16.

The VWQS establish water quality classes and associated management objectives. The protection of water quality and water-related uses can be promoted by establishing specific management objectives for bodies and stretches of water. The management objectives describe the values and uses of the surface water that are to be protected or achieved.

The Agency of Natural Resources is responsible for determining the presence of existing uses on a case-by-case basis or through basin planning and is also responsible for classification or other designations. Once the Agency establishes a management goal, the Agency manages state lands and issues permits to achieve all management objectives established for the associated surface water.

Before the Agency recommends management objectives through a classification or designation action, input from the public on any proposal is required and considered. The public may present a proposal for establishing management objectives for Agency consideration at any time, while the Agency typically relies on the publication of basin plans to identify candidates for reclassification (10 V.S.A. § 1424a). The Department of Environmental Conservation is developing and updating relevant procedures, forms, and guidance documents, as necessary, to enable submission, evaluation, and implementation of petitions to reclassify streams and lakes, and to designate Outstanding

Resource Waters. The Department has developed these procedures and documents for Class I wetland designations. When the public develops proposals regarding management objectives, the increased community awareness can lead to protection of uses and values by the community and individuals.

Public involvement is an essential component to restoring and protecting river and lake ecology. The VWQS indicate that in the basin planning process, "*Public participation shall be sought to identify and inventory problems, solutions, high quality waters, existing uses and significant resources of high public interest.*" Emphasis on the identification of values and expectations for future water quality conditions can only be achieved through public contributions to the planning process. The public, watershed partners, and stakeholders are encouraged to make recommendations for additional monitoring and research where very high-quality waters may exist.

A. Surface Water Classification

Vermont's surface water classification system establishes management goals and supporting criteria for uses in each class of water. The VWQS begin classification with two broad groups based on elevation:

- All waters above 2,500 feet altitude, National Geodetic Vertical Datum, are designated Class A(1) for all uses, unless specifically designated Class A(2) for use as a public water source.
- All waters at or below 2,500 feet altitude, National Geodetic Vertical Datum, are designated Class B(2) for all uses, unless specifically designated as Class A(1), A(2), or B(1) for any use.

Pursuant to Act 79 of 2016, the Vermont General Assembly, recognizing the wide range of quality for Class B waters, created a new intermediary water quality class between B(2) and A(1), now called Class B(1). Act 79 also sets forth the expectation that individual uses of waters (e.g., aquatic biota and wildlife, aquatic habitat, recreation, aesthetics, fishing, boating, or swimming) may be individually classified, so a specific lake or stream may have individual uses classified at different levels. Act 79 indicates that uses may be reclassified independently to Class A(1) or B(1) for individual uses if the quality of those uses are demonstrably and consistently of higher quality than Class B(2). The extent of the water being reclassified is subject to review based on documented conditions.

Current classifications of surface waters and their uses are identified through the tactical basin planning process or on a case-by-case basis. The current classification, however, does not signify that the A(1) or B(1) criteria are not met. Additional waters suitable for reclassification may be identified in the future as some waters have not been monitored. Table 2 lists the possible classes into which each use may be placed.

Table 2. A list of uses that can be placed into each water class in the Vermont Water Quality Standards.

Classification (2016)	Applicable Uses
Class A(1)	One or more of: Aquatic biota and wildlife, aquatic habitat, aesthetics, fishing, boating, or swimming
Class A(2)	Public water source
Class B(1)	One or more of: Aquatic biota and wildlife, aquatic habitat, aesthetics, fishing, or boating
Class B(2)	Aquatic biota and wildlife, aquatic habitat, aesthetics, fishing, boating, swimming, public water source or irrigation

A(2) Public Water Sources

The only water designated as A(2) public water source in Basin 16 is an unnamed tributary to the Connecticut River in Bloomfield. This water has been abandoned as a public water source and could be reclassified to reflect its current condition for each designated use (Table 3).

Table 3. Class A(2) designated public water sources in the Basin 16.

Waters	Water Source	Description
Unnamed tributary to the Connecticut River	Village of Bloomfield	**Abandoned**. An unnamed tributary to the Connecticut River and all waters within its watershed above the water intake in the Town of Bloomfield. The intake is approximately 0.5 mile above "Basin Hole."

A(1) & B(1) Waters for Aquatic Biota

Based upon biomonitoring assessments conducted by the DEC WSMD, five surface waters in Basin 16 consistently and demonstrably attain a higher level of quality than Class B(2), meeting Class A(1) or Class B(1) criteria for aquatic biota (Table 4 and Figure 10).

Ten sites require additional sampling to determine if they meet B(1) criteria for aquatic biota as listed in Table 4 and Figure 10.

Table 4. List of rivers and streams that either meet criteria for A(1) or B(1) for aquatic biota use or require more monitoring to make a determination. Map #'s correspond with Figure 10. *Potential A(1) or B(1).

Map #	Name	Use	Protection Class	Status
8	Madison Brook	Aquatic Biota	A(1)	Meets Criteria
17	Murphy Brook	Aquatic Biota	A(1)	Meets Criteria
2	Washburn Brook	Aquatic Biota	B(1)	Meets Criteria
12	North Branch Paul Stream	Aquatic Biota	B(1)	Meets Criteria
20	Nulhegan River	Aquatic Biota	B(1)	Meets Criteria
5	Granby Stream	Aquatic Biota	A(1) *	Needs Additional Monitoring
7	Rich Brook	Aquatic Biota	A(1) *	Needs Additional Monitoring
19	Mill Brook	Aquatic Biota	B(1) *	Needs Additional Monitoring
1	Miles Stream	Aquatic Biota	B(1)*	Needs Additional Monitoring
3	Cutler Mill Brook	Aquatic Biota	B(1)*	Needs Additional Monitoring

16	Paul Stream	Aquatic Biota	B(1)*	Needs Additional Monitoring
24	Blodgett Brook	Aquatic Biota	B(1)*	Needs Additional Monitoring
31	Willard Stream	Aquatic Biota	B(1)*	Needs Additional Monitoring
37	Capon Brook	Aquatic Biota	B(1)*	Needs Additional Monitoring
38	Clay Hill Brook	Aquatic Biota	B(1)*	Needs Additional Monitoring
39	Jacobs Chopping Brook	Aquatic Biota	B(1)*	Needs Additional Monitoring

B(1) Waters for Recreational Fishing

Certain waters in Basin 16 support productive populations of cold-water salmonids. Rivers and streams classified as B(1) recreational fishing waters support wild, self-sustaining salmonid populations characterized by the presence of multiple age classes and a minimum abundance of 1,000 individuals per mile (all species/ages/sizes); and/or 200 large (> 6 inches total length) individuals per mile; and/or 20 pounds/acre (all species/ages/sizes)[3]. The seventeen streams that meet B(1) criteria for recreational fishing (§29A-306 of the VWQS) are listed in Table 5 and shown in Figure 10.

Table 5. List of rivers and streams that meet criteria for B(1) for fishing. Map #'s correspond with Figure 10.

Map #	Name	Downstream limit	Use	Protection Class	Status
22	Clay Hill Brook	McConnell Pond	Fishing	(B)1	Meets Criteria
23	Fisher Brook	Confluence with East Branch Nulhegan River	Fishing	(B)1	Meets Criteria
28	Logger Brook	Lewis Pond	Fishing	(B)1	Meets Criteria
9	Madison Brook	Ferdinand Bog	Fishing	(B)1	Meets Criteria
17	Murphy Brook (Ferdinand)	Confluence with Nulhegan River	Fishing	(B)1	Meets Criteria
30	Nulhegan, Black Branch	Waterfall at 44.87574, -71.72685	Fishing	(B)1	Meets Criteria
32	Nulhegan, East Branch	Confluence with Spaulding Brook	Fishing	(B)1	Meets Criteria
25	Nulhegan, North Branch	Confluence with Whiskey Brook	Fishing	(B)1	Meets Criteria
15	Paul Stream, North Branch	Confluence with Paul Stream	Fishing	(B)1	Meets Criteria
29	Spaulding Brook	Confluence with East Branch Nulhegan River	Fishing	(B)1	Meets Criteria
6	Stony Brook	Confluence with Granby Stream	Fishing	(B)1	Meets Criteria

[3] It should be recognized that wild trout populations vary widely from year to year and therefore an individual population may sometimes go below or greatly exceed these values in any given year. The upstream and downstream extent of the stream classification should be based upon consistent or improving water quality, physical habitat quality and land use conditions. The reach should include all upstream habitats which are deemed essential to sustain water quality and physical habitat requirements necessary to support wild salmonid populations at a Very Good level.

26	Tim Carroll Brook	Confluence with North Branch Nulhegan River	Fishing	(B)1	Meets Criteria
4	Tolman Brook	Confluence with Granby Stream	Fishing	(B)1	Meets Criteria
33	Trib. To East Branch (next trib south of Mink Brook	Confluence with East Branch Nulhegan River	Fishing	(B)1	Meets Criteria
21	Tuffield-Willey Brook	Confluence with Clay Hill Brook	Fishing	(B)1	Meets Criteria
11	West Mountain Brook, North Branch	West Mountain Pond	Fishing	(B)1	Meets Criteria
10	West Mountain Brook, South Branch	West Mountain Pond	Fishing	(B)1	Meets Criteria

These waters shall be managed to achieve and maintain very good quality fishing. The seventeen waters identified may be adjusted in the future based on new and updated surveys and as protocols are refined. Waters that meet the revised criteria in the VWQS for both B(1) and A(1) fishing use will be continually identified and updated. It is important to note that all waterbodies that would naturally support fish populations are protected and maintained in perpetuity.

A(1) & B(1) Waters for Aesthetics

The 2016 VWQS contains a designated use for aesthetic conditions, and DEC developed numeric nutrient criteria for lakes and ponds in relation to this use (see Table 3 on page 30 in the VWQS). One lake in the basin, Maidstone Lake, meets the nutrient criteria for A(1) aesthetics while Miles Pond meets the nutrient criteria for B(1) aesthetics. Both Maidstone Lake and Miles Pond show increasing nutrient trends, which suggests a need for the intervention to reverse these trends. Strategies to address these trends are described in Chapter 4 and 5.

Four lakes were identified as potential A(1) candidates for aesthetics while an additional eleven were identified as potential B(1) candidates for aesthetics (Table 6, Figure 10). These lakes require additional monitoring to determine if they meet the relevant criteria. Lakes that are a priority for additional monitoring are covered in Chapter 5 in the Basin 16 Monitoring and Assessment Table. The Agency lacks the capacity to monitor all the lakes listed as needing additional monitoring in Table 6. A subset of these lakes has been recommended for monitoring in Chapter 5 based on factors such as A(1) potential, size, watershed land use, and increasing nutrient trends, which may indicate the lake is at risk for exceeding nutrient criteria. The priority lakes for additional monitoring are Wallace Pond, which is a large pond with increasing nutrient trend and a developed watershed, and Shadow Lake, which is a large pond with potential A(1) conditions and developed watershed. Lewis Pond, Nulhegan Pond, and South America Pond are all smaller, but potentially meet A(1) criteria.

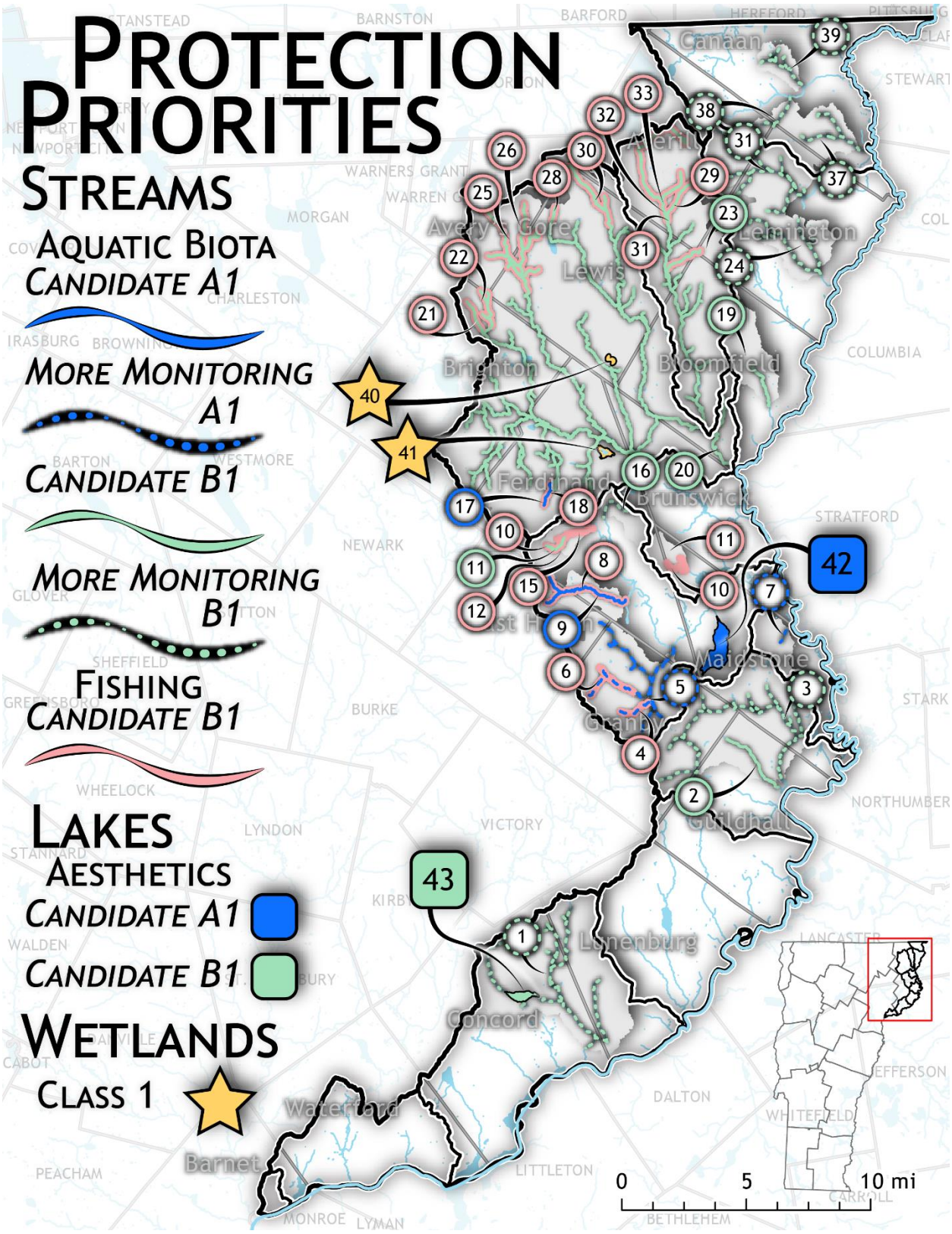


Figure 10. Map of A(1) and B(1) candidates in Basin 16 for aquatic biota, aesthetics and fishing uses that either exceed the 2016 VWQS or need additional sampling to determine their status and potential Class I wetlands.

Table 6. Lakes that meet criteria for A(1) or B(1) aesthetics or require additional monitoring to determine their status and their corresponding map identification number. *Potential A(1) or B(1) water.

Map #	Name	Use	Protection Class	Status
42	Maidstone Lake	Aesthetics	A(1)	Meets Criteria
43	Miles Pond	Aesthetics	B(1)	Meets Criteria
	Lewis Pond	Aesthetics	A(1)*	Needs Additional Monitoring
	Nulhegan Pond	Aesthetics	A(1)*	Needs Additional Monitoring
	Shadow (Concord)	Aesthetics	A(1)*	Needs Additional Monitoring
	South America	Aesthetics	A(1)*	Needs Additional Monitoring
	Dennis	Aesthetics	B(1)*	Needs Additional Monitoring
	Forest	Aesthetics	B(1)*	Needs Additional Monitoring
	Mcconnell	Aesthetics	B(1)*	Needs Additional Monitoring
	Neal	Aesthetics	B(1)*	Needs Additional Monitoring
	Notch	Aesthetics	B(1)*	Needs Additional Monitoring
	Paul Stream	Aesthetics	B(1)*	Needs Additional Monitoring
	Stevens	Aesthetics	B(1)*	Needs Additional Monitoring
	Tuttle (Brunswick)	Aesthetics	B(1)*	Needs Additional Monitoring
	Wallace	Aesthetics	B(1)*	Needs Additional Monitoring
	West Mountain	Aesthetics	B(1)*	Needs Additional Monitoring
	Wheeler (Brunswick)	Aesthetics	B(1)*	Needs Additional Monitoring

B. Class I Wetland Designation

It is policy of the State of Vermont to identify and protect significant wetlands and the values and functions they serve in such a manner that the goal of no net loss of such wetlands and their functions is achieved. Based on an evaluation of the extent to which a wetland provides functions and values, it is classified at one of three levels:

- **Class I**: Exceptional or irreplaceable in its contribution to Vermont's natural heritage and therefore, merits the highest level of protection
- **Class II**: Merits protection, either taken alone or in conjunction with other wetlands
- **Class III**: Neither a Class II nor a Class I wetland

Impacts to Class I wetlands may only be permitted when the activity is necessary to meet a compelling public need for health or safety. The VT Wetlands Program has created a Class I website with an interactive map. This website includes the determinations for nine Class I wetlands including six wetlands that were added since 2016.

In 2016 the Dennis Pond Wetland in Brunswick, Vermont was designated as a Class I wetland. Two wetlands have been identified for further study for Class I wetland designation. DEC supports the further study and petitioning of these wetlands. The VT Wetlands Program welcomes recommendations for Class I candidates.

Table 7. Class I wetlands candidates that require additional monitoring to determine their status.

Name	Protection Level	Use	Status
Moose Bog	Class I	Wetland	Needs further study
Yellow Bogs	Class I	Wetland	Needs further study

Those wetlands that satisfy criteria for designation may be proposed for such designation through departmental rulemaking authority, and as consistent with the Vermont Wetland Rules.

C. Warm- and Cold-Water Fish Habitat Designations

Warm-Water Fish Habitat

All surface water wetlands and the following waters are designated as warm-water fish habitat for purposes of the Vermont Water Quality Standards:

- Dennis Pond, Brunswick
- Stevens Pond, Maidstone

The VWQS specify a lower minimum dissolved oxygen concentration for warm-water fish habitat than waters in the remainder of the basin, which are cold-water fish habitat. There are no proposed changes to warm-water fish habitat designations currently.

Cold-Water Fish Habitat

All waters not designated as warm-water fish habitat above are designated as cold-water fish habitat for Basin 16, as noted in the VWQS (DEC, 2017).

D. Outstanding Resource Waters Designation

Vermont Act 67 ("An Act Relating to Establishing a Comprehensive State Rivers Policy," 1987) provides protection to rivers and streams that have "exceptional natural, cultural, recreational, or scenic values" through the designation of Outstanding Resource Waters (ORW). ORW designation may protect exceptional waters through permit conditions, in stream alterations, dams, wastewater discharges, aquatic nuisance controls, solid waste disposal, Act 250 projects, and other activities. ORWs are waters which can be designated by the ANR through a petition process.

There are currently no waters recommended for ORW designation in Basin 16. Although no other waters have been identified as ORW in this plan, there may be waters in the basin which merit this designation and for which ORW status should be pursued. The Agency will support collaborative efforts to develop the materials, and to conduct outreach necessary to support rulemaking for ORW designation of these waters, should there be public interest. On receipt of a signed written request, the Secretary shall consider the adoption, amendment, or repeal of rules regarding ORW designation and shall take appropriate action as required under 3 V.S.A. § 806. After consideration of all relevant information, the Secretary shall determine whether to enter rulemaking to designate the waters as

ORW if it finds that they have exceptional natural, recreational, cultural, or scenic values. (10 V.S.A. § 1424a).

E. Identification of Existing Uses

The ANR may identify existing uses of waters during the tactical basin planning process or on a case-by-case basis during application reviews for State or federal permits. Consistent with the federal Clean Water Act, the VWQS stipulate that existing uses may be documented in any surface water location where that use has occurred since November 28, 1975. Pursuant to the definition of Class B(1) in Act 79, the ANR may identify an existing use as Class B(1) when that use is demonstrably and consistently attained.

The ANR stipulates that all lakes and ponds in the basin have existing uses of swimming, boating, and fishing. The ANR recognizes that fishing activities in streams and rivers are widespread and too numerous to thoroughly document for Basin 16. In the case of streams too small to support significant fishing activity, the ANR recognizes these as potential spawning and nursery areas, which contribute fish stocks downstream where fishing may occur. These small streams support the use of fishing and therefore, are protected at a level commensurate with downstream areas.

Existing uses in Basin 16 should be viewed as a partial accounting of known existing uses based upon limited information. The list does not change protection under the Clean Water Act or VWQS for unlisted waters. The existing uses in Basin 16 of swimming, boating, fishing, and public water source are found in Appendix B. The public is encouraged to recommend waters for existing uses of swimming, boating, fishing, public water source, and ecological significance given that they provide evidence of such use. For existing uses of waters, the level of water quality necessary to protect those existing uses shall be maintained and protected regardless of the water's classification (DEC, 2017).

Chapter 3 – Priority Areas for Surface Water Restoration

A. Stressed or Impaired Surface Waters

The DEC monitors and assesses the chemical, physical, and biological status of individual surface waters to determine if they meet the VWQS per the 2019 Vermont Surface Water Assessment and Listing Methodology (DEC, 2019). Surface waters are assessed as: full support, stressed, altered, or impaired. To address Section 303(d) of the Federal Clean Water Act, the DEC develops the 303(d) List of Impaired Waters, which includes impaired lakes, ponds, rivers, and streams that do not meet VWQS.

The State also produces the Priority Waters List, which identifies other waters that do not meet water quality standards, but do not require a TMDL as other pollution control mechanisms are in place. Sections of that list include: Part B-impaired waters that have other required remediation measures in place; Part D-impaired waters with TMDLs in place; Part E-waters altered by Aquatic Invasive Species

(AIS); and Part F-waters altered by flow modifications. These lists can be viewed on the DEC Assessment and Listing webpage. For a more detailed description of monitoring results use the Vermont Integrated Watershed Information System (IWIS) online data portal. Figure 11 and Table 8 show the known stressed, impaired, or altered waterbodies in Basin 16. The State of New Hampshire follows a similar process for identifying impaired waters and so Connecticut River segments to which this basin drains that are listed as impaired by the State of New Hampshire are also included in Table 8 and Figure 11.

A primary goal of the plan is to identify and address pollutants degrading the listed waters with strategies listed in the Chapter 5 Implementation Table. The types of strategies prescribed are based on the sector-specific practices outlined in the Vermont Surface Water Management Strategy

Table 8. Basin 16 priority waters and pollutants. This table corresponds with Figure 11 map numbers.

Map #	Name	Pollutant/Problem	List
1	Connecticut River, Barnet	Low pH	**NH, Impaired**
2	Connecticut River, Waterford	Low pH	**NH, Impaired**
3	Connecticut River, Concord	Low Dissolved Oxygen	**NH, Impaired**
4	Connecticut River, Lunenburg	Low pH	**NH, Impaired**
5	Connecticut River, Lunenburg	Low pH	**NH, Impaired**
6	Connecticut River, Lunenburg	E. coli	**NH, Impaired**
7	Connecticut River, Guildhall	Low pH	**NH, Impaired**
8	Connecticut River, Maidstone & Guildhall	E. coli, Low pH	**NH, Impaired**
9	Connecticut River, Brunswick & Maidstone	E. coli	**NH, Impaired**
10	Connecticut River, Bloomfield	E. coli, Low pH	**NH, Impaired**
11	Connecticut River, Lemington	E. coli, Low pH, Substrate alteration	**NH, Impaired**
12	Connecticut River, Canaan	E. coli	**NH, Impaired**
13	Connecticut River, Canaan	E. coli, Low pH	**NH, Impaired**
14	Connecticut River, Canaan	Lead, Low pH	**NH, Impaired**
15	Unknown Pond (Averys Gore)	Acid	VT, TMDL
16	Moore Reservoir (Waterford)	Mercury	VT, TMDL
17	Comerford Reservoir (Barnet)	Mercury	VT, TMDL

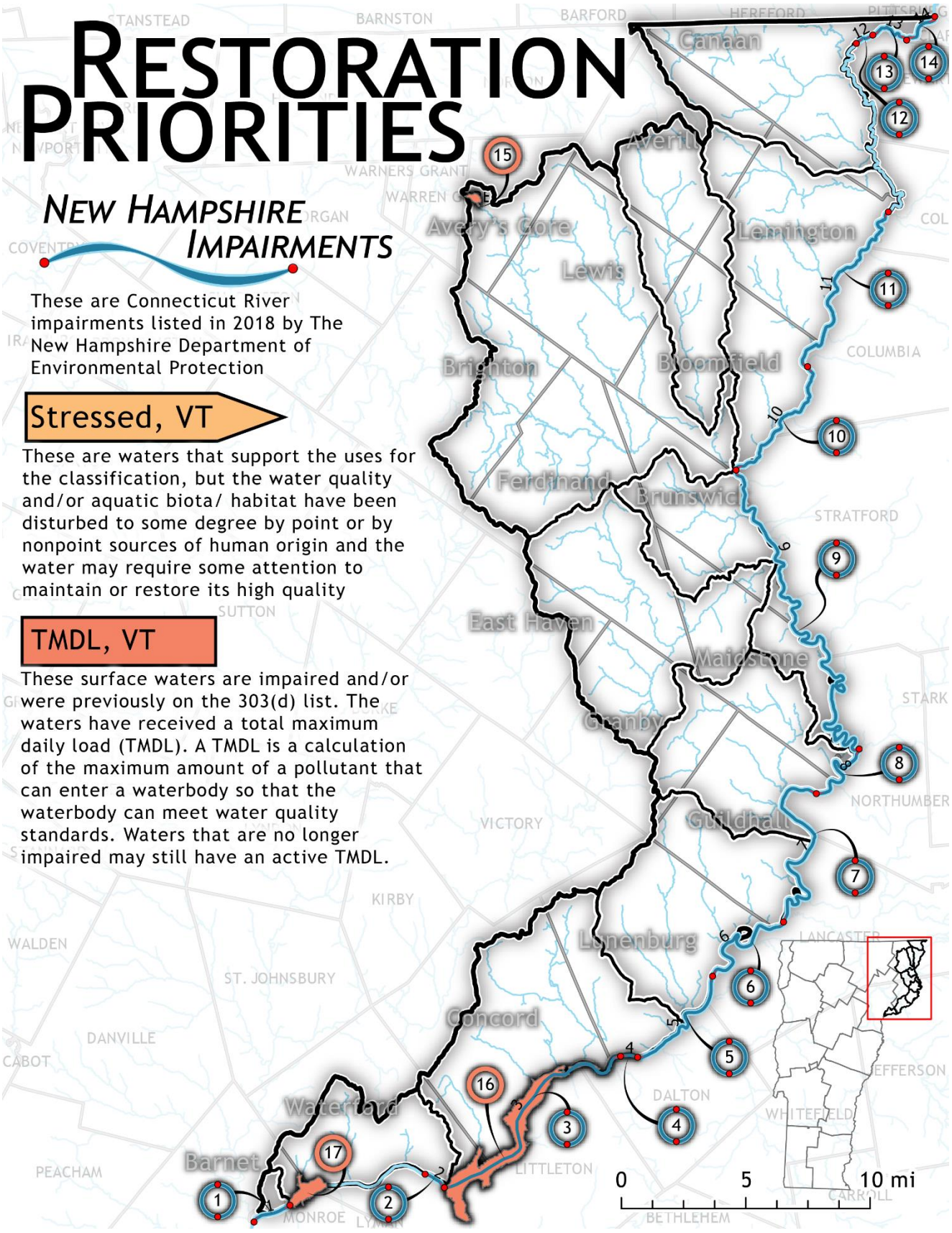


Figure 11. Priority waters for restoration in Basin 16.

B. Basin Specific Total Maximum Daily Loads (TMDLs)

A Total Maximum Daily Load (TMDL) is the calculated maximum amount of a pollutant that a waterbody can receive and still meet Vermont Water Quality Standards. In a broader sense, a TMDL is a plan that identifies the pollutant reductions a waterbody needs to meet Vermont's Water Quality Standards and develops a means to implement those reductions. TMDLs can be calculated for reducing water pollution from specific point source discharges or for an entire watershed to determine the location and amount of needed pollution reductions. Tactical Basin Plans serve as the implantation plan to guide the implementation of actions necessary to meet TMDL reduction targets specific to each planning basin.

TMDLs for Basin 16 include:

- 2003 TMDL for 30 Acid Impaired Lakes in Vermont
- Long Island Sound (LIS) Dissolved Oxygen TMDL
- Northeast Regional Mercury Total Maximum Daily Load
- NH Statewide TMDL for Bacteria Impaired Waters
    - Appendix I Upper Connecticut Watershed

Two TMDL's for waters in this Basin, the Acid Impaired Lakes and Mercury TMDLs are primarily focused on regional efforts to reduce atmospheric deposition and so are not described in greater detail beyond the link provided above. However, the Long Island Sound Dissolved Oxygen TMDL and NH Bacteria TMDLS for the Upper Connecticut River are described in greater detail below.

Long Island Sound TMDL

The Long Island Sound Dissolved Oxygen TMDL released in 2000 is designed to address low dissolved oxygen or hypoxia in Long Island Sound bottom waters. It is often referred to as the Connecticut River Nitrogen TMDL because it is linked to an overabundance of nitrogen discharging into the Sound from the Connecticut River and other tributaries. While nitrogen is essential to a productive ecosystem, too much nitrogen fuels the excessive growth of algae. When the algae die, they sink to the bottom, where they are consumed by bacteria. The microbial decay of algae and the respiration of these organisms use up the available oxygen in the lower water column and in the bottom sediments, gradually reducing the dissolved oxygen concentration to unhealthy levels (New York State Department of Environmental Conservation; Connecticut Department of Environmental Protection, 2000).

Vermont nitrogen watershed export to LIS is estimated to be about 12% of the total load to the Sound based on the recently published sparrow model (Astor, 2019). Approximately 10% of Vermont's estimated 12% nitrogen export to the LIS comes from Basin 16. Basin 16 delivered loading is 2% from municipal wastewater treatment, 6% from developed land runoff, 3% septic system effluent, and 9% from agriculture through nitrogen fixing crops, farm fertilizer and manure (Figure 12) (Astor, 2019). Approximately 80% of nitrogen from Basin 16 comes from atmospheric deposition (Astor, 2019). Figure 13 shows the delivered loading in kilograms per square kilometer. Efforts to reduce atmospheric deposition have been occurring at the national level through the 1990 Clean Air Act and its amendments. Total nitrogen deposition has declined since 1985.

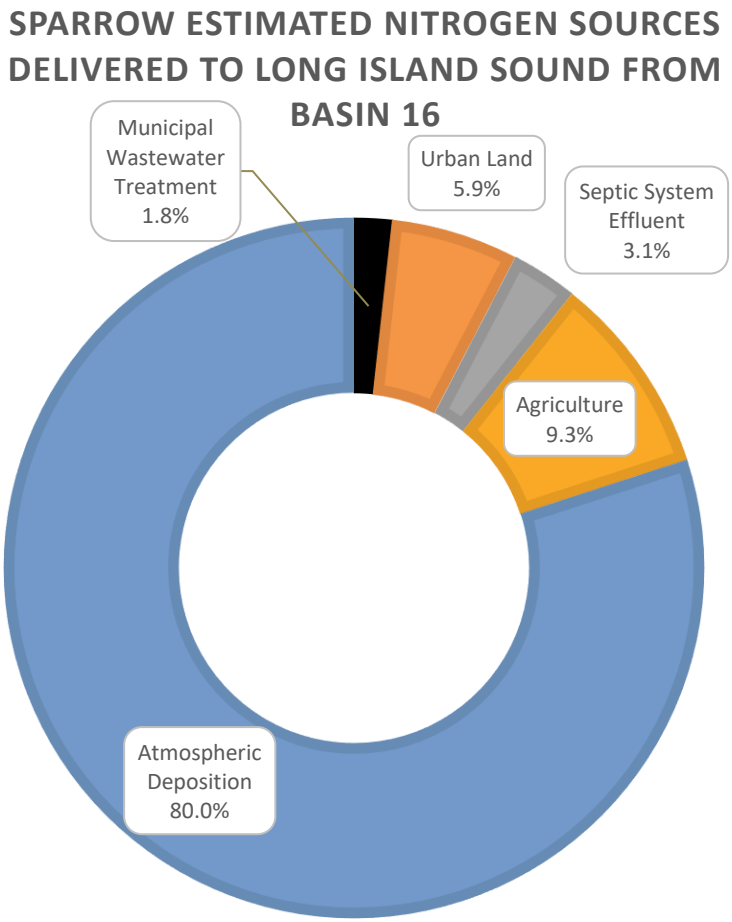
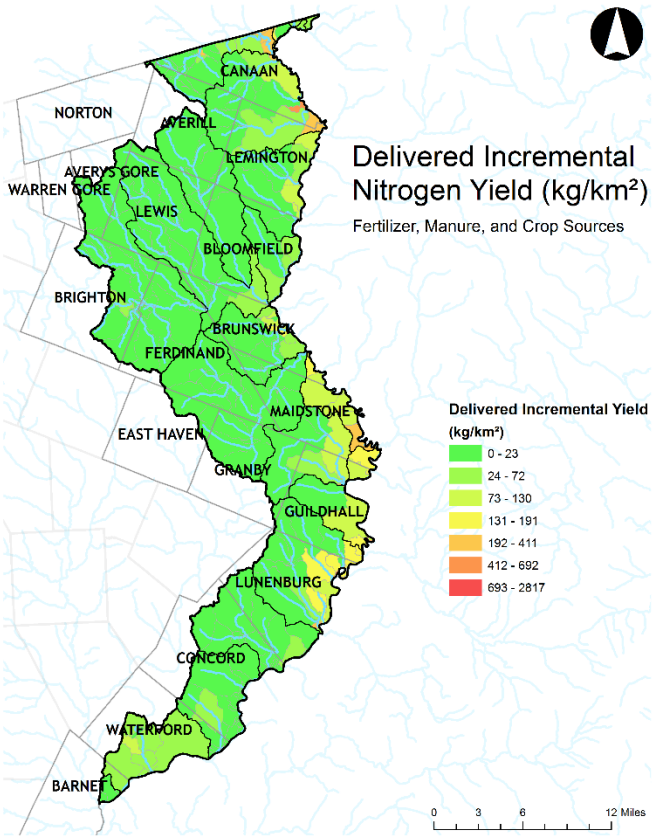
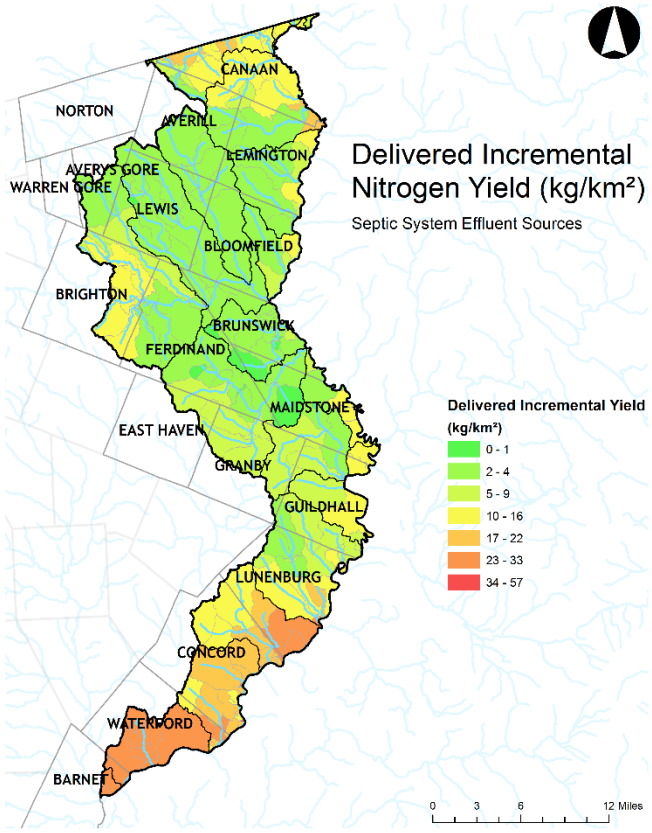


Figure 12. Estimated percent of nitrogen sources delivered to the Long Island Sound from Basin 16 based on the SPARROW model (Astor, 2019).

In 2017, USEPA embarked on its Nitrogen Reduction Strategy to investigate and better define control strategies to reduce nitrogen in the Long Island Sound. Information on the most current developments and strategies can be found in USEPA's Long Island Sound Study.

The sources of nitrogen to be addressed in Vermont include wastewater discharges, agricultural lands, developed lands, and forest practices. The adoption of Vermont's Act 64 , the Vermont Clean Water Act, helps implement overarching strategies and steps required to meet loading reductions for the Long Island Sound's TMDL.





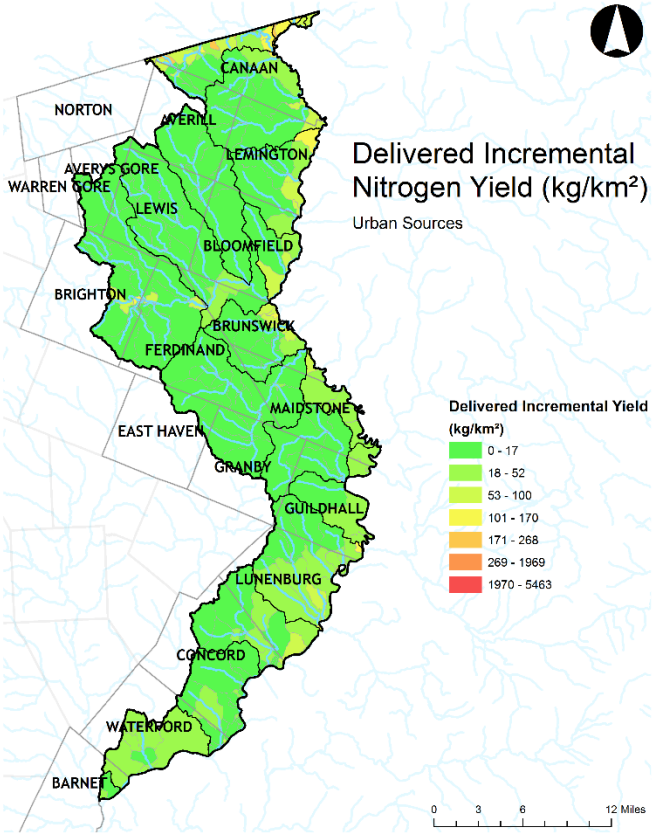


Figure 13. Estimates of Nitrogen loading reaching Long Island Sound per square kilometer (Yield) from catchments in Basin 16 from agricultural (manure, fertilizer, nitrogen fixing crops), Septic systems, and Urban sources. This is based on the SPARROW model (Astor, 2019). Note significantly different scales for nitrogen yield are used for each source in this graphic.

In 2013 a Vermont-specific section, the Vermont Enhanced Implementation Plan for the Long Island Sound TMDL, was added to the LIS-TMDL to address four goals:

1. To identify the Vermont sources of nitrogen as they are currently understood, across broad land use sectors, such as developed, agricultural and forested;
2. To identify the status and trends of important drivers of nitrogen export such as the intensity of agricultural and development activities and investigate how these might have changed since the TMDL baseline period of 1990;
3. To identify the management programs, operating at that time, that address these drivers of nitrogen loading that have a significant effect on reducing or preventing nitrogen export. A part of this is to identify a timeline as to when programs were initiated or enhanced; and
4. Using a weight-of-evidence approach, to assess the combined management programs/projects to develop a qualitative evaluation as to whether management efforts are sufficient to meet the original 2000 TMDL of a 10% non-point source nitrogen reduction and if these strategies are sufficient to maintain that control into the future (DEC, 2013).

In addition, the Long Island Sound Watershed Regional Conservation Partnership Program (LISW-RCPP) was created in 2015 across six states to coordinate the development and implementation of a comprehensive working lands program with foci on: 1) nutrient management and soil health, 2) protection of non-industrial forest habitat, biodiversity, and drinking water sources, and 3) stream erosion and flood resiliency improvements on working lands through riparian restoration. In partnership with the Vermont Association of Conservation Districts (VACD), UVM Extension, the Connecticut River Conservancy, The Nature Conservancy and federal, state and local organizations in VT, NH, MA, CT, NY and RI, ten million dollars is being invested in the adoption of best management practices on private working lands, providing both technical and financial assistance (Connecticut Council on Soil and Water Conservation, 2015).

NH Bacteria TMDL for Upper Connecticut River Watershed

The state of New Hampshire completed a TMDL for bacteria impaired waters in 2010, which includes seven impaired segments of the Connecticut River along Basin 16. The TMDL is available online at this link and there is an Appendix I with specific information for the upper Connecticut River segments. Data to classify these waters as impaired and to determine the level of reduction necessary to meet water quality standards were collected for the Guildhall (2004 and 2005) and Mt Orne covered bridge segments (2000 and 2001). Updating data for these locations would be help determine if these segments continue to exceed water quality standards. Efforts to reduce bacterial sources from agriculture, stormwater runoff, and poorly functioning septic systems is recommended for this basin.

Chapter 4 – Strategies to Address Pollution by Source Sector

Tactical Basin Plans address water quality by sector as summarized in the following sections which are consistent with the Clean Water Initiative Program's 2019 Performance Report (ANR, 2019). The following sections provide specifics about protection and restoration efforts underway or recommended for each source sector. A summary table of the strategies for each sector is found in the Executive Summary in Table 1. A more detailed list of priority strategies by source sector is included in Chapter 5 in the Implementation Table Summary.

Agriculture

- Conservation practices that reduce sources of pollution from farm production areas and farm fields.

Developed Lands--Stormwater

- Practices that reduce or treat polluted stormwater runoff from developed lands, such as parking lots, sidewalks, and rooftops.

Developed Lands--Roads

- Stormwater and roadside erosion control practices that prevent erosion and treat road-related sources of pollution.

Wastewater

- Improvements to municipal wastewater infrastructure that decrease pollution from municipal wastewater systems through treatment upgrades, combined sewer overflow (CSO) abatement, and refurbishment of aging infrastructure.

Natural Resources

- Restoration of "natural infrastructure" functions that prevent and abate pollution. Natural infrastructure includes: floodplains, river channels, lakeshores, wetlands, and forest lands.

A. Agriculture

Agricultural land use makes up approximately 2.6 percent of the land cover in Basin 16 (Figure 14). Two percent is hay or pasture and six tenths of a percent is cultivated crop. Since 2001 there has been a loss of 525 acres (8%) of hay/pasture lands but an increase in cultivated crops of nearly 60 acres(3%), most of this increase (35 acres) is within the Willard Stream watershed. Several farms have changed ownership or management over the last five years and so these changes in land use may continue. The highest concentrations of agricultural lands are found in the Connecticut direct tributary watersheds with almost no agricultural lands in the Nulhegan and Paul Stream watersheds.

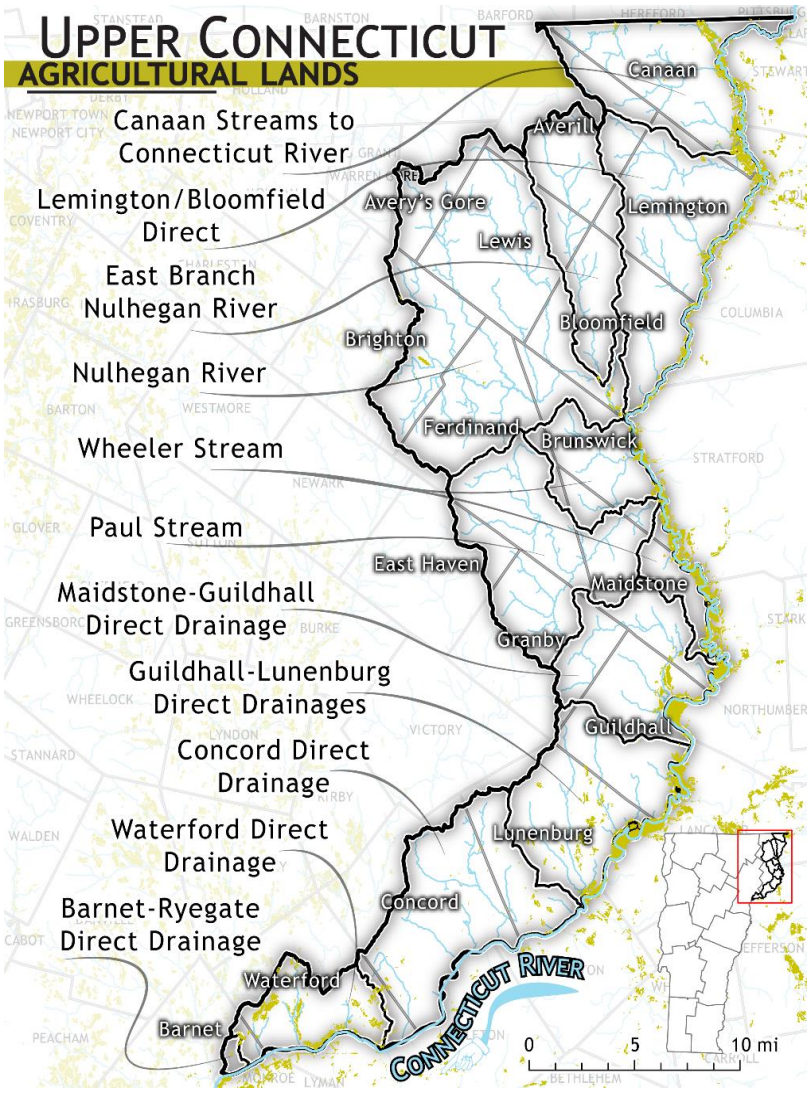


Figure 14. Agricultural land cover in Basin 16.

Dairy and Christmas Tree farms are the primary agricultural operation types along the Connecticut River Valley. Diversified operations with pasture management strategies are growing; this includes farms with poultry, sheep, and beef cattle. Not too far behind are the fruit and vegetable growers who sell their produce in Vermont and New Hampshire, as well as the potato growers moving product across the New England States. Hemp production is beginning to increase on previously fallow land. Maple sugaring operations are also expanding in this area however strategies to address this use are outlined in the section on forests.

Runoff from agricultural land is estimated to contribute nine percent of the nitrogen from this basin to Long Island Sound from fertilizer, manure, and agricultural field runoff. Nitrogen is a driver in

low dissolved oxygen levels addressed in the Long Island Sound Dissolved Oxygen Total Maximum Daily Load (TMDL). Areas of elevated nitrogen loading from agriculture have been mapped at the catchment scale and is elevated in areas along the Connecticut River where most agricultural land in this basin is concentrated as shown in Figures 13 and 14. Runoff from agricultural lands may also contribute to elevated levels of *E. coli* along several reaches which are listed as impaired by NH DES.

Vermont Agency of Agriculture, Food, and Markets (AAFM) regulatory programs work towards protecting surface waters by setting baseline farm management practices to ensure environmental stewardship. The recent revisions of the Required Agricultural Practices (RAPs) in 2016 and 2018 aim to reduce nutrients such as phosphorus and nitrogen entering state waterways. The RAPs apply to different types of farms, farm sizes and farming activities. In addition to the RAPs, Vermont farms are regulated by additional sets of rules promulgated by the AAFM based on farm animal numbers into large, medium, certified small and small farms as shown in this graphic. There are three permitted Medium Farm Operations (MFOs) and four Certified Small Farm Operations (CSFOs) in Basin 16. There are no Large Farm Operations (LFOs). MFOs are inspected at least once every three years and CSFOs are inspected at least once every seven years by the AAFM. AAFM estimates there are sixteen Small Farm Operations (SFOs) in the Basin that do not meet the thresholds of a CSFO and thus are not required to receive a routine inspection by AAFM, but still need to comply with the RAPs.

AAFM regulatory programs support farmers to ensure their clear understanding of the RAPs and program rules, while helping assess, plan, and implement any necessary conservation and management practices necessary to meet water quality goals. Inspections by AAFM include assessments of farm nutrient management plans (NMPs), production area assessments of all facilities associated with the permitted or certified operation, and cropland management assessments in accordance with RAPs and permit rules as applicable.

Availability of technical and financial assistance throughout the Basin is provided by the Essex and Caledonia Natural Resources Conservation Districts, UVM Extension, AAFM, and the Natural Resources Conservation Service (NRCS), who help facilitate compliance with water quality regulations and the voluntary adoption of conservation practices. AAFM and NRCS funded programs provide the majority of financial support directly to farmers as well as to the agricultural partner organizations. Outreach, education, technical assistance, and financial assistance is available for farmers to implement field Best Management Practices (BMPs), such as cover cropping, crop rotation, and reduced tillage practices, and also available for farmers to implement farmstead BMPs, such as waste storage facilities or clean water diversion practices.

The Vermont Department of Environmental Conservation has developed an interactive data report, that summarizes and analyzes agricultural land use and acreage of field BMPs implemented between State FY2016-2019 through NRCS and State funded programs by subbasin. This interactive analysis shows that the Comerford Station dam and Dennis Pond Brook subwatersheds have high degrees of field practice implementation relative to cultivated crop acreage, with conservation crop rotation and

cover cropping practices being the most popular (Figure 15). On the other hand, this analysis identified three watersheds, Willard Stream, Dean Brook and Mink Brook which have significant acreages of cultivated lands, but little field practice implementation based on records of NRCS and State funding programs. The higher level of cumulative agricultural intensity in these sub-basins make them a priority for outreach and implementation of field and farmstead BMPs for water quality.

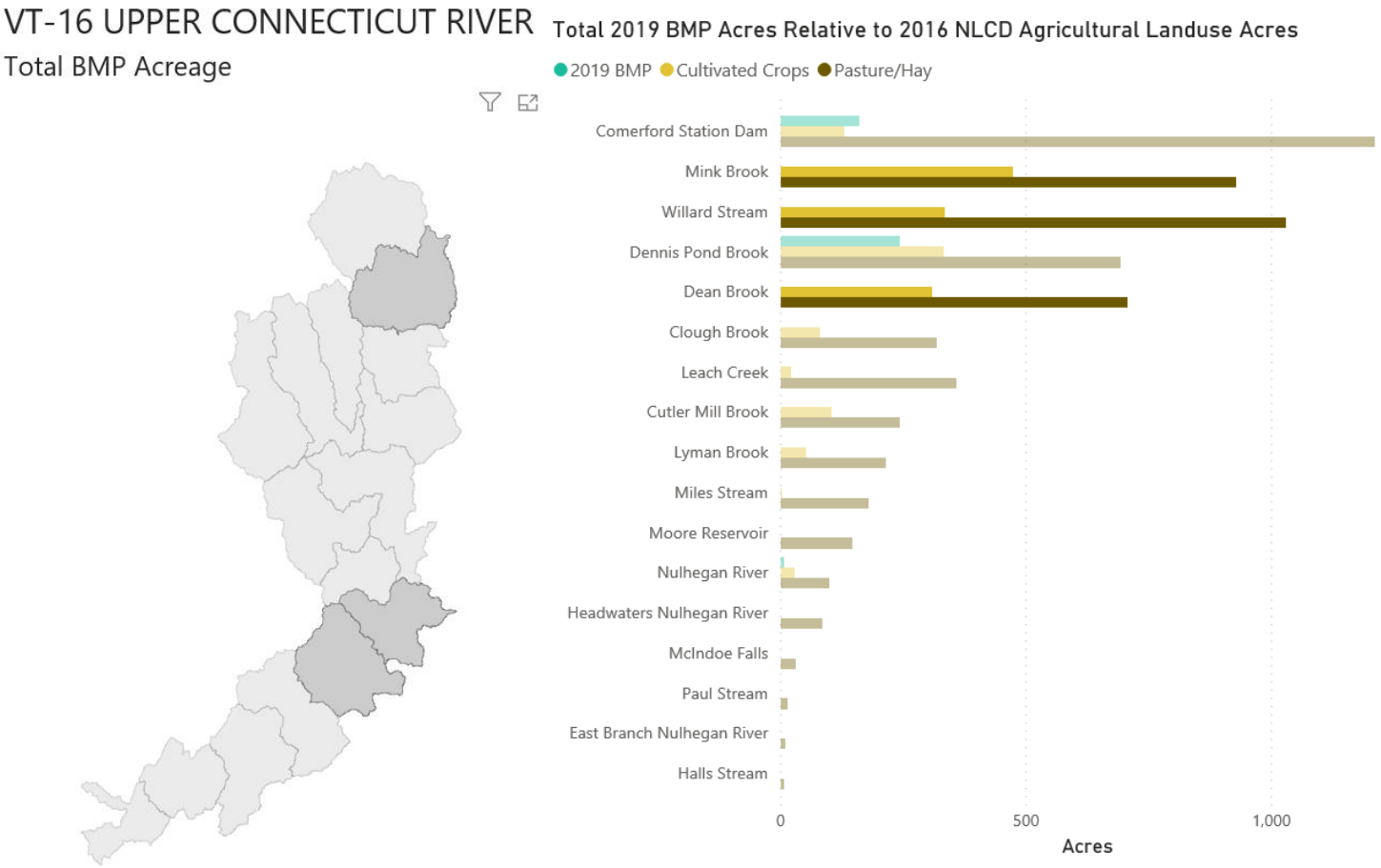


Figure 15. Acres of field BMPs implemented in State FY2019 by sub watershed relative to 2016 NLCD agricultural land use acres highlighting 3 watersheds with lower levels of BMP implementation. See Power BI Report for interactive map of field BMP implementation data between State FY2016-FY2020.

Acreage and conservation practice adoption may be higher throughout the Basin 16 watershed as DEC's accounting does not currently include practices that farmers may implement on their own without State or Federal assistance or continue to adopt annually beyond the original cost-share agreements. State and Federal cost share and practice implementation data is reported to the Vermont Clean Water Initiative Program annually. A summary of State investments and outcomes in the Basin 16 watershed can be found in the annual performance report.

Agricultural assistance and outreach programs are essential tools in promoting field and farmstead BMPs. In 2019, AAFM launched the Multi-Partner Agricultural Conservation Practice Tracking and

Planning Geospatial Database (Partner Database) to assist with coordinating efforts among agricultural partners throughout the watershed to streamline outreach to farmers where multiple resources may be available. The Partner Database aims to improve coordination among service providers, as well as provide a central tracking and reporting system for agricultural conservation practices across the state.

State and federal technical assistance programs and resources are available to farmers to implement agricultural practices that increase farm viability, protect water quality and improve soil health. AAFM resources can be found at this website and NRCS resources can be found at this website:

Figure 16. Hemp field in Concord, corn, and potato fields in Guildhall. Photos from Heather Johnson

Regional agricultural partners are essential service providers that serve farms directly through outreach, education and technical assistance and can leverage additional resources and financial assistance for farms. The Essex County (EC) and Caledonia County (CC) Natural Resource Conservation Districts (NRCDs) are strong non-regulatory agricultural partners in Basin 16. Since the last Basin 16 TBP was published in 2014 both districts have been actively pursuing strategies to improve water quality in the basin in relation to agricultural activities. ECNRCD and CCNRCD have been actively involved in partnerships with UVM extension to assist farms with nutrient management plan development, implementation, and updates with support from the VAAFM Agricultural Clean Water Initiative Program (AgCWIP). Additionally, ECNRCD has been actively working with farmers to improve nitrogen management on croplands though pre-sidedress nitrogen testing and corn stock nitrogen testing which together help farmers better target nitrogen applications. These tests take in account the amount of nutrients provided from manure and fertilizer and allows the farmer to analyze and apply

what the crop needs. It is science-based farming and through these efforts farmers are better able to maintain crop yields while reducing fertilizer costs and the potential for nitrogen loss into surface waters and groundwater.

Additionally, the ECNRCD works with Christmas tree farms and with maple sugaring operators. Christmas tree farms have nutrient management plans as well and ECNRCD engages with producers to utilize their plans to properly apply lime and nutrients.

UVM Extension and the Center for Sustainable Agriculture provides farm focused technical assistance related to soil health and water quality in Basin 16. UVM Extension staff have worked closely with farmers to support the purchase of a no till drill and also work with farmers on grazing management plans. They work on nutrient management planning, crop and soil fertility issues, no till, pest management, and hay ground revitalization. This work is also supported through the VAAFM AgCWIP.

In addition to the existing partnerships among agricultural service providers in Basin 16, networking with farmer watershed groups is an identified strategy (Chapter 5) to promote conservation practice adoption and leverage existing resources in the upper Connecticut River valley.

Watershed and agriculture partners in Essex and Caledonia Counties have been meeting twice per year to collaborate on agriculture initiatives and address water quality issues. During the development of this plan, this group met twice to talk specifically about accomplishments and current work in Basin 16 and identify gaps and needs to support farmers in improving practices that support water quality. Their feedback and recommendations for agricultural strategies for watershed health are found in the implementation table in Chapter 5. These strategies include providing workshops, outreach and technical assistance, local trials, soil health assessments, and equipment to support innovative practices to reduce nutrient runoff. Also identified are strategies to support restoration efforts as farms transition in the basin at a high rate and to better support diversified farms including Christmas tree and maple sugaring operations.

B. Developed Lands

Stormwater

This section integrates basin-specific information on stormwater-related water resource impairments, regulatory programs, Stormwater Master Plans (SWMP), Illicit Discharge Detection and Elimination (IDDE) studies, existing implementation efforts and partnerships to inform strategies to address stormwater-related water resource impairments. Developed lands cover just 2.5% of Basin 16, the majority of which is roads. Stormwater runoff from developed lands is any form of precipitation that flows over the land during or after a storm event or because of snowmelt. On undeveloped lands most of the water is absorbed into the ground through infiltration and the rest takes a relatively slow path to nearby rivers, lakes, and ponds. On developed lands, however, infiltration is reduced by impervious surfaces such as roads, rooftops, and driveways, which also increases the velocity and volume of polluted runoff into rivers and lakes. This leads to an increased frequency and intensity of flooding as well as a greater likelihood that runoff will become contaminated with pollutants.

Runoff from developed lands in Basin 16 may contribute nitrogen loading to Long Island Sound and *E. coli* impairments on the Connecticut River. The tactical basin planning approach engages local, regional, and federal partners in the development of strategies needed to accelerate adoption and monitoring of stormwater-related BMPs to meet the state's clean water goals including reductions to support the Long Island Nitrogen TMDL. This section is organized around the 3-acre operational permit, stormwater master planning, and IDDE studies, which are the primary drivers for voluntary implementation efforts in the basin.

General Permit 3-9050 (Three-Acre General Permit)

General Permit 3-9050 is a permit for stormwater runoff from impervious surfaces except for public roads. It is an important component of the Vermont Clean Water Act of 2015 (Act 64) and is designed to assist in the implementation of clean-up efforts in Lake Champlain, Lake Memphremagog, and stormwater-impaired waters, while also protecting high quality surface waters statewide.

This general permit covers all operational stormwater permitting, including new development, redevelopment, and permit renewal. This general permit serves as the "Three-Acre General Permit" as required under the Vermont Clean Water Act. Additionally, the thresholds for stormwater permitting are reduced to one-half acre of impervious surface on July 1, 2022.

Parcels with 3 or more acres of impervious cover in the Connecticut River watershed, including Basin 16, will need to apply for permit coverage by 2033. Since this date is well beyond the

timeframe for this plan, voluntary stormwater efforts through stormwater master planning are likely to be the primary drivers for stormwater implementation efforts for this planning cycle.

Stormwater Mapping and Master Planning

Stormwater infrastructure mapping projects are completed for municipalities by the Vermont Clean Water Initiative Program to supplement the existing drainage data collected by towns and with the intention of providing a tool for planning, maintenance, and inspection of the stormwater infrastructure. Stormwater mapping reports were completed for significant areas of six towns in Basin 16 (Table 9).

The reports and maps from each project are meant to provide an overall picture and understanding of the connectivity of the storm system on both public and private properties to raise the awareness of the need for regular maintenance. These reports identify potential priority projects in the study areas and provide information necessary to develop a SWMP. The highlighted projects can be completed separately or in conjunction with the development of a SWMP.

Projects identified as high priority in the stormwater mapping reports may be implemented by towns with the aid of Regional Planning Commissions or other partners where necessary. Towns with significant development should consider developing a SWMP, while a multi-town SWMP can be developed for smaller towns. No SWMPs have been completed in Basin 16 although two towns have completed SWMPs for village areas outside the watershed. Only Canaan is recommended to complete SWMPs using the stormwater mapping reports for reference although this might be combined with Bloomfield, Lunenburg, and Guildhall for a joint stormwater master planning project (Table 9). These towns could alternatively determine which projects they can pursue and move towards completing single or batch preliminary designs for those projects identified in Basin 16.

Table 9. Towns with completed stormwater mapping reports ranked by number of high priority projects identified in the mapping report. Click on the town to link to report.

Town Name*	Year Completed	Recommendations for Implementation	Number of High Priority Projects Identified	
			Highest	High
Bloomfield	2018	Single projects	1	0
Brighton	2014	SWMP completed for Memphremagog	0	0
Canaan	2014	SWMP	2	1
Concord	2014	SWMP completed for Moose River	0	0
Guildhall	2018	Single projects	1	0
Lunenburg	2014	Single projects	2	1

*Towns with mapping that do not have stormwater infrastructure in Basin 16 were not included. **SWMP** = Stormwater Master Plan.

The Vermont Green Infrastructure Toolkit is a clearinghouse of information useful to Vermont municipalities to explore how to promote the adoption of Green Infrastructure policies and practices to combat the problems caused by urban, suburban, and rural stormwater runoff.

Illicit Discharge Detection & Elimination Studies

In 2000, the Vermont Legislature required DEC to implement a statewide program to promote detection and elimination of improper or illegal connections and discharges. Illicit discharges are discharges of wastewater or industrial process water into a stormwater-only drainage system. All towns in Basin 16 with enclosed drainage systems have completed IDDE reports. The outcomes of these studies are listed in the following report:

- Detecting and Eliminating Illicit Discharges in the Upper and Middle Connecticut River Basin: Final Report (2017)

In Basin 16, drainages were evaluated in Canaan, Beechers Falls Village, Lunenburg, and Gilman Village.

Roads

This section integrates basin-specific information on road-related water resource impairments, regulatory programs such as the Municipal Roads General Permit (MRGP), existing implementation efforts, and partnerships to inform strategies to address road-related water resource concerns. Runoff from roads can increase stormwater runoff and for the primarily dirt roads in this basin roads are a significant source of sediment and can also impinge on stream floodplains and be a barrier to aquatic organism passage (AOP) with undersized culverts. In Basin 16 roads are a likely contributor to phosphorus loading to Maidstone Lake, Miles Pond, and Wallace Ponds, which are seeing increases in phosphorus levels and roads throughout the basin may contribute nitrogen loading to Long Island Sound.

State Managed Roads (Transportation Separate Storm Sewer System General Permit – TS4)

The Transportation Separate Storm Sewer System (TS4) General Permit covers stormwater discharges from all Vermont Agency of Transportation (AOT) owned or controlled impervious surfaces. The TS4 general permit combines the stormwater requirements for AOT associated with its designated regulated small municipal separate storm sewer systems (MS4s); industrial activities, commonly regulated under the Multi-Sector General Permit (MSGP); and previously permitted, new, redeveloped, and expanded impervious surface, commonly regulated under State Operational Stormwater permits. The permit also requires AOT to reduce the discharge of pollutants from the TS4 to the maximum extent practicable through compliance with the six minimum control measure requirements throughout the entire state.

Road Erosion Inventories

Road Erosion Inventories (REI) are used by Vermont municipalities to identify sections of local roads that do not meet MRGP road standards and are in need of sediment and erosion control practices and to rank road segments that pose the highest risks to surface waters. Required practices

include road crowning, lowering of road shoulders, grass- and stone-line ditching, and upgrading driveways, drainages, and intermittent stream culverts.

REI's are required by the Municipal Roads General Permit (MRGP) as part of the Road Stormwater Management Plan. The MRGP is intended to achieve significant reductions in stormwater-related erosion from municipal roads, both paved and unpaved. MRGP practices disconnect and infiltrate road stormwater into vegetated areas before entering waterways. Where disconnection and infiltration are not possible, practices focus on stabilizing conveyances. The MRGP also requires any bare soils within municipal connected segments to be stabilized with vegetation and or stone-lining within 5 days of disturbance.

Towns are required to bring 15% of connected segments scoring *Partially Meeting* or *Not Meeting* to the MRGP standards or *Fully Meeting* status by December 31, 2022. *Very High Priority* connected segments will have to be brought up to standards by December 31, 2025 for all road types, except for Class 4 roads, which will have to meet standards by December 31, 2028. All *Partially* and *Not Meeting* scoring segments are required to meet standards by December 2036. Towns will report and manage their implementation progress annually via the MRGP Implementation Table Portal database. The permit is required by the Vermont Clean Water Act (Act 64).

The implementation of the priorities identified in REI's will reduce sediment, phosphorus, and other pollutants such as metals, road salt and hydrocarbons associated with stormwater-related erosion generated from unpaved municipal roads that contribute to water quality degradation. The inventories are conducted for "hydrologically-connected roads". Hydrologically connected roads are those municipal roads within 100' of or that bisect a wetland, lake, pond, perennial or intermittent stream or a municipal road that drains to one of these water resources. These road segments can be viewed using the "Municipal Road Theme" on the ANR Natural Resource Atlas and REI results by town can be view in the MRGP Implementation Table.

Based on protocols developed by DEC with the assistance of the regional planning commissions, all of the towns in Basin 16 have completed REIs. This plan recommends that technical and financial assistance be prioritized for interested towns based on the water quality benefit of a project. Projects that *Do Not Meet* and *Partially Meet* standards and are in sub-basins with sediment or nutrient impairments or lakes with increasing nutrient trends are water quality priorities such as the Maidstone Lake, Wallace Pond and Miles Pond watersheds. Resources available from the Clean Water Fund (e.g., AOT Grants-in-Aid, DEC Small Equipment grant, and AOT Better Roads grants) assist with development of designs, capital budgets, cost estimates and implementation of road projects. Completion of these projects may be counted towards meeting the requirements of the MRGP. For additional information on the MRGP see the DEC Municipal Roads Program.

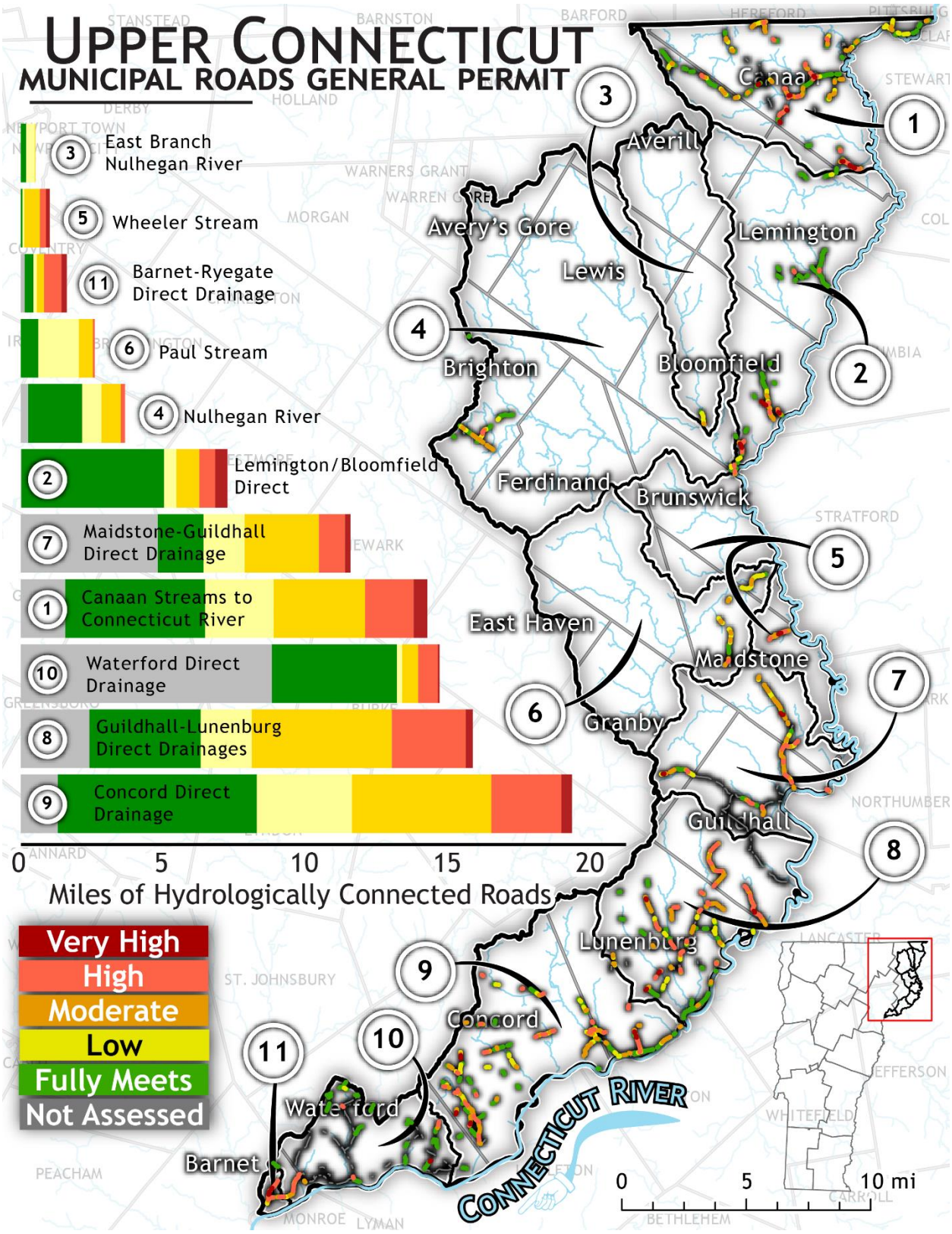


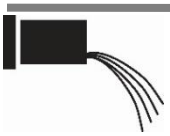
Figure 17. Upper Connecticut River project priority for roads based on REI's as part of the Municipal Road General Permit as of November 2020.

Most towns in this basin have limited capacity and funding for road maintenance and so these towns rely heavily on the Agency of Transportation, NVDA, and ECNRCD for technical support in meeting these MRGP standards. These organizations have joined together as the "Rivers and Roads Workgroup" to provide a forum to discuss outreach, technical and financial assistance, cost sharing opportunities, targeted trainings, and to identify gaps in service and assistance needs in communities.

These organizations play an important role in supporting towns in completing REIs and working with towns to get the equipment necessary to track progress in meeting MRGP requirements. The ECNRCD has also provided towns with support in acquiring and implementing better roads grants that are necessary to implement road projects to bring roads up to MRGP standards while NVDA has provided towns with support in implementing road projects with Grant-in-Aid funding. These organizations will need to continue to work together through the Rivers and Roads Workgroup to support towns most effectively in making improvements to roads to address water quality issues in this basin.

The town of Brighton hosts a hydroseeder that is shared between several municipalities in the basin. There is capacity for this program to expand to include the town of Maidstone and there is the potential for another program for the southern portions of the basin. Additionally, DEC has made available funding for small equipment purchases to assist municipalities in implementing required road standards, through its Small Equipment Grant. Funding for types of equipment include small hydroseeders, hay bale shredders, roller-compactors, plate compactors, and shoulder discs.

In addition to the MRGP, all towns in Basin 16 have voluntarily adopted the most current version of the Vermont Road and Bridge Standards. These standards are administered by AOT and go above and beyond MRGP standards. For example, municipalities may adopt MRGP standards for non-hydrologically connected roads. Towns adopting the Vermont Road and Bridge Standards, coupled with other requirements, may be entitled to higher cost share rates in federally declared flood event reimbursements.



C. Wastewater

Wastewater Treatment Facilities (WWTF)

The Canaan and the Lunenburg Fire District 2 (FD2) wastewater treatment facilities are subject to NPDES direct discharge permits in the basin (Table 10). An overarching consideration for the issuance of permits in Basin 16 is the Long Island Sound TMDL for total nitrogen (TN). This multi-state TMDL has been promulgated with interim wasteload and nonpoint source nitrogen load allocations. As of the issuance of this Plan, all facilities are operating under permits developed under a nitrogen permitting strategy whereby all Vermont WWTFs ultimately discharging to the Connecticut River must, collectively, discharge no more than 1,727 lbs. TN/day. Each individual facility has a unique baseline annual average load of TN assigned to assure the VT allocation is met.

In addition to the nitrogen loading baseline, WWTFs were required to develop optimization plans for maximizing nitrogen removal and regularly monitor for nitrogen compounds. Both facilities received approvals for their Nitrogen Optimization Plans in 2016 and have been reporting the annual average TN loading once a year since 2017.

Table 10. Basin 16 wastewater treatment facilities and other facilities subject to NPDES Direct Discharge Permits.

Facility (permit ID)	Permit effective date	Permit expiration date	Permitted flow (MGD)	IWC* 7Q10 /LMM	Current Flow/ Percent of Design Flow (2014-2019)	Treatment type	# of CSOs	Receiving water
Canaan (3-0330)	5-15-2015	3-31-2020	0.185	0.005/0.001	0.101 / 54%	Aerated lagoons, chlorination	0	Connecticut River
Lunenburg FD2 (3-1140)	7-01-2015	3-31-2020	0.076	<0.001 /<0.001	0.068 / 89%	Aerated lagoons, chlorination	0	Connecticut River

*IWC 7Q10/LMM means instream waste concentration at the seven-day 10 year and low median monthly flow rates.

Facility-specific information

Canaan

The Canaan Wastewater Treatment facility (WWTF) is a secondary wastewater treatment facility. The treatment system consists of a headworks, followed by three aerated lagoons in series for treatment, and a chlorination disinfection system. The effluent is treated through a series of diffusers that are submerged in the Connecticut River prior to discharging from the outfall. The facility underwent construction in 2014 which included an expansion of publicly available septage receiving, a new headworks building equipped with a mechanical fine screen and aerated grit chamber, new aeration system and two SolarBee mixers for the existing lagoons, a new control building with lab and office space, and new blowers. Four pump stations were also upgraded. In 2019, the facility installed a new comminutor to support septage receiving. The unique baseline annual average load of TN for this facility is 30 lbs./day and since 2017 the maximum reported daily loading is 16 lbs./day which is 47% below the baseline annual average load from the facilities permit.

Lunenburg FD2

The Lunenburg Fire District (FD#2) owns and operates the Lunenburg FD#2 WWTF. Built in the 1970's, the facility consists of three aerated lagoons, and chlorination for disinfection before discharge to the Connecticut River. The collection system primarily serves the village of Gilman. The original clay sewer lines are replaced with PVC as repairs and replacements occur. In 2016, the main pump station was upgraded and replaced with an above ground pump station with a new wet well, vacuum primed pumps, and an emergency generator. The force main from the pump station to the Lunenburg facility was also replaced during the 2016 construction. In 2018, a Parkson diffuser system obtained from the Quechee Wastewater Treatment Facility was installed, totaling six

diffusers distributed among the three lagoons. This addition has significantly improved aeration and treatment. The unique baseline annual average load of TN for this facility is 10 lbs./day and since 2017, the maximum reported daily loading is 6.7 lbs./day, which is 33% below the baseline annual average load from the facilities permit.

Septic Systems

The State of Vermont adopted, on July 1, 2007, universal jurisdiction over the design, permitting, and installation of all new wastewater systems and potable water supplies including septic systems. All new wastewater systems and potable water supplies need to obtain a Wastewater System and Potable Water Supply Permit for activities such as: subdivision of land; construction of a new building that needs a wastewater system (often referred to as sewage disposal or a septic system) or water supply; and repair and/or replacement of a failed wastewater system or water supply. Wastewater systems that have wastewater surfacing, backing up into the building or discharging to the waters of the State are considered failed systems. A permit is also required when there is an existing wastewater system and/or potable water supply but there will be an increase in water or wastewater design flows due to either a modification to, or a change in use of, a connected building.

Systems installed before July 1, 2007, and systems installed or receiving increased flows after 2007 that did not receive a permit could potentially discharge into surface waters if the system was not installed correctly and is located in close proximity to a river, lake, or wetland. Failed or poorly functioning systems can contribute *E. coli*, phosphorus, or nitrogen to surface waters. Failed systems that discharge pollutants into surface waters are difficult to identify without landowner permission and there is no current regulatory tool that requires inspections of pre- or post-2007 wastewater systems on a regular basis unless specified in their permit. If a citizen observes signs of a failed septic system, they should contact their Town Health Officer. There are programs that provide financial assistance to qualifying homeowners that need to upgrade their systems, but costly upgrades prevent many homeowners from upgrading their systems.

Momentum has been gaining in rural villages to explore options to deal with concerns about pollution from septic systems and growth in village centers that result in a need for centralized shared wastewater systems. An example of this is a demonstration project in the town of Warren, Vermont, which was reported to the USEPA as a different approach for managing wastewater in rural villages (Stone Environmental, Inc., 2005). Another example closer to this basin is a Northern Border Regional Commission grant to DEC that will help identify cost effective wastewater solutions for the villages of Wolcott, East Burke, and West Burke, providing models for other villages throughout Vermont. Areas with elevated *E. coli* levels like the Connecticut River could benefit from this type of approach. Funding is the most common barrier to identifying and remediating *E. coli* sources. People are also concerned about reporting or putting financial strain on their neighbors with potentially failing systems.

Septic Socials

Concerns around failing septic systems is especially important in lakeshore communities. Many camps along lakeshores were built before July 1, 2007, and many of the camps were built for seasonal occupancy. If a lake is experiencing an increase in nutrients or *E. coli*, it is often difficult to pinpoint the exact sources. Septic systems are often a source. One way to inform people about the health of their systems is to host a septic social. Septic socials are neighborhood gatherings where homeowners learn about the options for a well-functioning septic system and good maintenance practices, including household products that are kind to septic systems. The event provides an informal opportunity for people who may never have seen a septic system to learn about them. The host opens the gathering by talking about the importance of water quality protection. A septic system specialist discusses operation and maintenance of septic systems using the host homeowner's system as the demonstration model. Attendees are provided with brochures and other resource materials to take home. Septic socials are best for areas with old septic systems that may be having an impact on water quality.

Septic socials can also be held in riverbank communities. Areas in Basin 16 that would benefit from septic socials are all the larger populated lakes especially those with increasing nutrient trends including Wallace Pond, Maidstone Lake and Miles Pond. Areas with Village centers along the Connecticut River where it is listed as impaired for *E. coli* would also benefit from holding septic socials. More information about septic socials can be found at: http://dec.vermont.gov/watershed/lakes-ponds/lakeshores-lake-wise/lake-wise-septic-system-socials.

D. Natural Resources

Rivers

This section includes basin specific information on how to improve river connectivity. River connectivity means that a river is connected longitudinally, laterally, vertically, and temporarily to support stream equilibrium and riparian habitat. In simple terms, a connected river is a river that freely flows from upstream to downstream, freely meanders and exchanges water with lands, vegetation, and waterbodies alongside its path, freely accesses its floodplain, and freely cycles through its flow pattern with the seasons. Restoring river connectivity is essential for good water quality, healthy aquatic habitat, and flood resilience in the basin and will help to mitigate impacts of increased runoff and streamflow described in the climate change section.

Rivers are in a constant balancing act between the energy they produce and the work that must be done to carry the water, ice, sediment, and woody material produced in their watersheds. A change in any one of these factors will cause adjustments of the other variables until the river system comes

back into equilibrium (balance). These changes can be caused by natural events and by human activity. Human activities can disrupt the balance by changing flow inputs to the channel (such as by deforestation, increasing impervious surfaces and runoff, or water withdrawals) or by changing sediment regime (such as with dams, dredging, or in response to intensified erosion).

In Basin 16, channel alterations such as straightening, dredging, removal of riparian vegetation, and large scale logging and historical channel alterations to support log drives have played a significant role in the stream instability in several areas of the watershed (Figure 7). The history of logging and associated stream alterations and road building has not only impacted aquatic habitat and fisheries conditions in headwaters but has in many cases increased runoff causing streams to lose access to floodplains. This prevents streams from flowing onto their floodplains, losing energy, and depositing sediment, ice, and wood farther downstream. As a result, flood power and erosion increase, high flows are increasingly confined in the stream channel and are unable to spread out or slow down until they reach a place to break out. Sediment and floodwater that would have otherwise been deposited or stored along the way is transported downstream, leading to higher flood levels, increasing rates of channel migration and sediment loading downstream. This pattern is apparent as many of the smaller streams in confined valleys in this basin reach the broad Connecticut River floodplain. This results in deposition and active erosion and adjustments as these streams flow towards the Connecticut River.

While most of the Connecticut River is in New Hampshire, the boundary was set by the United States Supreme Court in 1936 (Gannett, 1936), so portions of the river are considered Vermont waters and Vermont regulations apply to the majority of the west bank of the Connecticut River. As such, the condition of the Connecticut River is included as a focus for this plan. As noted in Chapter 1, a long history of channel straightening and alterations, as well as the removal of riparian vegetation has resulted in increased erosion and reduced habitat quality along the Connecticut River. Therefore, a priority for this plan is to protect the river corridor along the Connecticut River to allow for a restoration of its natural sinuosity and floodplain access where still possible and to restore floodplain forests, and wetlands. The large scale of the Connecticut River and location along states border presents a special challenge when trying to restore natural planform and floodplain access. The upper reaches of the Connecticut River above Lancaster is where it is most possible, since the river's fluvial processes have not been as disrupted as on more impounded portions of river further downstream.

The tactical basin planning approach engages local, regional, and federal partners in the development of strategies needed to accelerate practices to increase river connectivity and meet the state's clean water goals including reductions to support the Long Island Nitrogen TMDL. This section provides an overview of riparian protection and planting projects in the basin, strategic wood addition efforts, AOP restoration efforts and community efforts to regulate floodplain and river corridor development.

Floodplain Forest, Forest Riparian Buffer, and River Corridor Easement Projects

There is a long history of partners protecting and restoring floodplain forests and forested riparian area buffers along the Connecticut River and its tributaries in the basin. This work has included:

- Essex County NRCD established a native plant tree nursery in the watershed to provide a local source of planting stock and implemented a Trees-for-Streams program to restore forested riparian buffers throughout the county,
- NRCS supported numerous large riparian buffer restoration projects through the CREP program, including 28 acres of buffer along the mainstem and tributaries of the Connecticut River at the Johnson Farm in Canaan and Lemington,
- Vermont Fish and Wildlife Department conserved 283 acres in the Johnson Farm Wildlife Management Area (WMA) in Canaan and Lemington and has supported extensive floodplain forest restoration projects on this property,
- The Nature Conservancy has completed several land conservation and riparian planting efforts, including a Dutch elm disease-resistant American elm restoration project in several, large fields at the Johnson Farm WMA,
- Vermont Land Trust completed several land conservation projects that included protection of Special Treatment Areas and restoration of forested riparian buffers, and river corridor easements,
- Vermont River Conservancy completed several riparian lands conservation, restoration, and river corridor easement projects along the Nulhegan River and Connecticut River,
- Connecticut River Conservancy has implemented a number of floodplain forest and forest riparian buffer restoration projects in recent years.

During 2005-2020, floodplain forest and forested riparian buffer restoration projects were completed at a minimum of 54 sites in the basin. Many of these projects occurred along the Connecticut River and the downstream reaches of its tributaries in the towns of Canaan, Lemington, Maidstone, and Guildhall. Aside from this work, there remains a need to restore floodplain forests and forested riparian buffers, as well as to protect river corridors along many sections of the Connecticut River and its tributaries in this basin. These restoration projects will restore fish and wildlife habitat, provide shading and reduce river temperatures, stabilize riverbanks and reduce channel migration, and reduce sediment and nitrogen loading to Long Island Sound.

Strategic Wood Addition to Rivers and Streams

As noted in Chapter 1 in the Vermont Fish and Wildlife Fisheries assessment, the long history of logging and log drives in this basin has left many streams in an alternate, but relatively stable state of single-thread channels with substantially reduced structural diversity, overbank flow, sediment storage, and avulsions. To increase large wood loading and improve Brook Trout habitat, FWD, Trout Unlimited, US Fish and Wildlife Service, and Weyerhaeuser have partnered to strategically add large woody material to streams in northeastern Vermont. This work began in 2012, and by 2023, the partners plan to have completed strategic wood addition on over 36 stream miles, most of which

are in Basin 16. A recent study found that Brook Trout biomass tripled on average at sites where large wood was added in the East Branch Nulhegan River watershed and that the large wood addition resulted in an overall increase in Brook Trout abundance rather than simply concentrating fish in areas of good habitat (Kratzer J. F., 2018).

Despite the large proportion of forested, undeveloped land in Basin 16 and despite extensive electrofishing by FWD in Basin 16, relatively few streams qualify as B(1) fishing waters (Table 1). This is likely a result of the low productivity of streams in this basin. In streams with sufficiently cool water temperatures and the right size and slope to hold large woody material, adding large wood could increase Brook Trout abundance enough to meet B(1) fishing standards.

Adding large woody material can benefit more than just fish. Large wood increases stream stability (Gurnell, 2002), (Camporeale, 2013), channel roughness (Comiti, 2008), and floodplain access (Jeffries, 2003), (Sear, 2010). Wood structures also help reduce nutrients downstream through sediment storage (Gurnell, 2002), (Davidson, 2013) and nutrient processing (Roberts, 2007), (Krause, 2014). In this age of increasing flood frequency and severity, restoring large wood loading to upland streams can benefit not only the aquatic organisms, but also humans living downstream. Large wood can improve floodplain connection in upstream, undeveloped areas, thereby potentially reducing flood impacts downstream through flood storage and sediment retention. It can also help to reduce nutrient loading downstream.

Many of the streams in Basin 16 and all of the wild Brook Trout ponds are on lands conserved through state or federal ownership or by easements (e.g., Weyerhaeuser). Riparian areas are protected on conserved lands and instream habitat restoration efforts have focused on these lands to-date. Private lands may provide potential for further protection of riparian forests and improvement of aquatic habitat. Whether on the public or private lands of Basin 16 continued efforts to protect and restore riparian forests, improve AOP, and restore large wood loadings will help to conserve and protect Brook Trout and other aquatic species for the future.

Improving Aquatic Organism Passage

Undersized culverts are the primary barrier to AOP in Basin 16 and they limit the movement of aquatic organisms throughout the stream network. Many species need to migrate along the stream network to fulfill various parts of their life cycle. For example, Brook Trout may move to cold water in the summer, spawning habitat in the fall, and deeper pools in the winter. Undersized culverts can also disrupt natural upstream-downstream sediment movement and can lead to greater erosion and property damage when they fail. To increase connectivity, the US Fish and Wildlife Service has pulled together the Upper Connecticut River AOP workgroup to support efforts to restore passage in the Vermont portions of the Connecticut River watershed north of the White River, including Basin 16. This team is made up of staff from FWD, DEC, Conte Refuge, Trout Unlimited, Native Fish Coalition, NRCD's and CRC. This group met twice in 2020 to develop a collaborative approach to identify priority

AOP projects and move them toward implementation as funding becomes available. This team has worked to improve AOP by replacing over 14 culverts that blocked the upstream movement of fish and other aquatic species in this basin.

This team is prioritizing AOP based on several factors including field assessments of the ability of culverts to support passage for salmonid and other fish species, modeling that identifies watersheds likelihood to continue to support Brook Trout with an increase in temperature by two degrees, assessments of current Brook Trout presence, the identification of other barriers to fish passage on the stream network, and finally the status of streams as B(1) for fishing use or the potential to become so with strategic wood additions. Through these efforts 30 potential culverts were identified in the watershed although three of these were found to have already been replaced. Three additional culverts are already in progress to be replaced, four more are identified as high priority, 12 as medium priority, two as low priority, and six culverts haven't been assessed as to their priority level. These are shown in Figure 18 or can viewed in an online map.

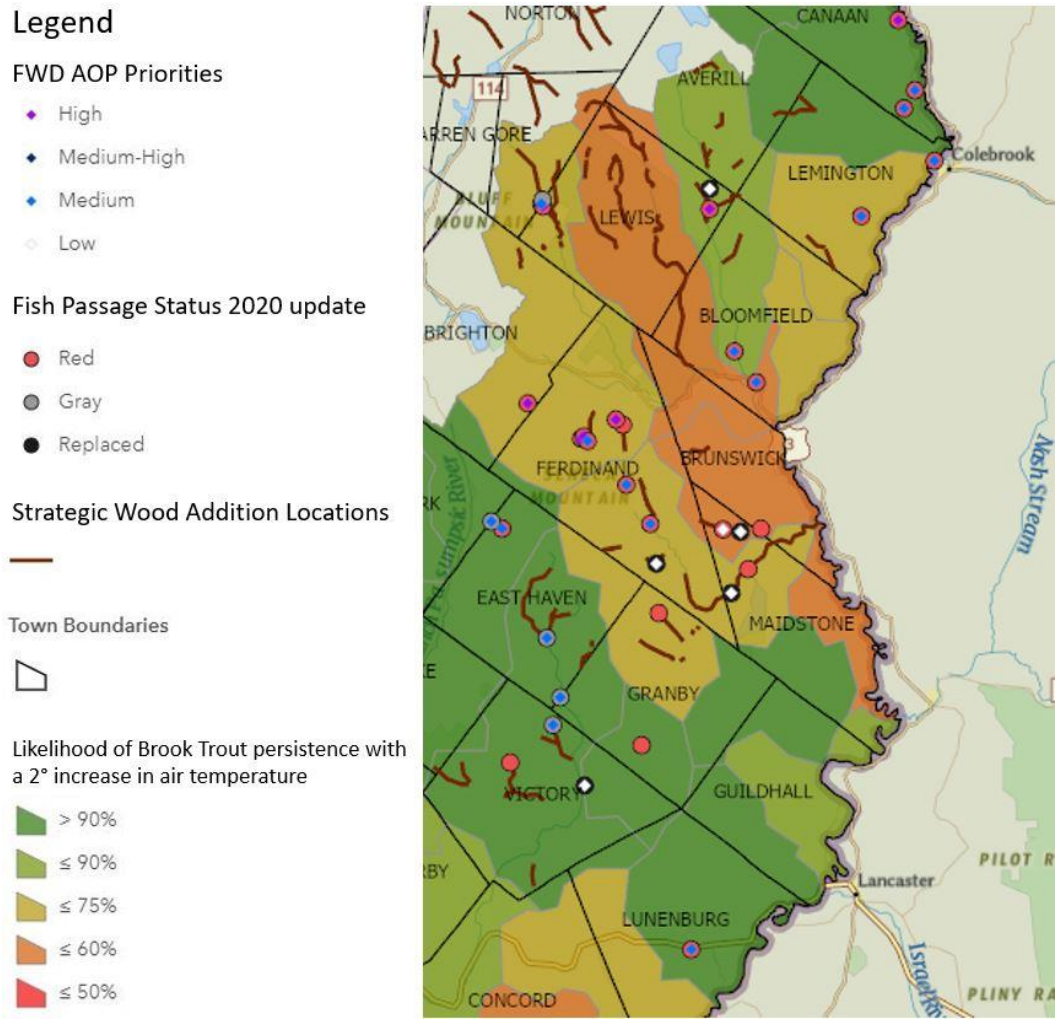


Figure 18. Aquatic organism passage priorities as of October of 2020 based on the Upper Connecticut Aquatic Organism Passage workgroup made up of local, state, and federal partners.

Partners across this basin will be making site visits and further prioritizing culverts for AOP and will also consider the potential geomorphic benefits of culvert replacement as well. As culverts are identified for replacement, partners will contact towns or private landowners to determine the level of support for replacing these structures, and to identify funding to design and implement projects.

Local Bylaws and Plans

Local zoning, bylaws, and town plan policies can provide community specific protections and guidance to maintain and enhance local water resources. Local protections also afford benefits to downstream communities and water resource users. Although a town may have bylaws or town plan policies, it does not mean their resources are afforded the strongest protection. Communities are encouraged to work with NVDA and DEC staff to identify opportunities that provide their constituents with the highest level of natural resource protection within their means. Communities often focus on this work when drafting the Flood Resilience element of the municipal plan or the Local Hazard Mitigation Plan or when the community is considering joining the National Flood Insurance Program.

Floodplains (flood hazard areas mapped by FEMA) and river corridors are key places where communities can protect water resources and increase community flood resilience. Municipalities can either adopt stand-alone flood hazard and river corridor regulations or include flood hazard and river corridor protections within local zoning bylaws. Flood hazard area regulations that meet or exceed federal minimum standards also allow a community to participate in the National Flood Insurance Program, which is administered by FEMA and makes flood insurance available to residents.

FEMA is in the process of modernizing flood hazard mapping in Vermont, including all of the Upper Connecticut basin. In April 2020, the US Geological Survey in partnership with FEMA, scheduled Discovery Meetings to inform updated Flood Insurance Rate Maps (FIRMs) throughout the lower reaches of Basin 16 including the towns of Waterford, Concord, and Lunenburg. A virtual discovery meeting was held on May 26, 2020. A virtual discovery meeting was held for towns in the upper portions of the basin on November 17th.

Updated FIRMs will identify the high-risk flood hazard areas in the basin that are the focus of municipal flood regulations. Most of the area will have much improved computer-model based Zone A hazard information using updated flood discharge data and one-foot contours. Some reaches will have older studies aligned with current topography. A few areas may be prioritized for updated field-based studies incorporating data from bridges and other obstructions. The effective date for the new maps is likely 2025 or later. In the meantime, communities will have the chance to participate in the multi-year update process and can start planning bylaw updates as needed in anticipation of new maps.

In the upper Connecticut River watershed, 13 out of the 16 towns with significant lands in the basin participate in the NFIP program (Table C1). Several communities, including Barnet, Granby,

Guildhall, and the Unified Towns and Gores (Lewis, Ferdinand, Averill and Avery's Gore), have bylaws that provide additional protections beyond minimum NFIP requirements. While the minimum NFIP standards provide some protection for new development, these standards have not been enough to prevent significant flood damages in Vermont, especially in relation to fluvial erosion, nor have they been adequate for protection of water quality from stressors associated with increased development encroachment. Higher than minimum standards vary slightly from community to community and recognize the need to maintain the natural and beneficial flood functions of floodplains and river corridors. Higher standards typically include avoiding new building in hazardous areas, limiting fill or other changes that may displace floodwater, and siting development back from the stream to preserve space for stream channels to move and change over time. DEC provides model municipal flood bylaw text that communities can use as a starting point for adoption of bylaws that increase flood resilience and protect floodplains and river corridors.

Communities can also adopt zoning bylaws to protect river corridors. Protecting river corridors helps protect roads and buildings from erosive damage, improves water quality, moderates flooding, enhances wildlife habitat, and sets up communities for a more sustainable long-term relationship with rivers and streams. River corridor protection limits development close to stream and river channels to allow the channel to establish and maintain a least-erosive path through the valley lessening the need to armor channel edges. The Unified Towns and Gores including Averill, Ferdinand and Lewis are the only towns in this basin that have adopted river corridor protection. These river corridor protections are important since these regulations will limit further encroachment and allow the upper Connecticut River tributaries to reestablish floodplain access, which will slow the transport of sediment and flood waters downstream, reducing peak flood levels which are one driver of the instability of the Connecticut River.

River Corridor maps are available for all perennial streams in the basin, except the Connecticut River, which will be mapped by DEC Rivers as a separate effort. Where available, SGA data has been used to inform River Corridor maps that can be viewed online at tinyurl.com/floodreadyatlas and on the ANR Natural Resources Atlas at http://anrmaps.vermont.gov/websites/anra5/. More information about River Corridor mapping is available at floodready.vermont.gov.

Adopting and implementing new development standards can be challenging. Continued support of these community policies is important to help communities explain the benefits and refine implementation of these new standards within the community. Priorities for community outreach are to continue to provide information to the three communities that don't currently participate in the NFIP program in the basin to encourage participation and provide support as communities consider joining this program. Another priority is to encourage communities to adopt river corridor protections with a focus on communities in the upper watershed, and finally to support communities that have adopted new regulations as these regulations are applied.

Community flood resilience planning and regulations can make a significant contribution to stream stability and equilibrium conditions in the watershed. When new development is placed in a river corridor or floodplain, encroachment on the stream increases the likelihood of conflict with stream

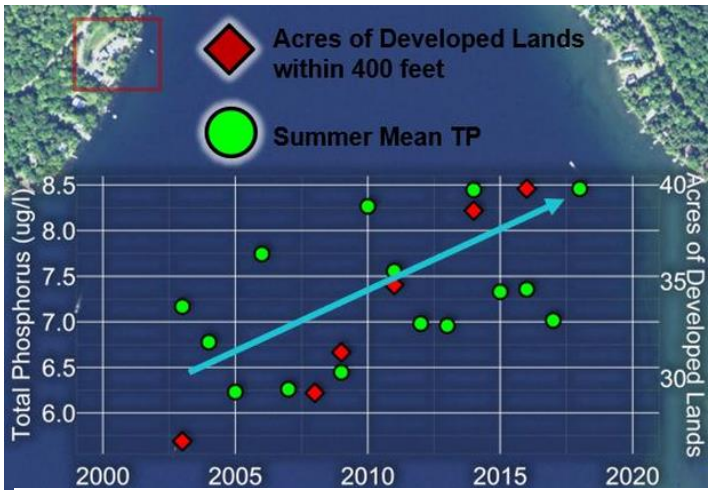
adjustment and the desire to channelize the stream to protect property. Given the space, streams can regain their natural stability and floodplain access. Information about municipal flood resilience planning efforts is available online at https://floodready.vermont.gov/. Questions regarding the flood hazard bylaws or flood resilience planning should be directed to the appropriate DEC Regional Floodplain Manager: bit.ly/flood-manager.

Lakes

Recommendations for Restoration

Effective July 1, 2014, the Vermont Legislature passed the Shoreland Protection Act (Chapter 49A of Title 10, §1441 et seq.), which regulates shoreland development within 250 feet of a lake's mean water level for all lakes greater than 10 acres in size. The intent of the Act is to prevent degradation of water quality in lakes, preserve habitat and natural stability of shorelines, and maintain the economic benefits of lakes and their shorelands. The Act seeks to balance good shoreland management and shoreland development.

Shoreland developed prior to July 1, 2014 is not required to retroactively meet standards. The Lake Wise Program, an Agency of Natural Resources initiative that awards lake-friendly shoreland property, including that of state parks, town beaches, private homes and businesses, is available to lakeshore owners and Lake Associations to assess shoreland property for improvements that benefit water quality and wildlife habitat. Lakes with a fair shoreland score will benefit from implementing Lake Wise Program best management practices. More information on the program can be found at: http://dec.vermont.gov/watershed/lakes-ponds/lakeshores-lake-wise/what. Three lakes in Basin 16 are a highest priority for Lake Wise based on increasing nutrient trends and poor or fair shoreland conditions are: Maidstone Lake, Miles Pond and Wallace Pond. In addition to this Neil and Shadow



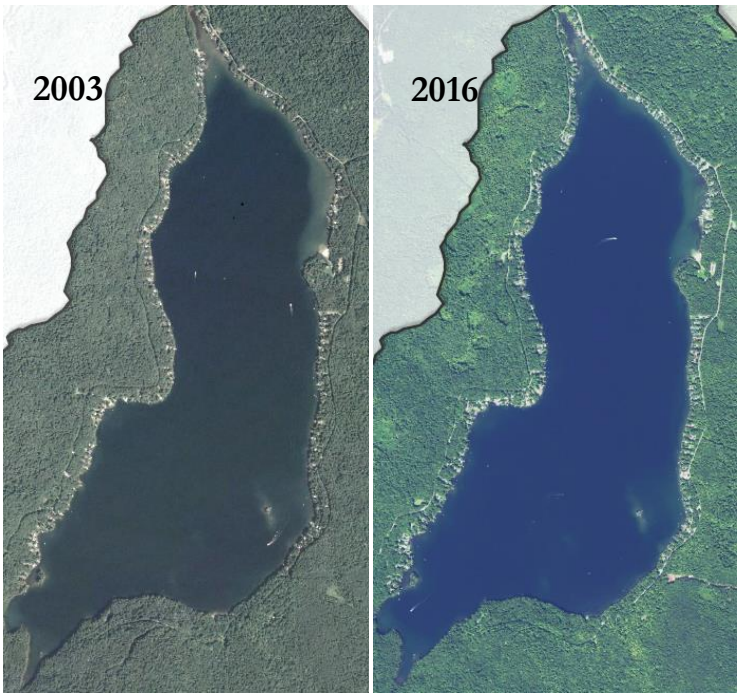


Figure 19. Graph showing a 37% increase in impervious surface within 400 feet of Maidstone Lake from 2003 through 2016 and an increase in mean phosphorus concentration over this same timeframe. The increase in impervious surface is visible in the photos to the right from 2003 and 2016.

lake are also a priority for Lake Wise assessments due to fair shoreland conditions. Maidstone lake is the highest priority for restoration in Basin 16 due to the fact that it a large lake with an oligotrophic classification and meets A(1) aesthetic criteria but is exhibiting a poor condition nutrient trend and has been identified as having fair shoreland conditions. Spring and summer TP are highly significantly increasing, although the summer Secchi trend is increasing in depth (suggesting improved clarity), and the summer Chlorophyll-a levels are decreasing which suggests better water quality. Researchers at the University of Vermont are looking into why we may be seeing these conflicting trends which have been seen in several lakes in the region. These graphs can be viewed at this link: Lake score card trends

The cause for the increasing phosphorus trends at Maidstone Lake is likely related to widespread shoreland development that occurred along this lake over the last several decades including the conversion of many smaller seasonal camps to year round homes with the associated increase in impervious surface, lawn and landscaped areas and septic systems which have been shown to contribute significant phosphorus loading to lakes (Figure 19). In 2014 the Shoreland Protection Act was passed in Vermont which limits the impact of future developments however efforts are needed to restore the already developed shoreline areas.

The Essex County NRCD and Maidstone Lake Association have been working together since 2015 to complete Lake Wise assessments, identify design and implement BMP projects to address runoff issues around the lake. Thirty assessments have been completed along with 28 projects implemented around the watershed with nine landowers receiving Lake Wise awards which is the fourth highest of any lake in the state. An additional ten landowners have received Lake Wise certificates. More detailed information on the Lake Wise awards for this basin can be viewed at the Lake Wise map.

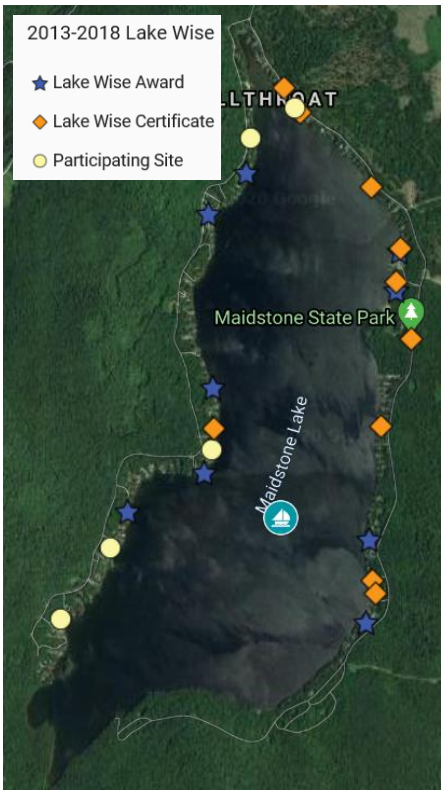


Figure 20. Lake Wise assessment locations around Maidstone Lake

While a substantial amount of work has been accomplished, additional assessment, design and implementation efforts are needed to protect the lake. Partners in the basin are encouraged to seek support for a Lake Watershed Action Plan for Maidstone Lake to complete the assessment and design work and also to evaluate other potential watershed phosphorus sources such as roads or forestry operations. In addition to this, designs are needed to support the implementation of previously identified BMP's which can be implemented at the Maidstone State Park and which can be integrated into the Lake Watershed planning effort. If 15% of lakeshore owners on Maidstone Lake get Lake Wise awards, then Maidstone Lake could be considered a Gold Star Lake.

Miles Pond also has increasing nutrient trends and fair shoreland conditions and so is another priority for protection and

restoration efforts. In the fall of 2020, plans were made to produce a pamphlet to distribute to lakeshore owners containing actions they can take to reduce nutrient runoff in the hopes that this can generate interest similar to efforts on Maidstone lake and stabilize phosphorus concentrations on this pond as well.

Increasing nutrient levels and poor shoreland conditions on Wallace Pond are a concern on this international waterbody that straddles the US-Canadian border. Lake users interested in becoming involved in the health of their favorite lake or pond should use the Lake Score Card Checklist of Lake Protection Actions, on the DEC Lakes and Ponds website, as a first step to moving toward a healthier lake or pond.

Preventing Aquatic Invasive Species

No aquatic invasive species have been confirmed in Basin 16 which presents an opportunity for continued protection of lakes and ponds in this basin. Lakes with the highest risk potential for invasive species introduction should take preemptive measures to prevent spread. Lakes and ponds with any public access areas are good sites to host spread prevention signage and materials, Vermont Invasive Patrollers (VIP), and frequent aquatic plant surveys. VIP volunteers survey waterbodies to monitor for any initial AIS threat. If a threat is found, DEC Aquatic Invasive Species Program would initiate an Early Detection and Rapid Response Plan to eradicate the threat. Access areas that are frequented by motorboats and area at a higher risk potential should also host VT Public Access Greeter Programs supported by the Aquatic Nuisance Control Grant-in-Aid such as those found at Maidstone and Miles. VT Public Access Greeters interact with boaters, inspect watercraft, identify any suspicious matter, collect and report data, and distribute educational material on aquatic invasive species. The Grant-in-Aid Program is offered by DEC and provides financial assistance to municipalities and agencies of the state for aquatic invasive and nuisance species management programs. Funding for Grant-in-Aid grants comes from a portion of annual revenues from motorboat registration fees and federal funds. This grant program has supported over 70 municipalities since 1994.

Wetlands

Wetland Restoration

The protection and restoration of floodplain forests and wetlands, which effectively attenuate nonpoint source pollution, is one strategy that has been adopted to protect and improve water quality in the Upper Connecticut River watershed. Historically there were large areas of wetlands along the Connecticut River that have been converted over time for agricultural and developed land uses. Some of these areas are now only marginally productive for agricultural or developed land uses, and these areas offer opportunities to restore wetlands and their associated functions and values. There have been only been a few wetland restoration projects completed in this basin, but restoration efforts are a priority going forward for the importance of riparian and wetland habitat, flood storage and the potential for nitrogen reduction as wetlands can support denitrification processes.

In 2012, Beck Pond LLC created a map of potential wetland restoration sites for all of Essex County. To create this map, they first developed a GIS-based site selection model to identify potential wetland restoration sites >1.2 ha (3 acres) in size that met the following three criteria: 1) agricultural and other non-forested land uses, 2) hydric soils, and 3) slopes ≤6%. In addition to this model, a qualitative approach could be undertaken to rank the potential wetland restoration sites based on their ability to reduce sediment and nutrient loading into the Connecticut River and ultimately into Long Island Pond, but such a ranking has not yet been undertaken. With this information, watershed partners can undertake on-the-ground site assessments and landowner outreach to identify those sites where there is landowner interest and the appropriate site conditions to restore wetlands and can guide funding for restoration of these potential wetland restoration sites.

Forests

Forestry AMPs and Skidder Bridge Programs

The DFPR updated the AMPs for Maintaining Water Quality on Logging Jobs in Vermont effective as of October 22, 2016. Vermont first adopted these rules 1987. The AMPs are intended and designed to prevent any mud, petroleum products and logging slash from entering the waters of the State and to otherwise minimize the risks to water quality. The AMPs are scientifically proven methods for loggers and landowners to follow for maintaining water quality and minimizing erosion. The new manual was published in 2019 and can be downloaded from DFPR' website.

Compliance with Vermont's Use Value Appraisal program (UVA) requires that the AMPs be employed to the maximum practicable extent. If the AMPs are not employed on UVA enrolled forestland but no discharge occurs, it may affect UVA eligibility without presenting a water quality violation. However, if the AMPs are not employed to the maximum practicable extent on the UVA parcel resulting in a discharge, it may affect parcel eligibility in UVA and be a water quality violation. While there is overlap between requirements of the AMPs and UVA, they should be viewed as distinct from each other. Almost fifty percent of the State's forestland employs the AMPs as a requirement of the UVA program or because of state ownership (Figure 21). This does not mean that the other forestland areas are not employing the AMPs but may be less likely to require AMPs on their property.

The Vermont Department of Forest Parks and Recreation (DFPR) provides temporary steel truck bridge rental opportunities for loggers during timber harvests. When properly installed, used, and removed, portable temporary bridges minimize stream bank and stream bed disturbance as compared with alternative devices, such as culverts or poled fords. Portable skidder bridges are also economical because they are reusable, easy to install, and can be transported from job to job. In addition, these bridges reduce the occurrence of sedimentation, channeling, and any degradation of aquatic habitat, while allowing loggers to harvest timber in compliance with The Acceptable Management Practices (AMPs) for Maintaining Water Quality on Logging Jobs in Vermont. For more information on the truck bridge rental program visit this website.

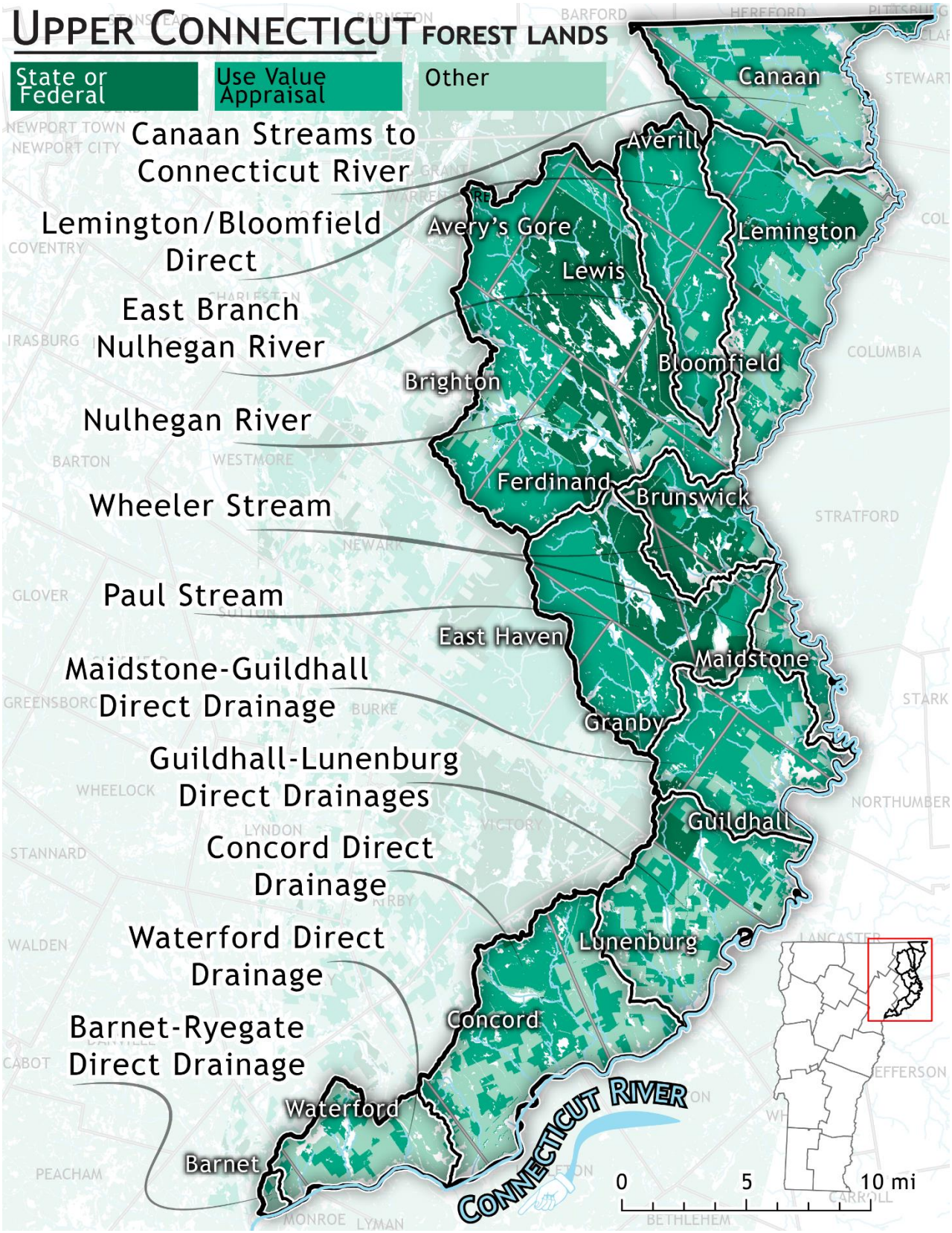


Figure 21. Forestland in Basin 16 represented by forestland management and ownership types.

In March 2018, the DFPR held a temporary skidder bridge lottery and twelve loggers and logging companies were chosen to receive bridges that were constructed by Fontaine Millworks in East Montpelier. The DFPR will also be offering workshops for building bridges throughout the state. Specifications for building your own skidder bridge can be found here: https://fpr.vermont.gov/skidder-bridges.

In addition to programs like the AMPs and skidder bridge rentals, AMP county foresters are available for consultation when questions arise about practices to protect water quality. Portions of Paul Stream and the Nulhegan River watersheds are in public land management by the DFPR and FWD. DFPR has replaced and removed many of their stream crossing structures under forest roads to restore geomorphic condition of streams. DFPR is also collaborating with DEC on the development of a forest road stormwater inventory process to assess the condition of forest roads and recommend BMPs to prevent erosion of logging road infrastructure and sedimentation into streams. The Basin also includes the federally owned Silvio O Conte refuge lands which covers a significant portion of the Nulhegan River watershed.

Chapter 5 – The Basin 16 Implementation Table

A. Progress in Basin 16

The Tactical Basin Plan addresses all impaired, stressed, and altered waters in the basin as well as protection needs for high quality waters. The list of strategies in the Implementation Table (Table 11) and the Monitoring and Assessment Table (Table 12) cover future assessment and monitoring needs, as well as projects that protect or remediate waters and related education and outreach.

The Implementation Table provides a list of 43 priority strategies created with the intention to be used as the go-to guide in the first step toward watershed action. A list of related individual project entries is found in the online Watershed Projects Database (WPD). The projects vary in level of priority based on the strategies outlined in the summary. All projects in WPD are not expected to be completed over the next five years, but each action in the summary is expected to be pursued and reported upon in the following plan and updated in the WPD.

As projects are developed, priority for Clean Water Initiative Program funding will be given to those projects that achieve the highest water quality benefits. Additionally, projects that provide cumulative benefits (i.e., flood resiliency, water quality improvement, water resource protection, aquatic organism passage) will receive additional consideration for prioritization.

The previous Basin 16 plan was completed in 2014. A total of 31 action items were identified in the plan. Seventy-seven (77%) have been implemented or are in progress by ANR and its watershed partners, five are awaiting action and have been carried over to this plan, and two have been discontinued (Figure 1). A report card for each of the 31 strategies can be viewed in Appendix A.

The 2020 Basin 16 Tactical Basin Plan builds upon those original plan recommendations by promoting specific, geographically explicit projects in areas of the basin that have been identified for intervention, using environmental modeling and on-the-ground monitoring and assessment data where available.

B. Coordination of Watershed Partners

There are several active organizations undertaking watershed monitoring, assessment, protection, restoration, and education and outreach projects in Basin 16. These partners are non-profit, private, state, and federal organizations working on both private and public lands. Partnerships are crucial in carrying out non-regulatory projects to improve water quality. Caledonia Natural Resources Conservation District (CNRCD), Connecticut River Conservancy (CRC), Essex County Natural Resources Conservation District (ECNRCD), Northeastern Vermont Development Association, US Fish and Wildlife Service, Vermont River Conservancy, lake associations, and municipal groups including local conservation commissions are active in:

- providing outreach and education to local stakeholders, private landowners, and municipalities.
- developing stream and floodplain protection and restoration projects (e.g., river corridor easements, tree plantings, culvert and bridge upgrades, dam removals, stream channel habitat restoration).
- developing stormwater projects (e.g., SWMPs, road erosion inventories, implementation of town road BMPs).
- monitoring water quality (e.g., lay monitoring program on lakes, *E. coli* and nutrient monitoring in rivers).

Partners active in working with farms in the basin developing and implementing BMPs for water quality include Natural Resource Conservation Service (NRCS), Agency Agriculture Food and Markets (VAAFM), CNRCD, CCNRCD, DEC, CRC and the University of Vermont Extension Service.

The large amount of work that is necessary to meet water quality targets in this basin require collaborations among all these groups to maximize the effectiveness of watershed partners. Without funding or partners, little of this work would be possible.

C. Basin 16 Implementation Table

The process for identifying priority strategies is the result of a comprehensive compilation and review of both internal ANR monitoring and assessment data and reports, and those of our watershed partner organizations. The monitoring and assessment reports include, but are not limited to, stormwater mapping reports, geomorphic assessments, river corridor plans, bridge and culvert assessments, Hazard Mitigation Plans, agricultural modeling and assessments, road erosion inventories, biological and chemical monitoring, lake assessments, fisheries assessments, and natural communities and biological diversity mapping.

A summary of priority strategies to address water quality in Basin 16 are identified in Table 11. The summary is the guiding list to go to as a first step for watershed action. The strategies can be linked to the on-going detailed list of projects in the online Watershed Projects Database.

The following tables serve to identify high priority implementation strategies and tasks that provide opportunities for all stakeholders in surface water management across each major river basin to pursue and secure technical and financial support for implementation. For these priorities to be achieved, partners and stakeholders must help to carry out the strategies identified in the basin plan.

Table 11, the Implementation Table Summary, provides a summary of strategies and actions to address water quality priorities by sector.

Table 11. Summary implementation strategies for the Basin 16 Tactical Basin Plan. *See list of acronyms on page 71.

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
Strategies to address runoff from Agricultural Lands				
1. **Connect basin farmers with the Connecticut River Watershed Farmers Alliance to facilitate information sharing and regional workshops and involvement with this group.**	Basin wide	All towns	ECNRCD, CRWFA, UVM Ext., AAFM	ACWIP
2. **Continue biannual meetings of the Caledonia and Essex County agricultural workgroup to help coordinate outreach, technical assistance, and financial assistance to farmers in the watershed to address water quality issues.**	Basin wide	All towns	ECNRCD, UVM Ext., AAFM, CRC, NRCS	ACWIP, TBPSG
3. **Hold annual workshops in the watershed for farmers to share information on field Best Management Practices such as no till and cover cropping, nitrogen application, shorter day corn varieties and use of innovative equipment.**	Basin wide	All towns	ECNRCD, CRWFA, UVM Ext., AAFM	ACWIP, FAP
3. Provide technical assistance in updating Nutrient Management Plans for existing farms, including assistance with soil and manure sampling.	Connecticut River floodplain and lowest reaches of tributaries	Canaan, Guildhall Lemington, Lunenburg, Bloomfield, Maidstone, Brunswick	ECNRCD	ACWIP
4. **Provide technical assistance to farmers in the basin that manage large acreages of cultivated cropland to maximize efficiency of nitrogen fertilizer use through preside nitrate testing (PSNT) and corn stalk nitrate testing (CSNT) and developing application recommendations.**	Connecticut River floodplain and lowest reaches of tributaries	Canaan, Guildhall Lemington, Lunenburg, Bloomfield, Maidstone, Brunswick	ECNRCD, UVM Ext., NRCS	ACWIP, LIS FF, RCPP
5. **Conduct outreach to farms with cultivated cropland to encourage the use of cover crops by providing information on the availably of state and federal funds for implementing this practice and providing technical assistance to address any limitations farms have implementing this practice.**	Mink Brook, Dean Brook and Willard Stream watersheds	Canaan, Guildhall Lemington, Maidstone	ECNRCD, UVM Ext., NRCS, AAFM	ACWIP, LIS FF, RCPP
6. **Develop a basin specific trial to support the advancement of inter seeding through either diversified cover crops and/or shorter day corn.**	Connecticut River floodplain and lowest reaches of tributaries	Canaan, Guildhall Lemington, Lunenburg, Bloomfield, Maidstone, Brunswick	ECNRCD, UVM Ext., NRCS	ACWIP, LIS FF, NRCS - CIG
7. **Provide technical and financial support to farmers to acquire equipment necessary for effective implementation of Best Management Practices such as cover cropping and no/min tillage.**	Connecticut River floodplain and lowest reaches of tributaries.	Canaan, Guildhall Lemington, Lunenburg, Bloomfield, Maidstone, Brunswick	ECNRCD, UVM Ext., NRCS	CEAP, VHCB, ACWIP

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
8. **Provide information and technical assistance to farmers to improve soil health through Soil Health Assessments, the development and implementation of grazing plans, and education about pasture and hay land BMPs that directly improve soil health and water quality.**	Connecticut River floodplain and lowest reaches of tributaries.	Canaan, Guildhall Lemington, Lunenburg, Bloomfield, Maidstone, Brunswick	UVM Ext., ECNRCD, NRCS	RCPP, ACWIP
9. **Identify a process and priorities for including floodplain and wetland restoration projects as farms transition ownership or are conserved to support sustainability for the farm and maximize water quality benefits.**	Connecticut River floodplain and lowest reaches of tributaries.	Canaan, Guildhall Lemington, Lunenburg, Bloomfield, Maidstone, Brunswick	VLT, CRC, ECNRCD, UVM Ext., NRCS, VRC	ERP, MEF, CREP, EQIP, WRE
10. **Provide technical assistance to Christmas tree growers in developing nutrient management plans and assist with on farm issues such as pests, disease, and weeds.**	Basin wide	All towns	ECNRCD, VFPR	ACWIP
Strategies to address runoff from Developed Lands - Stormwater				
11. **Develop Stormwater Master Plan(s).**	Canaan including Beecher Falls	Canaan	ECNRCD, DEC, Canaan	CWI, TBPSG, LISFF
12. **Work with watershed partners and municipalities to prioritize stormwater projects in Basin 16 where Stormwater Mapping Reports have been completed.**	Basin wide	Bloomfield, Canaan, Guildhall, Lunenburg	NVDA, DEC, ECNRCD, Municipalities	CWI, TBPSG, Grant-in-Aid
Strategies to address runoff from Developed Lands - Roads				
13. **Complete Road Erosion Inventories (REIs) to meet Municipal Road General Permit (MRGP) requirements.**	Basin wide	All towns	ECNRCD, AOT, NVDA	AOT MAB Grants, Grant-in-Aid
14. **Coordinate work of partners through the NEK R&R workgroup to provide and support training for road crews on using REI results to prioritize projects, to update road segment status in the MRGP database as well as the install and maintain of road BMPs to meet MRGP standards.**	Basin wide	All towns	Better Roads, ECNRCD, CCNRCD, AOT, NVDA, DEC	TBPSG, River & Roads Training Program
15. **Apply for Better Road Category A grants for towns to develop Capital Budgets for Very High and High Priority segments**	Basin wide	All towns	Better Roads, ECNRCD, CCNRCD, AOT, NVDA, DEC	Better Roads
16. **Provide support for towns in the application of Better Roads grants and Grant in Aid funding to maximize the effectiveness of projects for improving water quality.**	Basin wide with a focus on Maidstone Lake, Wallace Pond and Miles Pond watersheds	Maidstone, Concord, Canaan	Better Roads, ECNRCD, AOT, NVDA	TBPSG, transportation funding

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
17. **Continue support for the shared Hydroseeder program including training and expanding to the town of Maidstone.**	Basin wide	All towns	NVDA, ECNRCD DEC, AOT	AOT MAB Grants, Grant-in-Aid, CWI
18. **Provide support to towns and AOT on BMP's to avoid invasive species spread along roads and invasive species control efforts.**	Basin wide	All towns	All towns, ECNRCD, UCIZMA, Conti refuge, AOT	
Strategies to address Wastewater				
19. **Promote septic system maintenance through local outreach and education programs, such as a septic social.**	Maidstone Lake, Miles Pond, Wallace Pond, village centers along the Connecticut River	Canaan, Concord, Maidstone, Guildhall, Bloomfield	DEC, Maidstone Lake Association	FWD Watershed Grant
20. **Provide information on the ANR Village Wastewater Solutions to any communities that have inadequate individual onsite wastewater treatment on small, challenging sites, and funding for planning and implementation of priority projects that are identified and have community support.**	Village centers along the Connecticut River adjacent to *E. coli* impaired segments.	Concord, Maidstone, Guildhall, Bloomfield	DEC, Towns, RPC	CWSRF, EPA Engineering Planning Advance, MPG, USDA-RD SEARCH grants
Strategies to support Natural Resource Protection and Restoration - Rivers				
21. **Develop and prioritize a map or list of potential floodplain restoration locations in the basin including areas where existing buffers can be expanded to restore functional floodplain or wetlands.**	Connecticut River floodplain and lowest reaches of tributaries.	Canaan, Guildhall Lemington, Lunenburg, Bloomfield, Maidstone, Brunswick	ECNRCD, CRC	ERP, MEF, NFWF
22. **Identify potential River Corridor Easement or lake conservation opportunities when there may be landowner interest in floodplain/wetland restoration or conservation.**	Leach Creek, Lower portions of the: Nulhegan, East Branch Nulhegan, Willard, Blodgett, Capon, Bolter, and Keyer.	Canaan, Bloomfield, Lemington	ECNRCD, CRC, VLT DEC, VRC, VFW	ERP, MEF
23. **Work with partners in the basin to implement priority floodplain restoration projects.**	Connecticut River floodplain and lowest reaches of tributaries.	Canaan, Guildhall Lemington, Lunenburg, Bloomfield, Maidstone, Brunswick	ECNRCD, CRC, FWD, TNC, VLT	ERP, MEF, NFWF, CREP, EQIP

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
24. **Expand local sources of native tree species, such as the ECNRCD native plant nursery, so there will be a sufficient supply to restore native habitats in the basin.**	Basin wide	All towns	ECNRCD, private nurseries	ERP, MEF
25. **Support research and implementation of floodplain forest restoration through cultivation of lands and hydroseeding native species to create denser floodplain forests than traditional buffer planting approach on a shorter timescale.**	Connecticut River floodplain and lowest reaches of tributaries.	Canaan, Guildhall Lemington, Lunenburg, Bloomfield, Maidstone, Brunswick	FWD, CRC, USFWS, DEC	ERP, MEF, RCPP, NFWF,USFWS
26. **Support riparian and wetland invasive control efforts through the Upper Connecticut Cooperative Invasive Species Management Area (UCISMA) with a priority on invasive species that threaten wetland and floodplain restoration efforts.**	Basin wide	All towns	UCISMA, ECNRCD, FWD	ERP, USFWS
27. **Target strategic wood additions to restore Brook Trout habitat in streams which were historically impacted by logging operations.**	Headwaters regions		FWD, TU	ERP, MEF, NFWF
28. **Evaluate priority culverts for AOP restoration potential and impact along with potential geomorphic benefits**	See Figure 18	Maidstone, Lunenburg, Lemington, Granby, Ferdinand, Brighton, Lewis, Canaan	ECNRCD, Towns, NVDA, FWD, CRC, TU, USFWS	TBPSG, MEF, SWIG
29. **Work with towns and private landowners to retrofit or replace priority culverts to restore AOP.**	See Figure 18	Maidstone, Lunenburg, Lemington, Granby, Ferdinand, Brighton, Lewis, Canaan	ECNRCD, Towns, NVDA, FWD, CRC, TU, USFWS	ERP, MEF, Better Roads, SWIG
30. **Identify potential dam removal projects in the basin**			American Rivers, CRC, FWD, TU, USFWS	TBPSG, MEF, RCPP, NFWF, USFWS
31. **Provide information on the benefits of the NFIP program and technical support for towns that are interested in joining the program and to provide information on the flood hazard map update process.**		Maidstone, Lunenburg, East Haven, Concord, Waterford.	DEC, NVDA, Towns, CRJC	TBPSG, MPG
32. **Provide support to local communities as they consider river corridor protections in towns plans or zoning bylaws.**	Basin wide	All towns	DEC, ECNRCD, NVDA, CRJC	TBPSG, MPG
33. **Provide support to regional and community projects to provide access to rivers for recreation while maximizing riparian restoration opportunities and minimizing any permanent constraints on rivers.**	Connecticut River, Nulhegan River	Canaan, Guildhall Lemington, Lunenburg, Bloomfield, Maidstone, Brunswick, Ferdinand, Brighton	Towns, ECNRCD, FWD, NVDA, DEC, TU, USFWS, NFCT, CRPT, CRC	MEF, Rec Trails Grants, Watershed Grant, ERP (for restoration)

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
Strategies to support Natural Resource Protection and Restoration - Lakes				
34. **Complete a Lake Watershed Action plan for Maidstone Lake that addresses shoreland areas, roads and Maidstone State Park, building off previous Lake Wise assessments, design and implementation efforts.**	Maidstone Lake Watershed	Maidstone	DEC, ECNRCD, Maidstone Lake Association, Town of Maidstone, VFPR	ERP, TBPSG, Watershed Grant
35. **Design and implement projects identified through Lake Wise assessments and through the Lake Watershed Action Plan for Maidstone Lake.**	Maidstone Lake Watershed	Maidstone	DEC, ECNRCD, Maidstone Lake Association, Town of Maidstone, VFPR	ERP, TBPSG, Watershed Grant
36. **Complete outreach to the Miles and Wallace Pond communities around increasing nutrient trends and opportunities to support Lake Wise assessments and implementation or the development of a Lake Watershed Action if there is local support.**	Miles and Wallace Ponds	Concord, Canaan	DEC, ECNRCD, Miles Pond Association	TBPSG
37. **Implement an aquatic invasive species spread prevention plan throughout the basin that includes hosting a VIP training in the watershed and initiating a Volunteer Invasive Patrol (VIP) Program at priority lakes, installing signage on public accesses, conducting aquatic plants surveys.**	Maidstone Lake, Miles Pond, Wallace Pond, Comerford and Moore Reservoirs,	Maidstone, Concord, Canaan, Waterford	DEC, ECNRCD, CRC, Maidstone Lake Association, Miles Pond Campers Association, towns volunteers	
38. **Continue to implement and support local Public Access Greeter Programs.**	Maidstone Lake, Miles Pond	Maidstone, Concord	DEC, Maidstone Lake Association, Miles Pond Campers Association, Volunteers, Towns	ANC Grant
Strategies to support Natural Resource Protection and Restoration - Wetlands				
39. **Complete site visits and/or location specific restoration maps for potential wetland restoration locations in the basin with a priority on locations where landowners are supportive of WRE projects.**	Connecticut River floodplain and lowest reaches of tributaries.	Canaan, Guildhall Lemington, Lunenburg, Bloomfield, Maidstone, Brunswick	ECNRCD, CRC, DEC	ERP, MEF, NFWF, LIS FF, RCPP, WRE
40. **Develop geographic area rate caps for Essex County or an alternative approach that doesn't require an appraisal for any WRE project to move forward that isn't on conserved lands.**	Basin wide	All towns	ECNRCD, NRCS,	

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
41. **Develop funding and stewardship model to support smaller scale wetland restoration projects (5-30 acres) in the basin.**	Basin wide	All towns	ECNRCD, CRC, DU, FWD, DEC, USFWS	MEF, LISFF, ERP, RCPP
42. **Identify where FWD or other conservation partners may be interested in acquiring larger restored wetlands after wetland restoration projects are completed which can make WRE work better for landowners who may not want to own a conserved wetland.**	Connecticut River floodplain and lowest reaches of tributaries.	Canaan, Guildhall Lemington, Lunenburg, Bloomfield, Maidstone, Brunswick	VFW, VLT, VRC, TNC	
43. **Research alternatives to estimate nitrogen reduction potential for wetland restoration projects in the basin. Consider water quality sampling for projects that are implemented to directly evaluate nitrogen reductions.**	Connecticut River floodplain and lowest reaches of tributaries.	Canaan, Guildhall Lemington, Lunenburg, Bloomfield, Maidstone, Brunswick	DEC, ECNRCD,	LISFF,
Strategies to support Natural Resource Protection and Restoration - Forests				
44. **Complete forest road erosion inventories on state lands in the basin and fix high priority forest road erosion problems that are identified.**	Nulhegan, Paul Stream, Dennis Pond		DFPR, FWD, DEC, TNC	CWI
45. **Work with large forestland owners, especially those with roads that have access easements, to consider using the road erosion inventory to identify forest road restoration projects to address water quality issues.**	Basin wide	All towns	DFPR, FWD, DEC, Forestland owners	CWI
46. **Work with large forestland owners to develop a program to identify erosion, or alteration of watershed hydrology that is a result of historical logging operations and that could be restored. Develop a program to provide financial incentives to restore these issues during planned logging operations while equipment is on site.**	Basin wide	All towns	DFPR, FWD, DEC, Forestland owners	CWI
47. **Promote skidder bridge funding to increase applications for the purchase and use of skidder bridges in the basin.**	Basin wide	All towns	DFPR, ECNRCD	Skidder Bridge program

D. Basin 16 Monitoring and Assessment Table

Table 12, the Monitoring and Assessment Table, provides a preliminary list of water quality monitoring priorities to guide monitoring over the next 5 years. This list has more sites than there is capacity to sample and as a result, will be further prioritized before monitoring occurs in 2022.

Table 12. Basin 16 priorities for monitoring and assessment. Monitoring on private lands requires landowner permission.

Waterbody	Project Description	Location	Partner(s)	Purpose
Lakes and Ponds				
1. Wallace Pond	Lay monitor to collect in-lake chemistry, VIP to monitor for invasive species	Canaan	DEC Lakes & Ponds, Lay Monitoring Volunteer	To identify sources of phosphorus leading to in-lake increased total phosphorus during spring and summer. To collect data to support reclassification as a B(1) water for aesthetics. To identify, track and prevent aquatic invasive species
2. Shadow Lake	Lay monitor to collect in-lake chemistry, VIP to monitor for invasive species	Concord	DEC Lakes & Ponds, Lay Monitoring Volunteer, VIP Volunteer	To collect data to support reclassification as an A(1) water for aesthetics to identify, track and prevent aquatic invasive species
3. Lewis Pond	Lay monitor to collect in-lake chemistry, Monitor presence/absence of aquatic invasive species.	Lewis	DEC Lakes & Ponds, Lay Monitoring Volunteer	To collect data to support reclassification as an A(1) water for aesthetics, to identify, track and prevent aquatic invasive species.
4. Nulhegan Pond	Lay monitor to collect in-lake chemistry	Brighton	DEC Lakes & Ponds, Lay Monitoring Volunteer	To collect data to support reclassification as an A(1) water for aesthetics
5. South America Pond	Lay monitor to collect in-lake chemistry, Monitor presence/absence of aquatic invasive species.	Ferdinand	DEC Lakes & Ponds, Lay Monitoring Volunteer, VIP	To collect data to support reclassification as an A(1) water for aesthetics. To identify, track and prevent aquatic invasive species.
6. Maidstone Lake	Lay monitor to collect in-lake chemistry VIP to monitor for invasive species	Maidstone	DEC Lakes & Ponds, Lay Monitoring Volunteer, VIP	Continue summer monitoring to track increasing phosphorus trends. To identify, track and prevent aquatic invasive species
7. Miles Pond	Lay monitor to collect in-lake chemistry, VIP to monitor for invasive species	Concord	DEC Lakes & Ponds, Lay Monitoring Volunteer	Continue summer monitoring to track increasing phosphorus trends. To identify, track and prevent aquatic invasive species
8. Neal Pond	VIP to monitor for invasive	Lunenburg	DEC Lakes & Ponds, VIP	To identify, track and prevent aquatic invasive species.
9. Brunswick Springs	Monitor presence/absence of aquatic invasive species. Next Generation Lake assessment.	Brunswick	DEC Lakes & Ponds, VIP	To identify, track and prevent aquatic invasive species. To understand conditions that may support ORW for cultural values.
10. Forest Lake	Monitor presence/absence of aquatic invasive species.	Averill	DEC Lakes & Ponds, VIP, Quimby country	To identify, track and prevent aquatic invasive species.

Waterbody	Project Description	Location	Partner(s)	Purpose
11. Comerford reservoir	Monitor presence/absence of aquatic invasive species or establish VIP to monitor for invasive species. Spring p (or integrate NH DES status)	Barnet, Waterford	DEC Lakes & Ponds, VIP, CRC	To identify, track and prevent aquatic invasive species.
12. Moore Reservoir	Monitor presence/absence of aquatic invasive species or establish VIP to monitor for invasive species / Spring p (or integrate NH DES status)	Waterford, Concord	DEC Lakes & Ponds, VIP, CRC	To identify, track and prevent aquatic invasive species.
Rivers and Streams				
13. Leach Creek Lower	Biological and chemical monitoring, Phase II or Phase II lite SGA	Canaan	BASS, RMP, ECNRCD	Data gap. Large watershed with no data. Phase I SGA suggested Phase II assessment is warranted.
14. Upper Leach Creek	Biological and chemical monitoring	Canaan, Averill	BASS, Volunteers	Data gap. Moderate sized watershed with no data, may help to understand increasing nutrient trends in Wallace Pond.
15. Catbow Brook	Biological and chemical monitoring	Canaan	BASS	Data gap. Moderate sized watershed with no data.
16. Halls Brook	Biological and chemical monitoring	Lunenburg	BASS	Data gap. Moderate sized watershed with no data.
17. Chandler Brook	Biological and chemical monitoring	Waterford	BASS	Data gap. Moderate sized watershed with no data and moderate levels of developed land use.
18. Mink Brook	Biological and chemical monitoring	Lunenburg	BASS	Data gap. Moderate sized watershed with no data.
19. Emery Brook	Biological and chemical monitoring	Guildhall	BASS	Data gap. Moderate sized watershed with no data.
20. Clough Brook	Biological and chemical monitoring	Bloomfield, Lemington	BASS	Data gap. Large watershed with no data. B(1) potential based on undeveloped watershed.
21. Mad Brook	Biological and chemical monitoring	Waterford	BASS	Data gap. Smaller sized watershed with no data but higher percentage developed lands.
22. Upper North Branch Nulhegan	Biological and chemical monitoring	Avery's Gore	BASS	Data gap. Large watershed with no data and land use that suggest potential A(1) or B(1) water.
23. Granby Stream	Biological and chemical monitoring		BASS	Determine reclassification status for aquatic biota
24. Rich Brook	Biological and chemical monitoring		BASS	Determine reclassification status for aquatic biota
25. Mill Brook	Biological and chemical monitoring		BASS	Determine reclassification status for aquatic biota
26. Miles Stream	Biological and chemical monitoring	Concord	BASS	Determine reclassification status for aquatic biota
27. Cutler Mill Brook	Biological and chemical monitoring	Guildhall	BASS	Determine reclassification status for aquatic biota
28. Paul Stream	Biological and chemical monitoring	Maidstone	BASS	Determine reclassification status for aquatic biota
29. Blodgett Brook	Biological and chemical monitoring		BASS	Determine reclassification status for aquatic biota
30. Willard Stream	Biological and chemical monitoring		BASS	Determine reclassification status for aquatic biota
31. Capon Brook	Biological and chemical monitoring		BASS	Determine reclassification status for aquatic biota
32. Clay Hill Brook	Biological and chemical monitoring		BASS	Determine reclassification status for aquatic biota
33. Jacobs Chopping Brook	Biological and chemical monitoring		BASS	Determine reclassification status for aquatic biota

Waterbody	Project Description	Location	Partner(s)	Purpose
34. Paul John Stream	Biological and chemical monitoring		BASS	Update 2012 fair to good assessment to determine if this meets WQS
35. East Branch Nulhegan	Biological and chemical monitoring, Phase II Lite SGA		RMP, ECNRCD, CRC, BASS	Update 2017 good assessment to determine if this meets WQS or if conditions have improved with upstream strategic wood addition and habitat improvement efforts
36. Connecticut River	E. *coli*	Canaan	DEC, ECNRCD, NH DES	Update old data on *E. coli* impairment
37. Connecticut River	E. *coli*	Lemington	DEC, ECNRCD, NH DES	Update old data on *E. coli* impairment
38. Connecticut River	E. *coli*	Bloomfield	DEC, ECNRCD, NH DES	Update old data on *E. coli* impairment
39. Connecticut River	E. *coli*	Brunswick, Maidstone	DEC, ECNRCD, NH DES	Update old data on *E. coli* impairment
40. Connecticut River	E. *coli*	Lunenburg	DEC, ECNRCD, NH DES	Update old data on *E. coli* impairment
41. Nulhegan River	Phase II lite SGA at sentinel site and/or reaches with wood additions, biological and chemical monitoring	Bloomfield, Brunswick, Lewis	RMP, ECNRCD, CRC, BASS	Link SGA data to other data collection efforts, continue sentinel site data collection, understand nitrogen concentrations
Wetlands?				
42. Moose Bog	Collect additional information to support reclassification of Moose Bog	Ferdinand	FWD, CRC	Determine biological condition and if site meets Class I wetland criteria
43. Yellow Bogs	Collect additional information to support reclassification of Yellow Bogs	Essex County	USF&W, CRC	Determine biological condition and if site meets Class I wetland criteria

List of Acronyms

604(b)	Federal Clean Water Act, Section 604b
ACWIP	Agricultural Clean Water Initiative Grant Program
AIS	Aquatic Invasive Species
AMPs	Acceptable Management Practices (for logging)
ANC	Aquatic Nuisance Control grant
ANR	Vermont Agency of Natural Resources
AOP	Aquatic Organism Passage
AOT	Vermont Agency of Transportation
BASS	Biomonitoring and Aquatic Studies Section
BMP	Best Management Practices
BR	Better Roads
CCNRCD	Caledonia County Natural Resources Conservation District
CEAP	Capital Equipment Assistance Program
CRC	Connecticut River Conservancy
CRWFA	Connecticut River Watershed Farmers Alliance
CREP	Conservation Reserve Enhancement Program
CWI	Clean Water Initiative Grant Funding
CWIP	Clean Water Initiative Program
CWSRF	Clean Water State Revolving Fund
DEC	Department of Environmental Conservation
DFPR	Vermont Department of Forests, Parks and Recreation
EBTJV	Eastern Brook Trout Joint Venture
ECNRCD	Essex County Natural Resources Conservation District
EQIP	Environmental Quality Incentive Program
ERP	Ecosystem Restoration Program
FAP	Farm Agronomic Practices
FWD	Vermont Fish and Wildlife Department
GIS	Geographic Information System
GSI	Green Stormwater Infrastructure
IDDE	Illicit Discharge Detection (and) Elimination
LFO	Large farm Operation
LISFF	Long Island Sound Futures Fund
LULC	Land Use Land Cover
MAB	Municipal Assistance Bureau
MAP	Monitoring and Assessment and Program
MEF	Upper Connecticut River Mitigation and Enhancement Fund
MFO	Medium Farm Operation
MPG	Municipal Planning Grant
MRGP	Municipal Roads General Permit
NFIP	National Flood Insurance Program
NFWF	National Fish and Wildlife Foundation
NH DES	New Hampshire Department of Environmental Services
NMP	Nutrient Management Plan
NPS	Non-point source pollution
NRCD	Natural Resources Conservation District
NRCS	Natural Resources Conservation Service
NVDA	Northeast Vermont Development Association
NWSC	North Woods Stewardship Center
ORW	Outstanding Resource Water
RAP	Required Agricultural Practices
RCPP	Regional Conservation Partnership Program
RMP	River Management Program
RPC	Regional Planning Commission
SFO	Small Farm Operation
SGA	Stream Geomorphic Assessment
SWMP	Stormwater Master Plan
TBP	Tactical Basin Plan
TBPSG	Tactical Basin Planning Support Grants
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TS4	Transportation Separate Storm Sewer System General Permit
NRCD	Natural Resources Conservation District

TU	Trout Unlimited
UCISMA	Upper Connecticut Cooperative Invasive Species Management Area
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
UVA	Use Value Appraisal program, or Current Use Program
UVM Ext.	University of Vermont Extension Service
VAAFM	Vermont Agency of Agriculture, Food, and Markets
VACD	Vermont Association of Conservation Districts
VHCB	Vermont Housing and Conservation Board
VIP	Vermont Invasive Patrollers
VLCT	Vermont League of Cities and Towns
VLRP	Vermont Local Roads Program
VLT	Vermont Land Trust
VHCB	Vermont Housing and Conservation Board
VIP	Vermont Invasive Patrollers
VRAM	Vermont Rapid Assessment Method
VRC	Vermont Rivers Conservancy
VWQS	Vermont Water Quality Standards
VYCC	Vermont Youth Conservation Corp
WISPr	Water Infrastructure Sponsorship Program

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Appendix A. 2014 Basin 15/16 TBP Status Update

Overall, work completed in the watershed since the publication of the previous Tactical Basin Plan in 2014 has allowed several assessments and efforts to support the implementation of specific strategies. A total of 31 strategies were included in the joint Basin 15/16 plan of which 9 have been completed, 15 are in progress, five are awaiting action and two are discontinued.

Table A1. 2014 Basin 16 report card with 2020 updates from local, state, and federal watershed partners.

Action from 2014 TBP	Lead/Key Players	Funding	Priority	Objective	Status	Update/ Recommendation for 2020 TBP
ANR recommends that the Nulhegan River, Washburn Brook be considered as candidates for reclassification to Class A(1) waters.	**ANR/**Conte Refuge, Friends of the Nulhegan		Top 10	Protection of high quality waters	Awaiting action	With additional data Washburn Brook is now meets B(1) criteria along with much of the Nulhegan River watershed.
Petition for the reclassification of Mud and Dennis Pond wetlands as Class 1 Wetlands.	**DEC/** FWD, TNC, Consultants		Top 10.	Protection of high quality waters	Completed	Wetlands have been reclassified as a Class 1 Wetland.
Collect additional information on Moose and Yellow Bogs to determine if reclassification is appropriate.	**DEC**/Conte Refuge, Friends of the Nulhegan, Consultants		High	Protection of high-quality waters	Completed	In Wetlands program completed an assessment and determined that these do have exceptional functions and values and so are potential Class 1 wetlands.
Collect information necessary to support a petition for waters in the Nulhegan river basin as an ORW.	**ANR/** Conte refuge, Friends of the Nulhegan, Consultants		High	Protection of high quality waters	Discontinued	No local partner identified to support a petition. Consideration for reclassification as B(1) appears to be more appropriate.
Complete biological assessments and other assessments to evaluate reclassification of Mill Brook (Bloomfield), Paul Stream, East, Black, Yellow, Logger, and North Branches of the Nulhegan River as Class A(1) waters.	**ANR/** Conte Refuge, Friends of the Nulhegan, Consultants		High	Protection of high quality waters	In progress	Assessments completed and used to identify several streams that meet A(1) and B(1) criteria in this plan.
Reclassify Bloomfield water supply from Class A(2) waters to Class B or B(1) waters.	**DEC**/ Bloomfield		High	Protection of high quality waters	Awaiting action	No reclassifications have moved forward for this basin since 2014 so this will be carried forward in the 2020 plan.
Identify high priority lakes for protection or reclassification.	**DEC**		High	Protection of high quality waters	Completed	Lakes that met A(1) or B(1) nutrient criteria have been identified in this basin and are included in the 2020 Tactical Basin Plan

Action from 2014 TBP	Lead/Key Players	Funding	Priority	Objective	Status	Update/ Recommendation for 2020 TBP
Improve lakeshore buffer protections in town zoning bylaws for lakes and ponds in the basin.	**Towns/**NVDA, DEC, NRCD, Lake Associations.	604(b)	High	Protection of high quality waters	Discontinued	The shoreland protection act largely protects lake shorelands so addressing through local zoning is no longer a priority
Support easements or conservation of undeveloped lakeshore habitat on priority lakes and ponds.	**ANR/** Lake Assn., Land trusts, landowners	VHCB, MEF	Medium	Protection of high quality waters	Awaiting action	This strategy will be brought forward in 2020 plan. Land owned by DEC on Miles Pond and leased to the town of Concord – has been discussed for potential restoration opportunities.
Restore instream woody habitat in the East Branch Nulhegan watershed through strategic wood placement to increase brook trout populations. Based on study results extend these efforts to other watersheds where this practice is shown to be effective.	**Trout Unlimited/** VFW, Conte Refuge, Landowners	MEF	Medium	Protection of high quality waters	Completed	Restoration efforts on the East Branch and many other tributaries in this basin were completed since 2014 with over 30 miles of streams restored with wood additions. Several other streams are priorities for work in 2020 – 2022, so this strategy is included in the 2020 plan.
Implement an intensive water quality monitoring program to evaluate phosphorus, nitrogen, sediment and E. coli sources in the Basin. Use sampling results to identify pollution sources in the basin and work with basin partners to address these.	**ECNRCD/** CCNRCD, CRJC, Coos County NRCD, CRWC, DEC, Consultants	ERP, Watershed grants, LaRosa partnership, private funding sources	Top 10	Water Quality Monitoring	Awaiting action	An intensive monitoring program has not been developed due to logistical challenges – however Samplepalooza one day sampling event has provided some information.
Establish a long term bi-state volunteer monitoring program covering the Connecticut River main stem and if possible, major tributaries that is integrated with NH DES Volunteer River Assessment Program.	**Volunteers/** DEC, CRJC, NHDES, CRWC, Burke Conservation Commission	LaRosa Partnership,	High	Water Quality Monitoring	In progress	A water quality monitoring program was established with NH DES and CRWC for 2014, 2015, 2018, 2019 under the "samplepalooza" heading.
Where elevated levels of E. *coli* are confirmed in agricultural areas based on water sampling, target BMP projects on farms to reduce manure runoff in these areas.	**ARS/** VAAFM, NRCS, NRCD, DEC	MEF, ERP, Watershed Grant	High	E. *coli*	In progress	The Caledonia and Essex County Agricultural Workgroup has been established and focused work in these areas and these locations were a focus for CSFO inspections.
Contact landowners in priority areas with important floodplain protection or restoration opportunities to encourage participation in conservation	**ECNRCD/** CCNRCD, DEC, TNC, VLT, VRC, CRJC, Consultants	MEF, ERP, Watershed grant	Top 10	Protect and restore floodplain and wetland habitat	In progress	Several buffer planting outreach efforts were completed since 2014 although more work needs to be done in this area.

Action from 2014 TBP	Lead/Key Players	Funding	Priority	Objective	Status	Update/ Recommendation for 2020 TBP
and restoration programs.						
Complete floodplain protection projects and where applicable restoration projects.	**TNC /** VLT**,** VRC**,** NRCS, FWD, VRC, ECNRCD, CRWC	MEF, CREP, ERP, PF&W, watershed grant	High	Protect and restore floodplain and wetland habitat	In progress	Several buffer projects were completed on the Johnson Farm and other locations along the Connecticut River.
Complete wetland restoration projects on marginal agricultural lands which have been historically drained.	**DEC/** NRCS, ENRCD, TNC, VLT, FWD, Consultants	MEF, CRP, CREP, ERP, PF&W	High	Protect and restore floodplain and wetland habitat	In progress	Some wetland restoration on the Johnson Farm (confirm) but this will be a priority for the 2020 plan.
Work with towns on the Connecticut River from Lunenburg to Canaan to strengthen NFIP bylaws and shoreland protections along the Connecticut River.	**Towns/** DEC, NVDA, NRCD	Municipal planning grants	High	Protect and restore floodplain and wetland habitat	In progress	Some outreach has been done for these towns but so far there hasn't been interest in updating bylaws. A remapping effort was initiated for the southern towns in the basin which is expected to take 5 years to complete. Towns will need to updated bylaws to be compliant with minimum NFIP standards.
Complete outreach to farmers to improve nitrogen management on farms through the use of Adapt N software, pre side dress nitrate testing and demonstrating the use of shorter duration corn with legume cover crops.	**UVM Ext/** NRCD, AAFM, NRCS	Long Island Sound Futures fund, 319	Top 10	Reduce nitrogen loading to Long Island Sound	Completed	ECNRCD and UVM ext. have been working with farmers to do preside dress nitrogen and stock nitrogen testing. More work is needed, and this will continue to be a priority for 2020 TBP.
Identify potential nitrogen sources and highest priority BMP's for reducing nitrogen runoff from agricultural and developed lands in the Basin.	**ARS/** NRCS, DEC, NRCD, AAFM	ERP, MEF	High	Reduce nitrogen loading to Long Island Sound	In progress	The Caledonia and Essex Agricultural workgroup meet in 2019 and discussed priority BMP's from Agricultural lands. A potential LIS FF grant to better understand high impact BMP's has been discussed and may be considered for 2021.
Complete IDDE in Canaan-Beecher Falls, Lunenburg-Gilman subwatersheds.	**DEC/** CCNRCD, Towns	ERP	Medium	Reduce nitrogen loading to Long Island Sound	Completed	IDDE completed for these communities.

Action from 2014 TBP	Lead/Key Players	Funding	Priority	Objective	Status	Update/ Recommendation for 2020 TBP
Complete BMP's to address nitrogen runoff as suggested by studies above or low cost strategies such as buffer plantings in locations targeted to filter runoff or with other local water quality benefits targeting areas identified in Figure 7.	**DEC/** Lake Associations, DEC, NRCD's	EQIP, ERP, MEF, AG BMP, CREP, CRP	Medium	Reduce nitrogen loading to Long Island Sound	In progress	Several BMP practices have been installed in the watershed since 2014.
Complete ANR Bridge and Culvert surveys in the upper Connecticut River watershed with priorities on the Leach Stream watershed and the towns of Canaan and Concord.	**ECNRCD/** Towns, NVDA, DEC	ERP, Better backroads grant, Watershed grant, MEF	High	Reduce phosphorus loading to stressed lakes and ponds	Completed	Bridge and culvert surveys have been completed and an AOP work group was initiated in 2020 to prioritize culvert replacement or retrofit projects.
Complete projects to address major identified sediment sources (or AOP barriers) while working to minimize concentration of runoff into ditches.	**Towns/**DEC, NRCD, AOT , NVDA,	Better backroads, ERP	Medium	Reduce phosphorus loading to stressed lakes and ponds	In progress	Over half of roads have been assessed in the basin and towns working on completing Grant in Aid and Better Roads projects with support from ECNRCD and NVDA. AOP work group initiated to prioritize culvert projects.
Purchase a hydroseeder through a cooperative agreement to share with multiple towns.	**NVDA**/ NRCD, AOT, DEC, Town Road Foreman and Select Boards	MEF, ERP grant	Medium	Reduce phosphorus loading to stressed lakes and streams	Completed	Hydroseeder purchased by towns in the upper watershed and housed in Brighton. Suggested expansion to include Maidstone.
Complete lake assessments on lakes listed as stressed for sedimentation and nutrient enrichment to determine current status and where high levels of nutrient and sediment stress are confirmed complete watershed assessments.	**DEC/** Lake associations	DEC staff	Medium	Reduce phosphorus loading to stressed lakes and streams	In progress	
Identify logging sites in these watersheds that are sources of sediment and determine cause of sedimentation, how to prevent this in future logging jobs and any potential restoration opportunities such as restoring hydrology where past logging roads have captured runoff.	**DEC/**DFPR, Lake Associations, NRCD's	NSRC	Medium	Reduce phosphorus loading to stressed lakes and streams	In progress	Some evaluation done – with monitoring in 2018 but no impacts observed to date.

Action from 2014 TBP	Lead/Key Players	Funding	Priority	Objective	Status	Update/ Recommendation for 2020 TBP
Set up a series of workshops and trainings with towns to discuss key barriers preventing towns from addressing priority water quality issues associated with transportation infrastructure building on the well-attended road resiliency workshop held in 2012.	**NRCD**/NVDA, AOT, DEC, Town Road Foreman	ERP grant, Watershed grant	Medium	Reduce phosphorus loading to stressed lakes and streams	Completed	CCNRCD received watershed grant and held a workshop in 2014
Identify lake associations or blocks of interested landowners for targeted outreach for the Lake Wise certification program.	**DEC/** Lake associations, NRCD	Watershed grant	High	Restore littoral habitat on impacted lakes and ponds in the Basin	In progress	Lake Wise efforts completed on Maidstone. Needs for this work on Shadow and Miles Ponds
Fund buffer restoration to allow landowners to meet Lake Wise standards targeted to contiguous blocks of landowners.	**DEC/** Lake associations, NRCD	ERP	Medium	Restore littoral habitat on impacted lakes and ponds in the Basin	In progress	A number of Lake Wise restoration efforts completed on MaidstoneMaidstone, but more work is needed on this lake and on Miles and Shadow lakes.
Support Upper Connecticut Cooperative Invasive Species Management Area (UCCISMA) as an organization that can coordinate early detection and rapid response for invasive species in this basin.	**ECNRCD**/ NRCS, DFPR, DEC, Conte, NorthWoods	MEF	Medium	Reduce the spread of aquatic invasive species	In progress	The UCISMA program has continued with limited funding but has completed mapping and knotweed and phragmites control efforts. There has been discussion of options to support efforts though RCPP grant.
Support lake associations in starting up and continuing VIP programs on lakes in the basin.	**Lake associations**/ DEC	ANS	Medium	Reduce the spread of aquatic invasive species	Awaiting action	

Appendix B. Existing Use Tables

Table B1. Determination of existing uses of flowing waters for swimming in Basin 16.

Surface water	Location of Use	Town	Documentation of Use
Capon Brook	Downstream of Rt 102 culvert	Canaan	Public reports of swimming use during 2014 planning process with confirmation.

Table B2. Determination of existing uses of flowing waters for boating in Basin 16.

Surface water	Location of Use	Town	Documentation of Use
Nulhegan River	Headwaters to Connecticut River. Flat water to Class-IV rapids. Inclusion on the Northern Forest Canoe Trail. Very remote and scenic river scenery.	Brighton, Ferdinand, Brunswick, Bloomfield	Vermont's White Water Rivers/Northern Forest Canoe Trail. Put in: Route 105 Brighton. Take out: Debainvile Access Connecticut River confluence in Bloomfield

Table B3. Determination of existing uses of flowing waters for fishing in Basin 16.

Surface water	Location of Use	Documentation of Use
Keyer Brook	From Clay Brook Road to mouth	Fishing use and road access
Carr Brook	From above Carr Brook Ln. to Below Rt 2 Crossing	Fishing use and road access
Nulhegan River	From Nulhegan Pond to mouth.	Fish stocking sites
Nulhegan River East Branch	From North side of Sable Mountain to Route 105	Fish stocking sites Fishing use and public access easement lands
Broulliard Brook	Entire length	Fishing use and public access easement lands
Fisher Brook	Entire length	Fishing use and public access easement lands
Murphy Brook	Entire length	Fishing use and public access easement lands
Spaulding Brook	Entire length	Fishing use and public access easement lands
Nulhegan River Black Branch	Peanut Dam Road	Fish stocking sites public access easement lands and road access
North Branch Nulhegan River	Entire length	Fishing use and road access
Tim Carroll Brook	Entire length	Fishing use and road access
Paul Stream	Entire length	Fish stocking sites and West Mountain WMA
Madison Brook	Entire length	Fish stocking sites, West Mountain WMA, public access easement
Granby Stream	From West Mountain WMA to Bridge crossing Granby Stream 2.1 up Granby Stream Road	Fish stocking sites

Appendix C. Dams in Basin 16

There are approximately 13 dams of different types, sizes, and condition in Basin 16. While dams are used to generate energy and recreational opportunities such as boating, fishing, and swimming, they can also:

- impede a stream's ability to transport flow and sediment.
- cause streambank erosion and flooding problems;
- degrade and alter fisheries habitat;
- create barriers to fish movement and migration;
- alter downstream temperature
- degrade water quality; and
- impede river-based recreational activity.

Of the 13 inventoried dams, 5 are in-service, six are fully breached and two are partially breached. The seven active in-service and partially breached dams constrict the stream channel enough to reduce sediment transport, prevent lateral movement, and inhibit aquatic organism passage (AOP). A detailed list of known non-historic dams in the watershed can be found in Table C1.

On January 18, 2018, H.554 or Act 161, the Dam Safety bill, passed the Vermont House of Representatives and received final approve on May 10th of the same year. The bill was developed collaboratively with the DEC, Vermont Natural Resources Council, Vermont Trout Unlimited, the Vermont Section of the American Society of Civil Engineers, and other partners. The bill addresses gaps in inspection requirements for hundreds of small dams. Under the bill, DEC will be required to maintain an inventory of all dams in the state and develop rules that will require all dams to be regularly inspected.

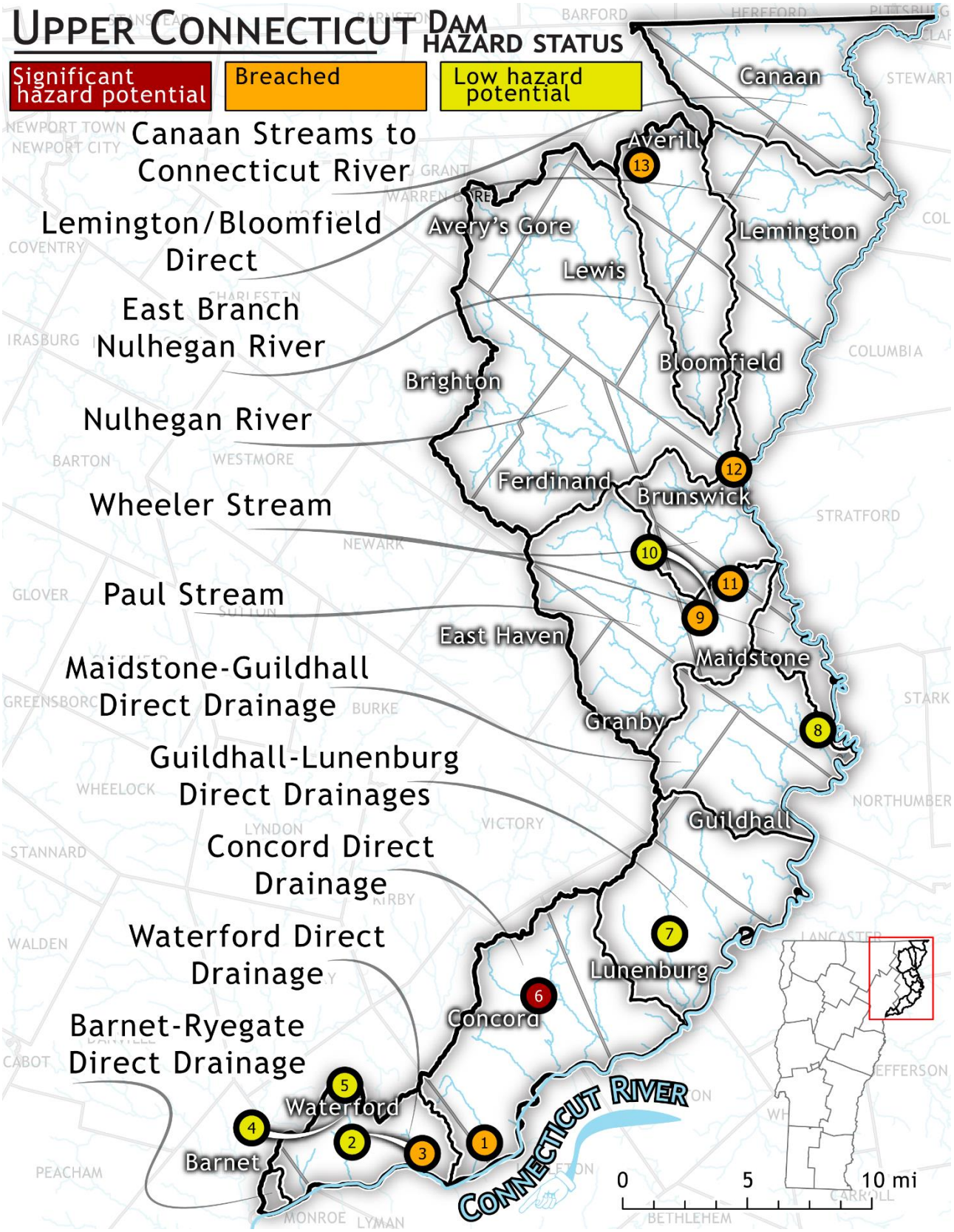

Figure C1. Non-historic dams located in Basin 16. Map #'s in table C1 correlate with the numbers in this map. Source: Source: Vermont Dam Inventory (accessed: 8/18/2020)

Table C1. Active dams in Basin 16. These dams are either in service, partially breached, or deleted. Dams that are not "in-service" are in italics. Source: Vermont Dam Inventory (accessed: 8/18/2020)

Map #	Dam Name	Town	Stream	Owner Type	Surface Acres	Drainage (m^2)	Dam Status	Purposes	Year Built	Original Purpose	State Reg	Fed Reg
1	Concord-5	Concord	Halls Brook				Breached				None	None
2	Waterford-9	Waterford	Chandler Brook		2.45		In Service				None	None
3	Waterford-8	Waterford	Chandler Brook				Breached				None	None
4	Chandler Brook (Upper)	Waterford	Chandler Brook		3.23		Breached (Partial)				None	None
5	Waterford-7	Waterford	Chandler Brook-TR		0.8		In Service				None	None
6	Miles Pond	Concord	Miles Stream	State	206	6.54	In Service	Recreation	1900	Mill Power	DEC	None
7	Neal Pond	Lunenburg	Neal Brook	State	181	8.83	Breached (Partial)	Recreation			DEC	None
8	Stevens Pond	Maidstone	Connecticut River-TR	Private	26	0.28	In Service				DEC	None
9	Bull Throat	Maidstone	Paul Stream				Breached				None	None
10	Maidstone Lake	Maidstone	Maidstone Brook	State	800	5	In Service	Recreation	1931	Recreation	DEC	None
11	Browns Mill	Maidstone	Paul Stream		0		Breached				None	None
12	Bloomfield 6	Bloomfield	Nulhegan River				Breached				None	None
13	Dam No. 6	Averill	East Branch Nulhegan River				Breached				None	None

Appendix D. Municipal Water Quality Protectiveness Table for Basin 16

Table D1. Municipal protectiveness matrix for towns with significant area in Basin 16 (as of 10/12/2020)

	National Flood Insurance Program (NFIP)	River Corridor Protection	Flood hazard regulations	Town Plan	Road and Bridge Standards	Emergency Operations Plan (LEOP)	Hazard Mitigation Plan (LHMP)	ERAF	FEMA RiskMap Flood Study	Illicit Discharge Detection and Elimination
	Status[4]	Adopted?	Date of revisions	Date of Adoption	Adopted?	Completed?	Adopted?	Percent	Underway?	Completed?
Averill UTG	Enhanced	Yes	2014	2019	Yes	Yes	Yes	17.5%	Yes	NA
Barnet	Enhanced	No	2018	2019	Yes	No	No	7.5%	Yes	Yes
Bloomfield	Minimum	No	1987	none	Yes	Yes	No	7.5%	Yes	NA
Brighton	Minimum	No	1986	2018	Yes	Yes	Yes	12.5%	Yes	NA
Brunswick	Minimum	No	1989	2019	Yes	No	No	7.5%	Yes	NA
Canaan	Minimum	No	2018	2017	Yes	Yes	Yes	12.5%	Yes	Yes
Concord	Minimum	No	<2012	2015	Yes	Yes	Yes	12.5%	Yes	NA
East Haven	Not enrolled	No	none	none	Yes	Yes	No	7.5%	Yes	NA
Ferdinand UTG	Enhanced	Yes	2014	2019	Yes	Yes	Yes	17.5%	Yes	NA
Granby	Enhanced	No	2011	2016	Yes	Yes	Yes	17.5%	Yes	NA
Guildhall	Enhanced	No	2013	2013	Yes	Yes	Yes	17.5%	Yes	NA
Lemington	Minimum	No	1990	1995	Yes	Yes	No	7.5%	Yes	NA
Lewis UTG	Enhanced	Yes	2014	2019	Yes	Yes	Yes	17.5%	Yes	NA
Lunenburg	Not enrolled	No	None	NVDA[5]	Yes	Yes	No	7.5%	Yes	Yes
Maidstone	Not enrolled	No	None	2016	Yes	Yes	No	7.5%	Yes	Yes
Waterford	Minimum	No	<2013	2016	Yes	Yes	Yes	12.5%	Yes	NA

[4] **Minimum** - the minimum NFIP standards, **Enhanced** – substantially higher protections for floodplains

[5] Lunenburg adopted the regional plan as a town plan