Memphremagog Watershed Basin 17 Tactical Basin Plan

September 2023 | Final

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.

Approved:

9/19/2023

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Cover Photo: Ben Copans. Picture of Lake Salem lakeshore restoration project.

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Lake Memphremagog Tomifobia and Coaticook River Basin Towns

Albany	Coventry	Irasburg	Sheffield*
Avery's Gore*	Craftsbury	Morgan	Sutton*
Averill	Derby	Lowell*	Wolcott*
Barton	Eden*	Newark*	Warner's Grant
Brighton*	Greensboro*	Newport City	Warren Gore
Brownington*	Glover*	Newport Town*	Westmore
Charleston	Holland	Norton	

**Only a very small area of the town is in the watershed and is covered in more detail in corresponding basin plans.*

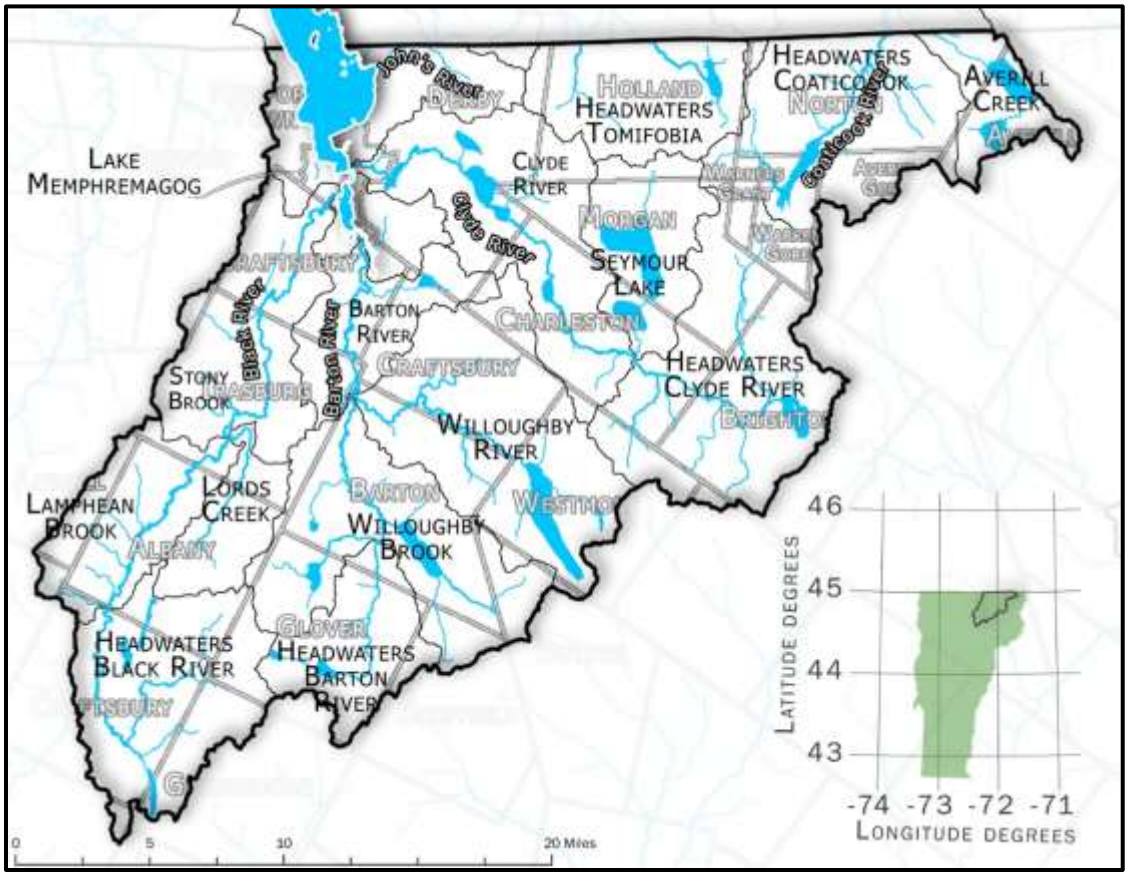


Table of Contents

Executive Summary 1
What is a Tactical Basin Plan? 4
Chapter 1 – Basin Description and Conditions 6
A. Basin Overview 6
B. Water Quality Conditions 10
Chapter 2 – Priority Areas for Surface Water Protection 27
A. Surface Water Reclassification and Designation 27
B. Class I Wetland Designation 33
C. Outstanding Resource Waters Designation 34
D. Identification of Existing Uses 35
Chapter 3 – Priority Areas for Surface Water Restoration 36
A. Impaired and Altered Surface Waters 36
B. Total Maximum Daily Loads (TMDLs) 41
Chapter 4 – Strategies to Address Pollution by Sector 49
A. Agriculture 50
B. Developed Lands 57
C. Wastewater 66
D. Natural Resources 70
Chapter 5 – The Basin 17 Implementation Table 85
A. Progress in the Basin 85
B. Public Participation 85
C. Coordination of Watershed Partners 86
D. Implementation Table 87
E. Monitoring and Assessment Table 98
List of Acronyms 103
References 106
Appendix A. Dams in Basin 17 108
Appendix B. Responsiveness Summary 109
Appendix C. Municipal Protectiveness Table 113
Appendix D. Watersheds lacking biological assessment data. 115

List of Figures

Figure 1. Status of strategies from the 2017 TBP 3
Figure 2. Policy Requirements of Tactical Basin Planning 4
Figure 3. 5-year Basin Planning Cycle 4
Figure 4. Chapters of Tactical Basin Plans 5
Figure 5. The St. Francis River watershed showing major subwatersheds that drain north from Vermont into Quebec. 7
Figure 6. Land Cover by Acreage of Sub-watersheds 8
Figure 7. Maps showing the results of the Basin 17 macroinvertebrate (top) and fish monitoring (bottom) assessments from 2011 to 2020. 13
Figure 8. Average total phosphorus concentrations measured from 207 sub-watersheds of the Lake Memphremagog Basin during 2005-2022. 17
Figure 9. Geomorphic Condition of Assessed Rivers and Streams 18
Figure 10. Condition of Lakes and Ponds greater than 10 acres based on the Vermont Lake Scorecard 20
Figure 11. Wetland VRAM assessments Completed 25
Figure 12. River Aquatic Biota candidates for Reclassification. 30
Figure 13. Monitoring Needed to Evaluate Reclassification Opportunites 31
Figure 14. Lake reclassification candidates for A(1) Aesthetics 33
Figure 15. Wetland Protection Priorities 34
Figure 16. Impaired Lakes in Basin 17. 36
Figure 17. Impaired streams in Basin 17. 38
Figure 18. Altered lakes in Basin 17 39
Figure 19. Cyanobacteria Bloom in Lake Memphremagog 41
Figure 20. Estimated phosphorus loading from different land use sectors from the Vermont portion of the Lake Memphremagog watershed. 42
Figure 21. Percent of TMDL Final Phosphorus Target Achieved by Sector by Year 45
Figure 22. Land Use Sector Framework with practices used to enhance, maintain, protect, and restore water quality 49
Figure 23 Agricultural land use in Basin 17. 50
Figure 24 Agricultural land use in the Lake Memphremagog watershed by HUC 12 watershed 51
Figure 25. Phosphorus reductions from Field BMPs installed by State Fiscal Year 52
Figure 26. Agricultural phosphorus reductions as compared to TMDL targets in the lake Memphremagog watershed. 53
Figure 27. REI Project Priorities 63
Figure 28. Maps of rivers where monitoring is needed to evaluate attainment of aquatic biota use. 102

List of Tables

Table 1. Focus areas and priority strategies for restoration and protection. 1
Table 2. Bioassessment results in Basin 17 from 2011 to 2019. Map ID corresponds to the maps above for bug and fish communities. 14
Table 3. Condition of Lakes and Ponds greater than 10 acres based on the Vermont Lake Scorecard. 21
Table 4. Uses of Waters by Class 27
Table 5. Class A(2) Public Water Sources 28
Table 6. Monitoring Needed to Confirm Reclassification 30
Table 7. Streams that meet B(1) criteria for recreational fishing 32
Table 8. Impaired Lakes in Basin 17 37
Table 9. Impaired streams in Basin 17 38
Table 10. Altered lakes and streams in Basin 17 39
Table 11. Phosphorus Loading Summary (Source Load) 43
Table 12. Estimated Total Phosphorus Reductions by sector 44
Table 13. Interim and Final Phosphorus TMDL Reduction Targets by Sector 45
Table 14. Regulatory Programs for Phosphorus Reduction 46
Table 15. Wastewater Treatment Facilities 66
Table 16. Implementation Strategies (See List of Acronyms on Page 101.) 89
Table 17. Priorities For Monitoring and Assessment 98
Table A1. List of dams in Basin 17. These dams are either in service, partially breached, breached, or removed. Source: Vermont Dam Inventory (accessed: 01/10/2023). 108
Table C1. Municipal protectiveness matrix for towns with significant area in Basin 17 113
Table D1. Table of watersheds lacking biological data and the associated size and landuse. Bold indicates priority for monitirng 116

Executive Summary

Basin 17, the Lake Memphremagog Tomifobia and Coaticook Watershed, covers approximately 589 square miles, where waters flow north into the Saint Francis River. The majority of the watershed flows into Lake Memphremagog, a shared waterbody with Quebec, or into the Tomifobia River which flows into Lake Massawippi, two waterbodies impacted by elevated phosphorus levels. This Tactical Basin Plan (TBP) provides a detailed description of current watershed conditions and identifies water quality focused strategies to protect and restore the Basin's surface waters.

Although many surface waters monitored meet or exceed water quality standards, there are waters in need of restoration and continued monitoring. Thirty-three lakes, ponds, or river segments are identified for restoration. Two river segments and six lakes are considered impaired, five lakes and four rivers are considered altered by flow regime, three lakes are altered by aquatic invasive species (or AIS) and 13 lakes are impacted by increasing nutrient trends. Chapter 3 also includes progress reporting and target setting for the Lake Memphremagog Phosphorus Total Maximum Daily Load (TMDL).

Sector-based strategies are proposed to meet protection and restoration goals, including targets of the Lake Memphremagog Phosphorus TMDL, with a focus on voluntary participation and project implementation by watershed partners and the Basin's Clean Water Service Provider. Sixty-seven detailed strategies and 57 monitoring priorities are recommended for the next five years for implementation by ANR and many watershed partners, a number of which have been building capacity for this work. Monitoring priorities have been identified to fill data gaps, track changes in water quality condition, and identify waters for reclassification and Class I wetland designation.

Table 1. Focus areas and priority strategies for restoration and protection.

	Focus Areas	Priority Strategies
Agriculture	Lower Black, Lower Clyde, Willoughby, Direct to lake Memphremagog, Mud, Walker Ponds, Stearns Trib, Roaring Branch watersheds. Lake Parker, Shadow Lake, Lake Willoughby, Echo Lake, Lake Salem, Seymour Lake watersheds. Figure 8 target subwatersheds	• Target field Best Management practice (BMP) practice implementation in high priority watersheds. • Develop a pilot program to develop and implement trapping and control practices identified using Agricultural Conservation Planning Framework. • Improve nutrient management practices (NMP) through technical support, NMP workshops, and financial support for improved nutrient utilization. • Implement NMPs and associated agricultural water quality practices in high priority catchments. • Support monitoring efforts to track results of practices applied in priority watersheds and tell farmer success stories. • Support farm teams, conservation equipment programs, soil health assessments, and farmer participation in the pay for phosphorus program.

	Focus Areas	Priority Strategies
Developed Lands - Stormwater	Basin-wide with focus on Lake Willoughby, Little and Great Averill, Bean Pond, Crystal Lake, Echo Lake, Holland Pond, Parker Pond, Lake Salem watersheds and Newport City, Derby, Barton, and Glover	• Develop designs and implement stormwater treatment projects in the Memphremagog Stormwater master plan and subsequent assessments. • Support the design and implementation of small-scale stormwater practices through formula grant funding. • Provide outreach and technical support to landowners with 3 acre parcels to support early design and implementation of stormwater practices. • Develop a list of erosive stormwater outfalls and work with landowners and municipalities to stabilize and restore sites. • Develop a residential landowner stormwater BMP campaign/brochure to raise awareness of simple stormwater management solutions.
Developed Lands - Roads	Little and Great Averill, Bean Pond, Crystal Lake, Echo Lake, Holland Pond, Parker Pond, Lake Salem, Lake Willoughby, Albany, Charleston, Craftsbury, Derby, Glover, Holland	• Coordinate the work of partners through the NEK Rivers and Roads Workgroup to provide and support training for road crews. Develop prioritization and design guidelines to address gully erosion from road cross culvert outlets and failed class IV roads. • Provide technical support to towns to implement priority MRGP projects. • Develop private road phosphorus reduction estimates and complete private road segmentation and assessments. • Develop a phosphorus control plan for state transportation infrastructure in the Lake Memphremagog watershed as required by the state transportation permit TS4 permit.
Wastewater	Barton, Brighton, Glover, Orleans, Newport City, Lake communities	• Support towns in completing Wastewater Treatment Facility (WWTF) optimization efforts. • Provide technical and financial support for the town of Brighton to increase the level of phosphorus treatment for the Brighton WWTF. • Promote septic system maintenance and ANR Village Wastewater Solutions.
Rivers	Lower Clyde River, Middle Barton River, Black River, Lower Johns River, Mad Brook, Shalney Branch	• Develop a basin specific tool to estimate phosphorus reduction potential of stream projects and train local partners on this tool. • Complete phase 2 lite geomorphic assessments on priority reaches and implement priority stream protection and restoration projects. • Pilot low tech “process based” restoration and hydroseeding techniques. • Provide support for Municipalities to update flood hazard bylaws and to consider adoption of river corridor protections with new Federal Emergency management Agency (FEMA) maps. • Implement Aquatic Organism Passage (AOP), strategic wood addition, and dam removal projects.
Lakes	Willoughby, Shadow Parker, Salem, Echo, Seymour, Crystal, Great and Little Averill, Norton, Island, Holland, Bean, Memphremagog	• Develop lake watershed action plans and implement priority projects. • Increase local capacity for designing and implementing lakeshore projects. • Initiate, maintain, and build the capacity for aquatic invasive species spread prevention programs including Public Access Greeter and Vermont Invasive Patroller Programs. • Where applicable, increase protections for high-quality lakes through reclassification and/or Outstanding Resource Water Designation

	Focus Areas	Priority Strategies
Wetlands	Bucks Flats (Clyde River)	• Develop wetland restoration phosphorus reduction credits for the Lake Memphremagog watershed. • Develop and implement priority wetland restoration projects. • Develop an approach for funding and stewardship of small-scale wetland restoration projects including process-based wetlands restoration projects. • Provide support to the Wetlands Program for publicizing updated wetland mapping and local efforts for reclassification.
Forests	Headwaters of: Mad Brook, Nutting Brook, Brownington Branch, Sucker Brook, Minister's Brook, Webster's Brook, Pherrins River	• Complete forest road inventories and implement priority projects on state and private lands. • Develop Memphremagog specific forest road and trail reduction estimates. • Identify and implement feasible forest gully projects. • Support the use of skidder bridges through rental and incentive program. • Work with trail clubs to implement trail erosion control projects.

The 2017 Basin 17 plan identified 66 strategies to address protection and restoration of surface waters. Of the 66 strategies identified, 19 are complete, 38 are in progress, eight are awaiting action, and one is discontinued (Figure 1). The Basin 17 report card, available online on the Basin 17 webpage includes a list of detailed updates for each strategy identified in the 2017 Plan. Several strategies were carried over to this plan.

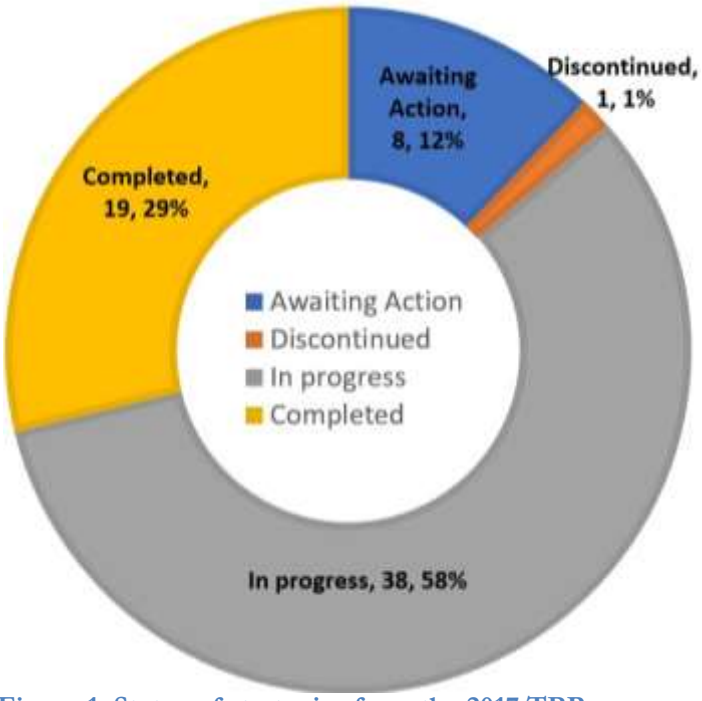


Figure 1. Status of strategies from the 2017 TBP

The 67 priority strategies identified in this plan reflect input from the public, state and federal water quality staff, sector-based workgroups, watershed groups, and regional planning commissions. During the basin planning process, stakeholders expressed that unified clean water messaging, technical support and training on how to protect and maintain surface waters, and continued financial and technical support, are all critical to meet water quality goals. There was a strong sentiment that all waters in the Memphremagog River Basin should be protected regardless of their current status. The importance of ensuring access to waters for all members of the community was identified including ensuring clean surface water for consumptive and recreational uses and the safe consumption of fish, access to waters for recreation for all abilities and economic levels, open space availability and access in more densely populated and equitable implementation of clean water projects.

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 and restore Vermont's surface waters. TBPs target strategies and prioritize resources to those actions that will have the greatest influence on surface water protection or restoration. TBPs are integral to meeting a broad array of both state and federal requirements including the U.S

Figure 2. Policy Requirements of Tactical Basin Planning

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 10 VSA § 925 and 10 V.S.A. § 1253 (Figure 2).

Figure 3. 5-year Basin Planning Cycle

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. A successful basin planning process depends on a broad base of partnerships with other state agencies, federal, regional, and local governments, organizations, and stakeholders, including citizens and non-profits groups and academic institutions. The partnerships support and strengthen the Agency's programs by proposing new ideas and input, increasing understanding of water quality issues, and building commitment to implementing solutions.

Basin-specific water quality goals, objectives, strategies, and projects described in this Plan 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). The TBP process shown in Figure 3, allows for the issuance of plans for Vermont's fifteen basins every five years.

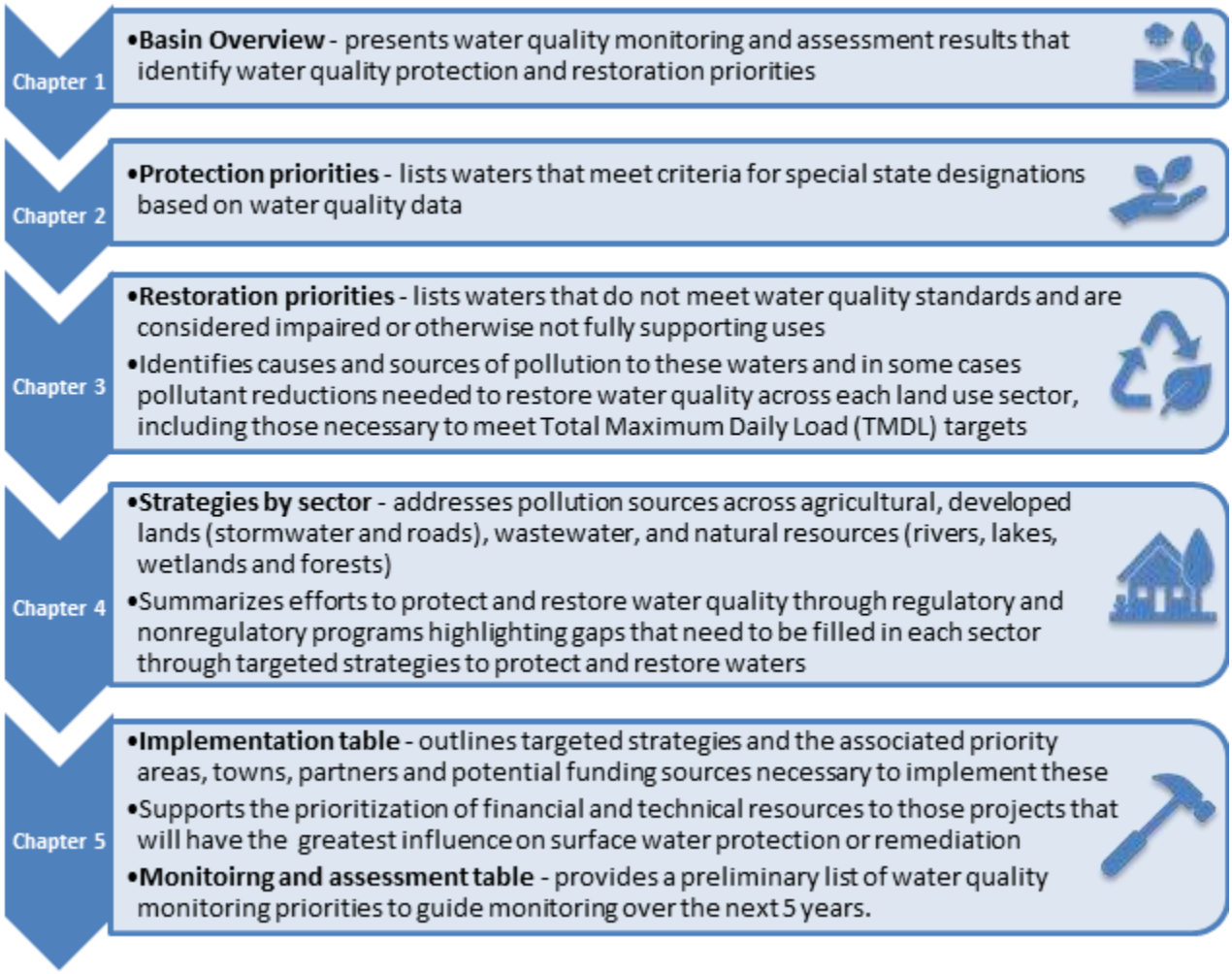


Figure 4. Chapters of Tactical Basin Plans

Chapters 1 through 4 in the TBP describe water quality in the Basin, protection and restoration priorities, and efforts to protect and restore water quality for each sector. This information supports the targeted strategies listed in the implementation table in Chapter 5 (Figure 4).

Tactical Basin Plans identify strategies that help ANR, and its partners, prioritize activities for the next five-years. These strategies inform individual projects that are identified and tracked in the Watershed Projects Database (WPD) and the Watershed Projects Explorer. The Project Database and Explorer are found on ANR's Clean Water Portal and are continuously updated to capture project information throughout the TBP process.

Chapter 1 – Basin Description and Conditions

A. Basin Overview

The Vermont portions of the St. Francis River watershed encompass a total of 589 square miles including the Vermont portions of the Lake Memphremagog watershed and the Tomifobia and Coaticook river watersheds. This basin includes about 75% of Orleans County, 15% of Essex County and small portions of Lamoille and Caledonia Counties in Vermont. Most of the basin within Vermont is part of the Northern Vermont Piedmont biophysical region, which is a hilly region with rich soils due to calcareous bedrock and dominated by northern hardwood forests. There are 90 inventoried lakes and ponds in the watershed covering 17,660 acres or over five percent of the basin.

The Lake Memphremagog drainage basin encompasses a total of 687 square miles of which 489 square miles (71%) are in Vermont and 198 square miles (29%) are in the Province of Quebec in Canada (see Figure 5). Although much more of the watershed is in the United States, about three-quarters of the lake's area is in Canada and the lake is the drinking water source for more than 175,000 people in Quebec including the City of Sherbrooke, the City of Magog, the municipality of Potton, and the municipality of Saint-Benoit-du-Lac. There are three main rivers in the U.S. portion of the Lake Memphremagog basin, the Black, Barton and Clyde rivers, which flow northerly into the southern end of Lake Memphremagog. There are also several smaller streams that flow directly into Lake Memphremagog covering an area of just under 30 square miles. Most of this area is drained by the Johns River which originates in Derby west of Nelson Hill.

Almost all of the Tomifobia River is in Canada although two significant tributaries, Holland Brook and Stearns Brook and their watersheds, are largely in the United States. The Coaticook River originates at the outlet of Norton Pond and flows northeasterly for over six miles passing just west of Norton and into Canada.

Land Use and Land Cover

The Lake Memphremagog, Tomifobia and Coaticook Watershed is a predominantly forested landscape. Forested land covers about 65% of the Basin while about 7.7% is wetlands and 4.7% open water and 3.2% other. Developed and agricultural land cover about 5.3% and 14% of the Basin, respectively (Figure 6). A basin wide analysis of land use change from 2001 to 2019 showed some small changes in land cover over this time including an increase in cropland acreage (279), developed lands (2243), and shrub scrub (3349), and wetlands (868) and decreases in pasture and hay (800), and forest (4626). The Lower Black River watershed accounts for 1087 acres of forest land cover loss and 66 acres of cropland and 177 acres of new developed lands. In addition to this the lower Clyde River watershed has seen a decrease in forest lands by 783 acres and 414 acres of new developed lands over this time. The direct drainage to Lake Memphremagog has lost 676 acres of

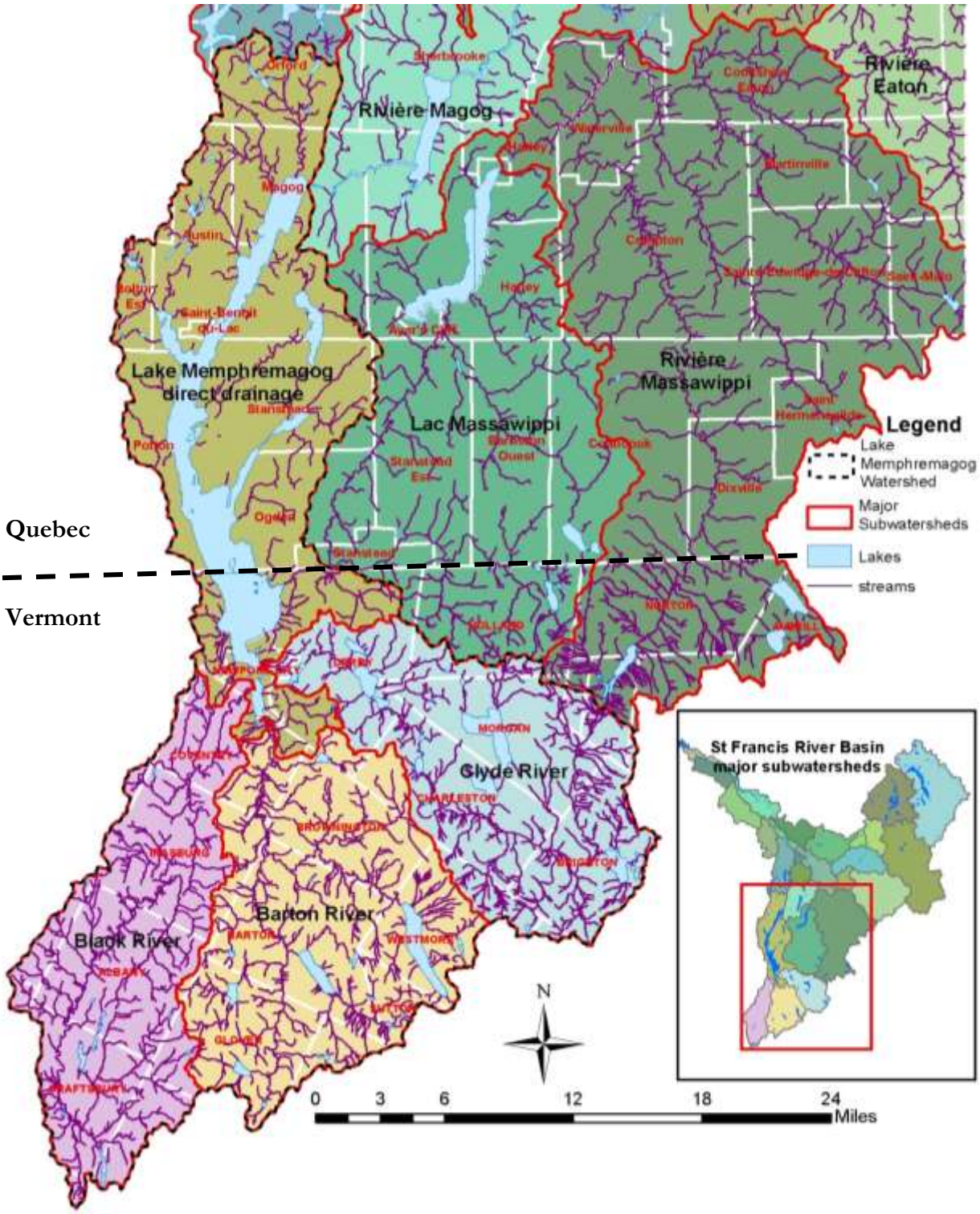


Figure 5. The St. Francis River watershed showing major subwatersheds that drain north from Vermont into Quebec.

forest cover and seen an increase in 269 acres of developed lands. Finally, the Willoughby River has seen a reduction in forest land cover of 430 acres and an increase in 248 acres of developed lands.

Together these data suggest that the increase in developed lands is happening in areas close to Lake Memphremagog and around Lake Willoughby. The increase in cropland and developed lands and reduction in forest lands likely contribute to increased nutrient levels.

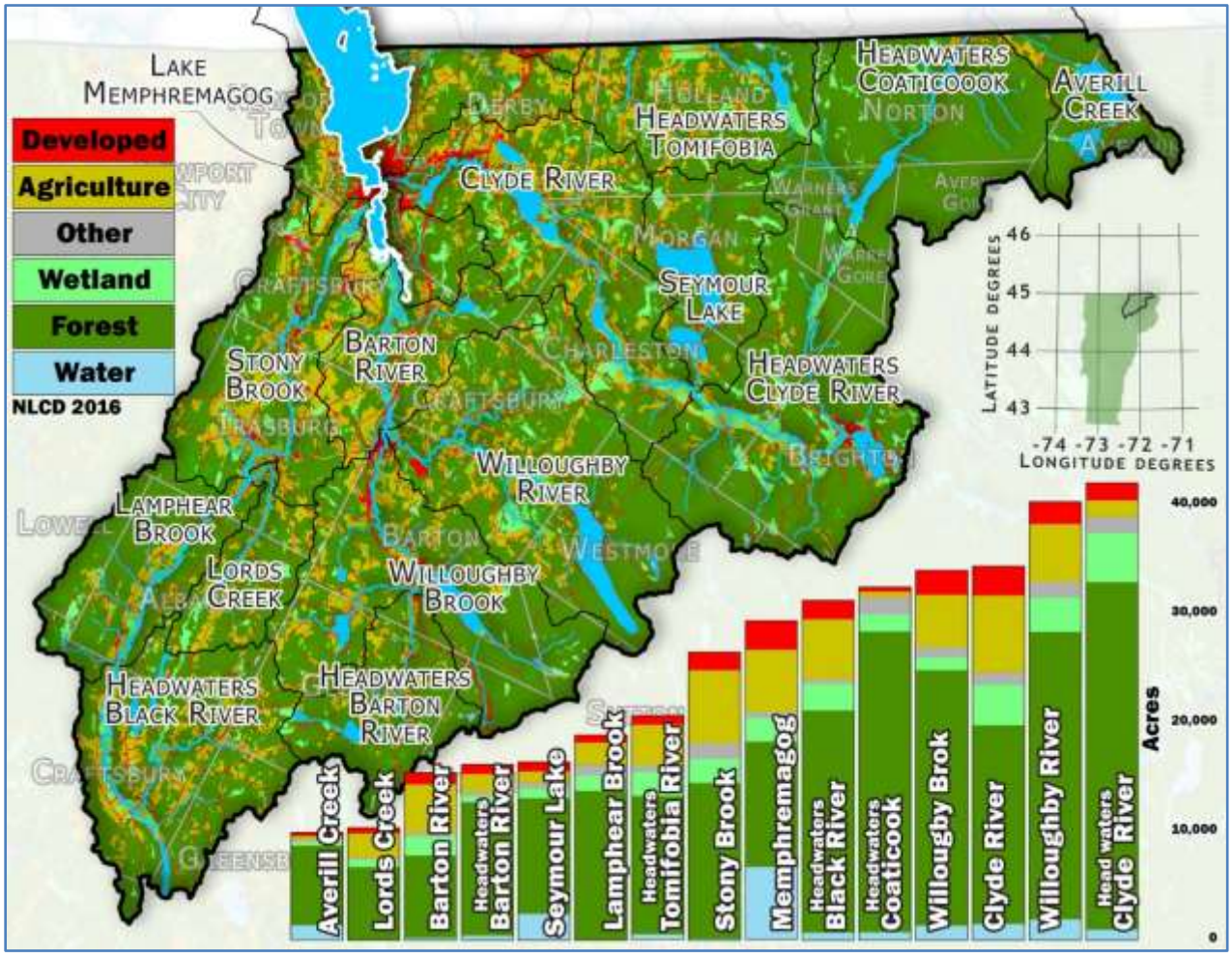


Figure 6. Land Cover by Acreage of Sub-watersheds

Large areas of properly managed forests, riparian buffers, and wetlands are principally responsible for the good water quality in the Basin. Where good management practices and quality local stewardship exist on agricultural and developed lands, good water quality will too.

Climate Change Implications for Water Resource Management

Adapting how we manage and use our surface waters in the face of climate change is one of the chief overarching challenges for basin planning. Climate is defined by long-term weather patterns, which in turn influence human and natural systems. 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).

The 2021 Vermont Climate Assessment established state-level climate change information with implications for local surface waters. Vermont's average annual temperature has increased by almost 2°F (1.11°C) since 1900 with warming occurring twice as fast in winter (Galford, 2021). The latter results in earlier thaw dates for rivers, lakes and ponds, and mountain snowpack. Common fish species such as trout and salmon, and warm-water fish like smallmouth bass rely on groundwater discharges for cooler refuges during summer seasons. These refugia will decrease in availability as groundwater temperature is expected to increase over time. Fish are heavily reliant on their physical landscape and connectivity in order to migrate, move through different environments at different life stages, and take advantage of multiple habitat types. Infrastructure such as roads and dams have severely hampered the mobility of aquatic species, and form a barrier for fish migrating and for fish seeking cold refuge during hot spells.

The 2021 Vermont Climate Assessment suggests extreme weather events such as droughts and floods are expected to continue to increase with climate change. Vermont experiences 2.4 more days of heavy precipitation than in the 1960s, typically in summer. 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. 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 alter their abundance and seasonal activities (Stamp J, 2020).

The Vermont Climate Assessment highlights five key messages for water resources in Vermont:

- Due to extreme variation in precipitation with our changing climate, periods of prolonged dry-spells and drought, coupled with higher water usage in snowmaking and agriculture could exacerbate low water availability.

- Increases in overall precipitation, and extreme precipitation, have caused streamflows to rise since 1960. Climate change will further this pattern, although the overall increase in streamflow comes with disruptions in seasonal flows cycles.

- Increases in heavy precipitation jeopardize water quality in Vermont. Storms produce large runoff events that contribute to erosion and nutrient loading. Combined with warm temperatures, this creates favorable conditions for cyanobacteria blooms.

- Increased occurrence of high streamflows increase the risk of flooding that causes damage to many roads and crossing structures. Risk reduction requires addressing outdated and unfit structures.

- Nature-based solutions are an effective, low-cost approach to climate change adaptation. River corridor, floodplain, and wetland protection dampen flood impacts and improve water quality along with green infrastructure.

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, forestry, and stormwater best management practices. Ongoing efforts to strengthen ecological resilience and the role of natural infrastructure in protecting built communities can be found on the Climate Change in Vermont website.

B. Water Quality Conditions

The Vermont Water Quality Standards provide the basis used by DEC in determining the condition of surface waters including whether the water meets or does not meet certain criteria. The assessment of a water's condition within the context of the Water Quality Standards requires consideration of the water's classification, designated and existing uses, and the corresponding narrative and numeric water quality criteria. This assessment categorizes Vermont's surface waters as either "full support, altered, or impaired".

DEC uses a 5-year rotational monitoring approach, where Basin sites are typically monitored once every 5 years. This state-collected data is augmented by community science monitoring programs throughout the state, including the LaRosa Partnership Program and the Lay Monitoring Program. Water quality monitoring and assessment work is described in detail in the Water Quality Monitoring Program Strategy.

Most surface water monitoring is led by programs in the WSMD, including the Monitoring and Assessment Program (MAP) and the Lakes and Ponds Management and Protection Program. The result of this work offers site specific assessments of the Basin's waters. Monitoring programs in this basin include:

- Within MAP, the Biomonitoring and Aquatic Studies Section focuses on biological monitoring of aquatic macroinvertebrate and fish communities, plus targeted water chemistry and temperature monitoring. Biomonitoring staff also support the LaRosa Partnership Program (LPP), a volunteer water quality monitoring program.

- The Rivers Program supports stream geomorphic assessments that evaluate geomorphic and physical habitat conditions of rivers.

- The Lakes and Ponds Program supports the Inland Lake Assessment and Lay Monitoring Programs, which evaluate nutrient conditions and trends on lakes, as well as shoreland condition, and more in-depth lake assessments through the Spring Phosphorus Program and Next Generation Lake Assessments. The Lakes and Ponds Program also performs surveys to monitor the spread of aquatic invasive species in Vermont's public waters through the Vermont Aquatic Invasive Species Program.

- The Wetlands Program conducts biological assessments on the functions and values of wetlands.

- The Vermont Fish and Wildlife Department (FWD) conducts fishery assessments and targeted temperature monitoring to assess the health of recreational fish populations and opportunities for habitat restoration.

- A network of streamflow gages maintained by the United States Geological Survey is funded and operated in partnership among DEC, Vermont Agency of Transportation (VAOT) and Vermont Department of Public Safety (VDPS).

- Statewide pesticide monitoring is conducted by the Vermont Agency of Agriculture, Food, and Markets (AAFM) with sampling sites throughout Vermont. AAFM also runs the Ambient Surface Water Study (ASWS) to establish baseline levels of pollutants and to monitor for the presence of neonicotinoids, glyphosate, corn herbicides, and nitrate in Lake Champlain and its contributing tributaries.

- Per- and Polyfluoroalkyl Substances (PFAS) are monitored by the Drinking and Groundwater Protection Division and the Watershed Management Division.

Tactical Basin Plans include monitoring information reported by Vermont State agencies as results relate to the designated uses defined by the Vermont Water Quality Standards. Most of the DEC monitoring data can be accessed through the Vermont Integrated Watershed Information System (IWIS) online data portal.

Compilation of this data following the 5-year monitoring cycle highlights the changes that have taken place over time. These changes are described by water resource including rivers and streams, lakes and ponds, wetlands, with a separate section for recreational fisheries.

Rivers and Streams

Biological Assessment

Biological communities reflect overall ecological integrity (i.e., chemical, physical, and biological integrity). Therefore, biosurvey results directly assess the status of a waterbody relative to the primary goal of the Clean Water Act (CWA). These communities integrate the effects of different stressors and thus provide a broad measure of their aggregate impact. They also integrate the

stresses over time and provide an ecological measure of fluctuating environmental conditions. Where criteria for specific ambient impacts do not exist (e.g., nonpoint-source impacts that degrade habitat), biological communities may be the only practical means of evaluation.

Biomonitoring is used for detecting aquatic biota impairments and their relative extent and severity of potential stressors, and for identifying streams at or near a reference level condition that may be suitable for higher levels of protection through reclassification. Each community of macroinvertebrates and fish is rated from *Poor* - not meeting Vermont's water quality standards (VWQS) - to *Excellent* - exceeding water quality standards. If a stream repeatedly fails to meet minimum expectations, it is a candidate for the impaired waters list.

DEC maintains 12 sentinel sites statewide which are monitored every year, although none of these sites are in this basin. These sentinel sites have negligible prospects for development or land use change and are closely monitored to isolate long term impacts related to climate change. However, because stream site locations are targeted, it is not possible to determine the overall biological condition of the Basin.

Macroinvertebrate and fish monitoring is conducted following procedures outlined in the Watershed Management Division Field Methods Manual (VTDEC 2022). Applying biocriteria and determining assessments for both communities is outlined in Appendix G or the VWQS (2022).

Macroinvertebrate Monitoring Results

A total of 75 macroinvertebrate assessments were completed between 2011 and 2020 in Basin 17 (Figure 7, Table 2) across 53 sites. The results of the assessments are described below. In addition, to ensure a comprehensive understanding of water quality basin wide, a gap analysis was conducted by VDEC to identify sites without current monitoring data. These will be prioritized for the 2024 monitoring season and can be found in Chapter 5 in the Basin 17 Monitoring and Assessment Table and in Appendix C.

Of the 53 macroinvertebrate assessments, 29 monitoring sites (55%) exhibited *Very Good* or better condition. Of these, nine (17%) were found to be *Excellent*, meaning their macroinvertebrate community is at reference or natural condition. Most of these waters are either headwater streams or located higher up in the watershed. Twenty (38%) were found to be in *Very Good* to *Very Good-Excellent* condition. Streams in *Very Good* or better condition exceed the VWQS criteria for B(2) classification and are priorities for additional assessment and protection. Ten (19%) macroinvertebrate assessments scored *Good* which meets B(2) criteria. Streams in *Good* condition meet the VWQS and are priorities for maintenance and protection. Eight sites (15%) had macroinvertebrate assessments that scored *Fair* or *Fair to Good* condition, but no sites scored lower than *Fair* (*Poor* or *Poor to Fair*).

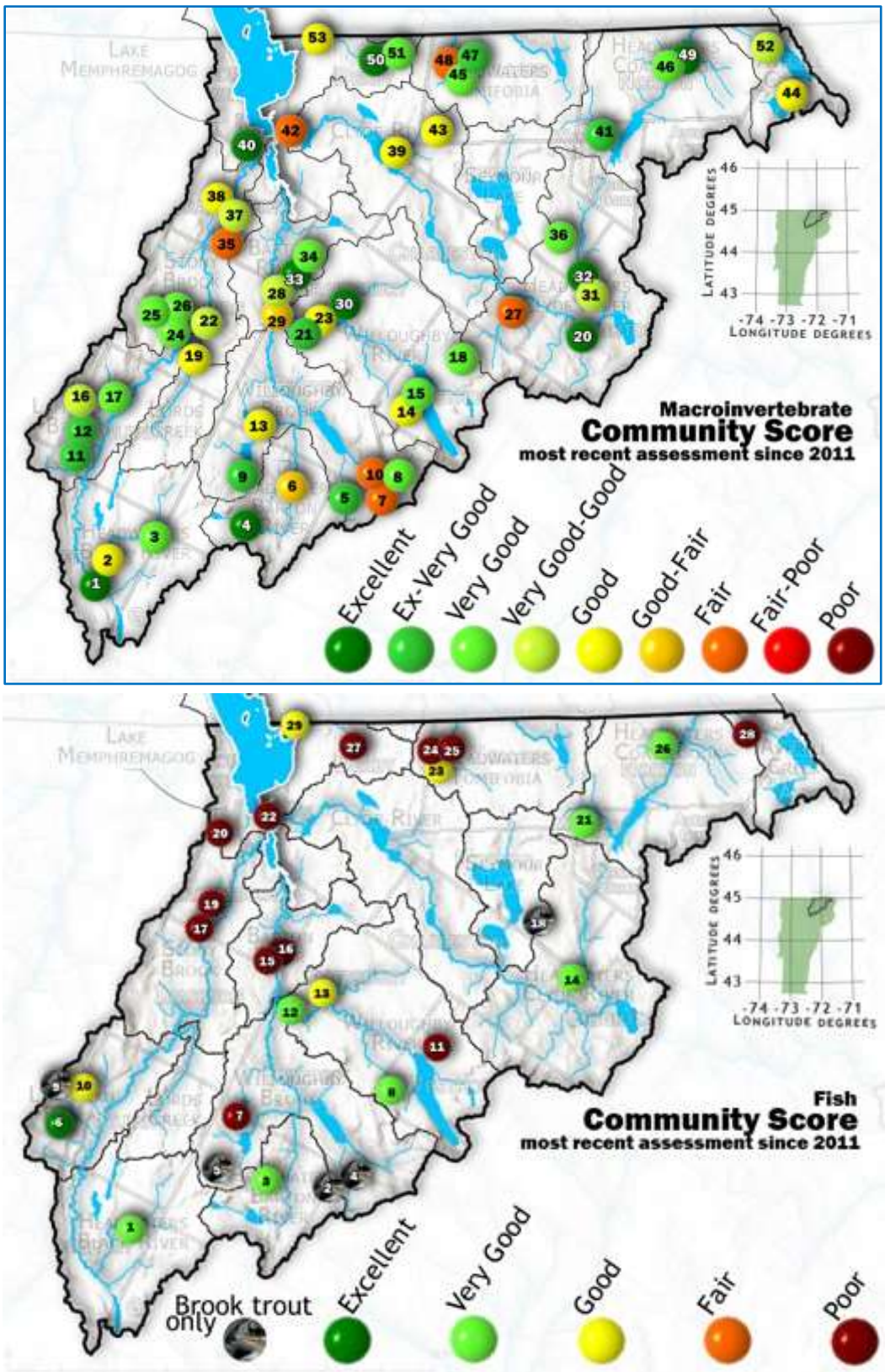


Figure 7. Maps showing the results of the Basin 17 macroinvertebrate (top) and fish monitoring (bottom) assessments from 2011 to 2020.

Table 2. Bioassessment results in Basin 17 from 2011 to 2019. Map ID corresponds to the maps above for bug and fish communities.

Site Name, River Mile	Year	Macro Map ID	Macroinvertebrate Assessment	Fish Map ID	Fish Assessment
Black River, 32.3	2011	**1**	Excellent		
Black River, 34.7	2019	**2**	Good		
Whitney Brook, 4.4	2019	**3**	Very Good	**1**	Very Good
Shadow Lake Brook, 3.1	2019	**4**	Excellent		
Duck Pond Brook Trib # 3, 0.2	2017	**5**		**2**	Brook Trout Only
Duck Pond Brook Trib # 3, 0.2	2013	**5**	Very Good		
Duck Pond Brook Trib # 3, 0.2	2012	**5**	Very Good		
Barton River, 21.3	2019	**6**	Fair-Good	**3**	Very Good
Annis Brook, 0.7	2011	**7**	Fair		
Annis Brook, 0.5	2019	**8**	Very Good	**4**	Brook Trout Only
Annis Brook, 0.1	2011	**10**	Fair		
Roaring Brook, 5.3	2014	**9**	Very Good-Excellent	**5**	Brook Trout Only
Roaring Brook, 2.4	2019	**13**	Good	**7**	Poor
Roaring Brook, 2.4	2014	**13**	Fair	**7**	
Rogers Branch, 1.0	2015	**11**	Very Good-Excellent		
Shalney Branch, 1.3	2015	**12**	Very Good-Excellent	**6**	Excellent
Shalney Branch, 1.3	2014	**12**	Excellent	**6**	Excellent
Shalney Branch, 1.3	2013	**12**	Very Good	**6**	Excellent
Shalney Branch, 1.3	2012	**12**	Very Good	**6**	Very Good
Shalney Branch, 1.3	2011	**12**	Good- Very Good	**6**	Poor
Wheeler Mountain Brook, 0.5	2019	**14**	Good		
Wheeler Mountain Brook, 0.1	2015	**15**	Very Good	**8**	Very Good
Wheeler Mountain Brook, 0.1	2014	**15**	Very Good-Excellent	**8**	Very Good
McCleary Brook, 2.0	2015	**16**	Good- Very Good	**9**	Brook Trout Only
McCleary Brook, 2.0	2014	**16**	Excellent	**9**	Brook Trout Only
McCleary Brook, 2.0	2013	**16**	Good- Very Good	**9**	Brook Trout Only
McCleary Brook, 2.0	2012	**16**	Fair-Good	**9**	Brook Trout Only
McCleary Brook, 2.0	2011	**16**	Fair-Good	**9**	Brook Trout Only
Lamphear Brook, 1.1	2019	**17**	Very Good	**10**	Good
Willoughby Trib #17, 1.7	2014	**18**	Very Good	**11**	Poor
Lords Creek, 2.5	2019	**19**	Good		
Oswegatchie Brook, 0.1	2019	**20**	Excellent		
Willoughby River, 2.4	2015	**21**	Very Good-Excellent		
Black River, 11.4	2014	**22**	Good- Very Good		

Site Name, River Mile	Year	Macro Map ID	Macroinvertebrate Assessment	Fish Map ID	Fish Assessment
Willoughby River, 3.0	2019	**23**	Good	**12**	Very Good
Brighton Brook, 0.9	2014	**24**	Very Good		
Brighton Brook Trib #1, 0.1	2014	**25**	Very Good		
Brighton Brook Trib #1, 0.2	2014	**26**	Very Good		
Mad Brook, 1.3	2019	**27**	Fair		
Barton River, 9.8	2019	**28**	Fair-Good		
Barton River, 9.7	2019	**29**	Good- Very Good		
Brownington Branch, 1.3	2019	**30**		**13**	Good
Brownington Branch, 1.3	2016	**30**		**13**	Very Good
Brownington Branch, 1.3	2015	**30**	Excellent		
Pherrins River, 2.0	2019	**31**	Good- Very Good	**14**	Very Good
Pherrins River, 3.1	2014	**32**	Excellent		
Trout Brook, 1.2	2016	**33**		**15**	Poor
Trout Brook, 1.2	2015	**33**	Excellent	**15**	Poor
Trout Brook, 1.6	2014	**34**	Very Good	**16**	Poor
Black River Trib #2, 0.5	2019	**35**	Fair	**17**	Poor
Black River Trib #2, 0.5	2015	**35**	Fair		
Webster Brook, 4.6	2014	**36**	Very Good	**18**	Brook Trout Only
Black River Trib #1, 0.1	2014	**37**	Good- Very Good	**19**	Poor
Stony Brook, 1.8	2019	**38**	Good		
Orcutt Brook, 1.0	2018	**39**	Good		
Lake Memphremagog Trib #9, 1.1	2014	**40**	Excellent	**20**	Poor
Hurricane Brook, 0.5	2019	**41**		**21**	Brook Trout Only
Hurricane Brook, 0.5	2014	**41**	Excellent- Very Good	**21**	Very Good
Clyde River Trib #1, 0.1	2019	**42**	Fair	**22**	Poor
Clyde River Trib #1, 0.1	2014	**42**	Good	**22**	Poor
Orcutt Brook, 3.9	2018	**43**	Good		
Averill Creek, 7.0	2019	**44**	Good		
Coaticook River, 40.0	2014	**46**	Very Good		
Stearns Brook, 2.3	2012	**45**	Very Good	**23**	Good
Stearns Brook, 1.7	2019	**47**	Excellent- Very Good	**24**	Poor
Stearns Brook Trib, 0.1	2019			**25**	Poor
Stearns Brook Trib, 0.1	2014	**48**	Fair	**25**	Poor
Stearns Brook Trib, 0.1	2012	**48**	Fair-Good	**25**	Poor
Number Five Brook, 0.7	2019	**49**	Excellent	**26**	Very Good
Crystal Brook, 0.3	2019	**50**	Excellent	**27**	Brook Trout Only
Crystal Brook, 0.3	2015	**50**	Very Good	**27**	Brook Trout Only

Site Name, River Mile	Year	Macro Map ID	Macroinvertebrate Assessment	Fish Map ID	Fish Assessment
Crystal Brook, 0.3	2014	**50**	Good	**27**	Poor
Crystal Brook, 1.4	2014	**51**	Very Good		
Averill Creek, 2.8	2019	**52**	Good-Very Good	**28**	Poor
Johns River, 1.3	2014	**53**	Good	**29**	Good

Fish Monitoring Results

A total of 54 fish community assessments were completed at 29 sites between 2011 and 2020 in Basin 17 (Figure 8, Table 2). Five of the sample sites only had Brook Trout which means that a community assessment could not be made, however, there is a density criterion that can be considered for upward reclassification of Brook Trout only streams. Of the 24 sites where fish communities could be assessed, eight (33%) had fish communities in *Excellent* or *Very Good* condition which indicate the fish communities at these sites exceed the VWQS for class B(2) streams. Four (17%) sites with fish assessments exhibited communities in *Good* condition which meet the VWQS for class B(2) streams and are priorities for maintenance and protection.

There were 12 sites (50%) where fish community assessments scored *Poor*. These included Stearns Brook Tributary 4 and Roaring Branch which are both impaired due to agricultural runoff; and Clyde River Tributary 1 and Black River Tributary 2 where macroinvertebrate assessments also suggest impacts from elevated nutrient levels. In addition, fish assessments at several sites including Stearns Brook, Averill Creek, Trout Brook, Willoughby tributary 17, Lake Memphremagog tributary 9 and Black River Tributary exhibited communities in *Poor* condition that do not meet the VWQS but have macroinvertebrate assessments of *Good* or better. Additional evaluation of these streams may be needed to understand what may be driving these conditions. Often, a fish community can suggest impacts separate from a macroinvertebrate community; for example, a site immediately downstream of a wetland might not score well based on the VT DEC Fish IBI metrics due to the natural warming of open canopied, slow-moving wetland streams, while the macroinvertebrate metrics are able to account for this. Sites that fail to pass WQS for a single community but score well for the other should be prioritized for further sampling to determine if anthropogenic impacts are responsible for the degradation. In Basin 17, the high percentage of *Poor* fish community assessments contrasts with the high productivity of many of these watersheds for Brook Trout, Atlantic Salmon and Rainbow Trout as monitored by the Vermont Fish and Wildlife Department and should be prioritized for additional assessment.

LaRosa water quality monitoring

A targeted tributary monitoring program has been supported through the LaRosa Partnership Program since 2005 and has sampled at 230 sites in the lake Memphremagog and Stearns Brook watersheds. In Basin 17, this water sampling program is led by the Orleans County Natural

Resources Conservation District and is focused on identifying and evaluating agricultural BMPs. Support has been provided through collaboration of several partners over this time including the NorthWoods Stewardship Center, the Memphremagog Watershed Association, Seymour Lake Association, and the Orleans County Natural Resources Conservation District with Fritz Gerhardt of Beck Pond LLC. Currently, the program includes sampling eight times a year for nitrogen, phosphorus and in previous years included turbidity with at least two dates targeting active runoff events. The focus has been on identifying source areas through sampling small tributaries and ditches or bracketing potential source areas. Through these efforts, 91 watersheds in the Lake Memphremagog watershed covering 16% of the basin have been identified as generating elevated nutrient levels (mean phosphorus concentrations of over 44 ug/l) and are current targets for

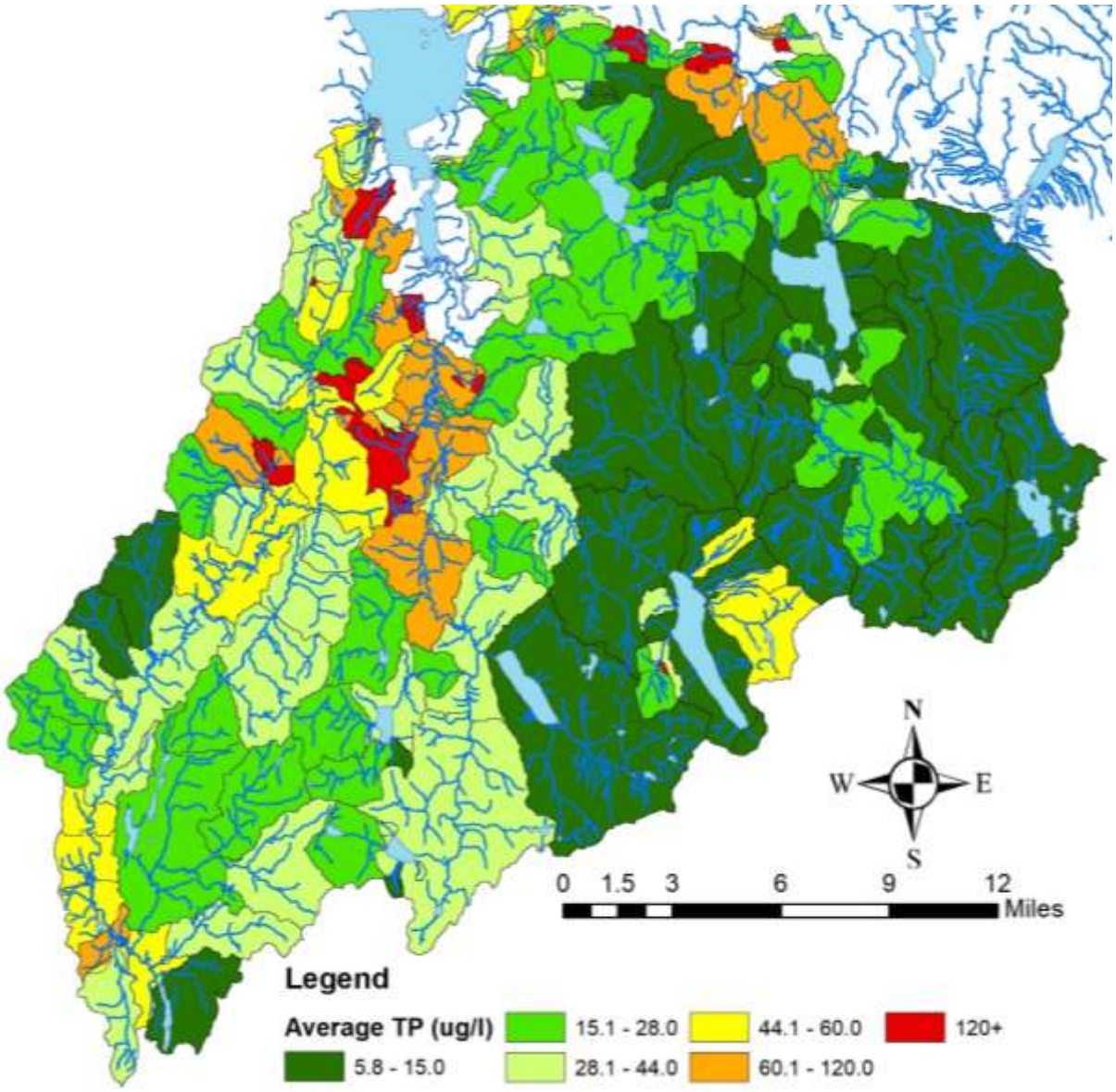


Figure 8. Average total phosphorus concentrations measured from 207 sub-watersheds of the Lake Memphremagog Basin during 2005-2022.

phosphorus load reduction interventions. Work has continued in collaboration with agricultural partners and landowners in many of these sub watersheds to identify and address phosphorus sources to target and then evaluate implementation efforts in coordination with the Memphremagog RCPP.

In addition to this, streams in six lake watersheds including, Echo, Seymour, Willoughby, Shadow, Parker and Little Averill have been monitored to evaluate nutrient contributions that may be contributing to lake nutrient concerns. Several subwatershed have been identified as having higher concentrations of phosphorus where assessment and implementation efforts should be focused.

Stream Geomorphic Assessment

Fluvial geomorphology is a subdiscipline of geomorphology that investigates how flowing water shapes and modifies Earth's surface through erosional and depositional processes. The Rivers Program conducts a three-phase approach to assess the physical condition of rivers in the State of Vermont. Phase 1 is a watershed assessment. Phase 2 is a rapid field stream assessment, and Phase 3 is a survey assessment. Figure 9 gives the overall Phase 2 geomorphic condition score of rivers in the

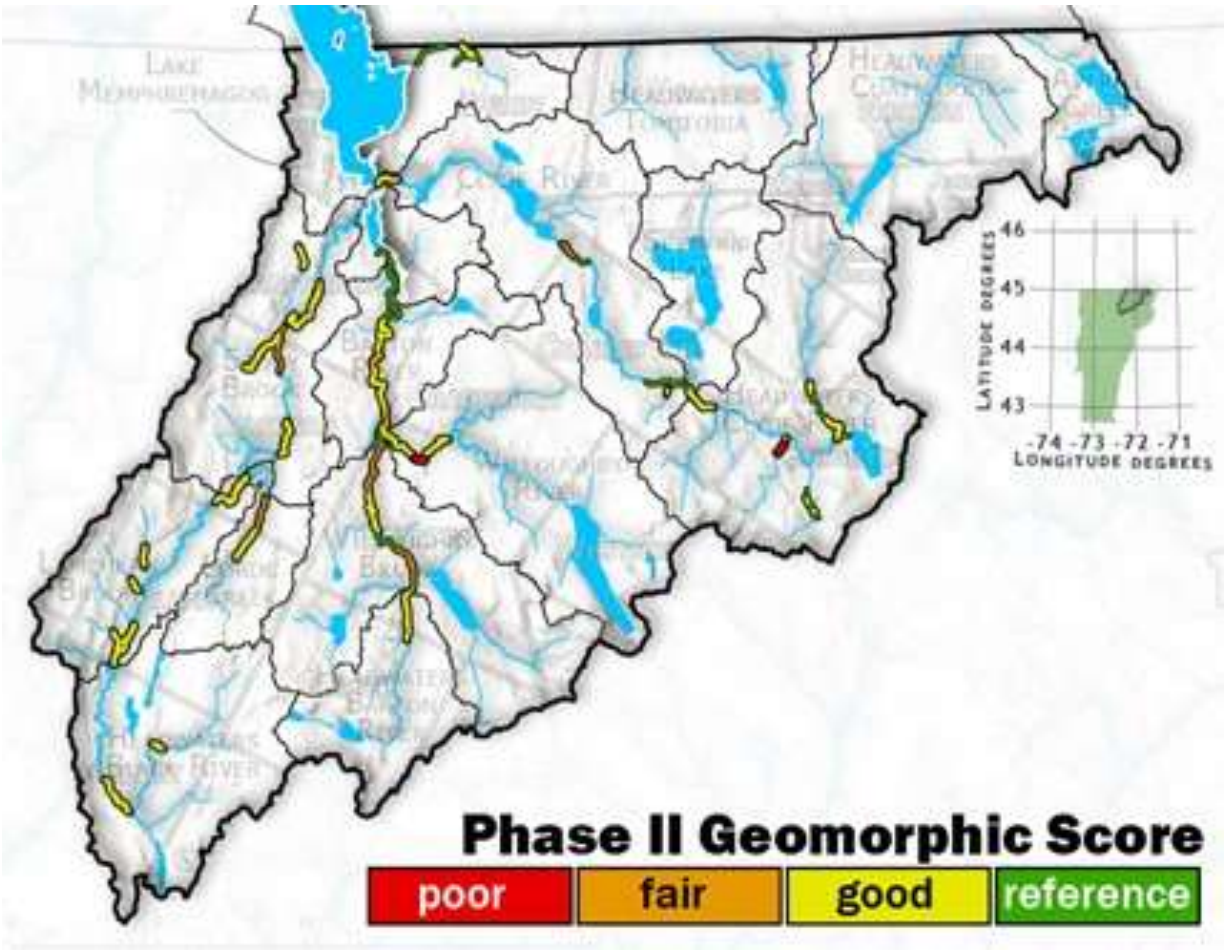


Figure 9. Geomorphic Condition of Assessed Rivers and Streams

Basin. For more information on these type of assessments see the Geomorphic Assessment webpage.

Phase 1 Stream Geomorphic Assessments (SGA) have been completed on nearly 740 miles of streams in the watershed (over 60% of streams miles), but only 68 miles of streams in the basin have had Phase 2 SGAs completed (about 6% of stream milage). Most of the stream reaches with Phase 2 assessments have been rated as good condition but several segments of the Barton are rated as fair, along with segments of lords Creek and the Black River.

In 2022, the Memphremagog Watershed Association partnered with OCNRCD and DEC Rivers Program to conduct SGA Phase 2 'lite' on select reaches of Valley Brook in Morgan and Mad Brook in Charleston. This pilot program aimed to evaluate geomorphic conditions in systems with known fluvial erosion issues and proposed stream restoration actions. Findings indicate a need for headwater forest road best management practices in the Mad Brook watershed and stream and floodplain restoration actions on the newly acquired FWD streambank management area on Valley Brook. Additional SGA Phase 2 'lite' assessments may address target reaches in other watersheds, as identified in the Review of Basin 17 Stream Geomorphic Assessments & Sediment Stressed Conditions in Stearns Brook memo (Hurley, 2022). Final SGAs can be accessed at: Stream Geomorphic Assessment - Final Reports.

Lakes and Ponds

There are 58 lakes and ponds in Basin that are ten acres or greater. This basin includes many of the largest lakes in the state including Lake Memphremagog, Seymour Lake, Lake Willoughby and Crystal Lake. Many of these lakes have naturally low levels of phosphorus due to their large size and depth relative to smaller and less developed watersheds. Lakes that are ten acres or greater should be managed in accordance with the Vermont Hydrology Policy and meet the Hydrology Criteria (§29A-304) in the 2022 VWQS to ensure full support of designated uses.

Lake Scorecard Assessment

The Vermont Lakes and Ponds Management and Protection Program share lake assessments using the VT Inland Lakes Scorecard (Figure 10, Table 3).The 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.

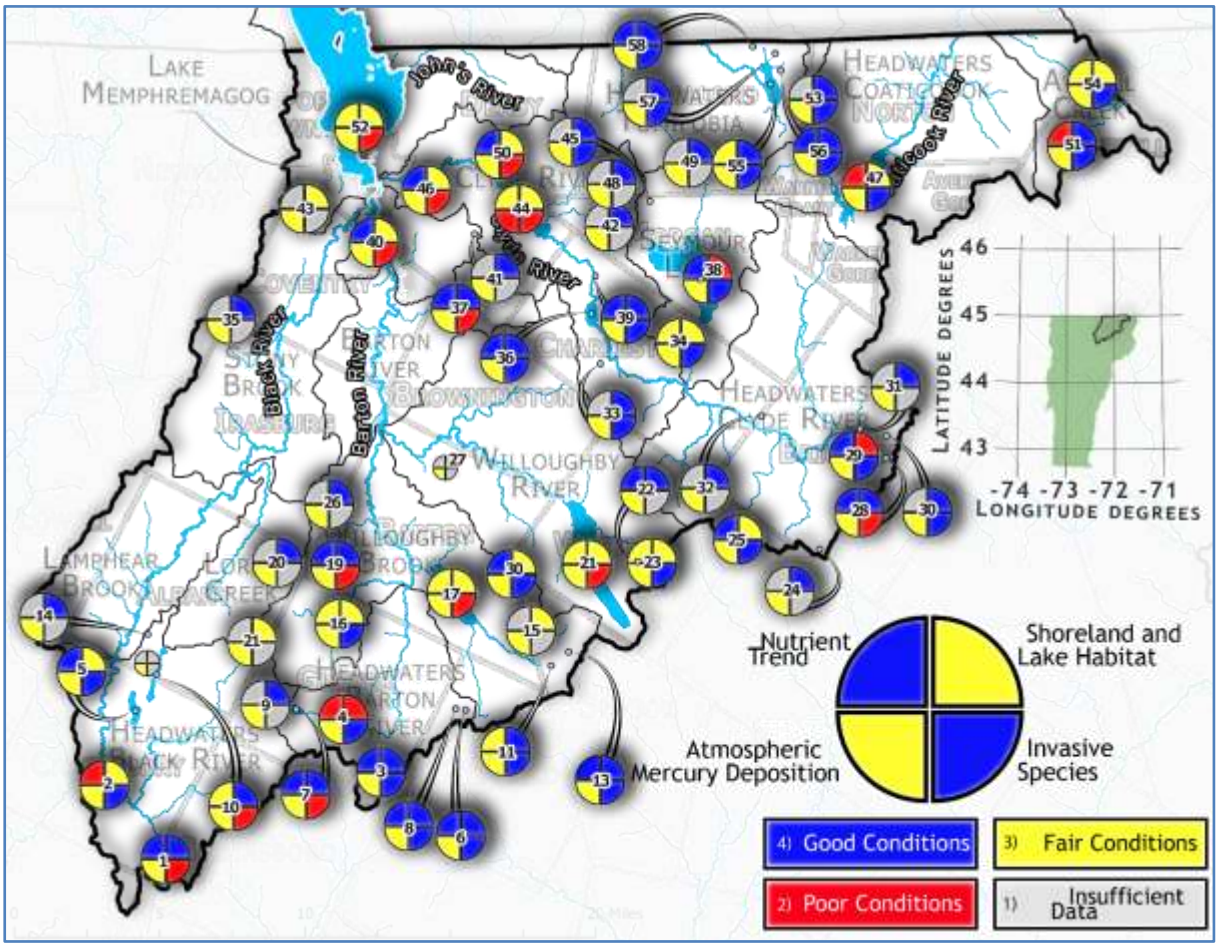


Figure 10. Condition of Lakes and Ponds greater than 10 acres based on the Vermont Lake Scorecard

Of the 57 lakes greater than 10 acres evaluated for shoreland condition in the Basin, 35 (61%) have good ratings, three (5%) have poor ratings and 19 (33%) waterbodies scored as fair. Of the 37 lakes scored for nutrient trends, 22 (58%) are rated as good, four lakes (11%) have a poor rating, while 12 (32%) are rated as fair which means that 43% of lakes in this basin with sufficient monitoring have increasing nutrient trends making this one of the major water quality concerns in this basin. Three waterbodies, Lake Memphremagog, Mud Pond (Craftsbury), Walker Pond are impaired by elevated phosphorus, with Mud Pond being considered impaired and with increasing nutrient levels.

Table 3. Condition of Lakes and Ponds greater than 10 acres based on the Vermont Lake Scorecard.

Map ID	Lake ID	Area (ac)	Depth (ft)	Nutrient Trend	Shoreland Condition	Aquatic Invasive Species	Mercury	WQ Status
1	ELLIGO	182.1	100	Good	Good	Poor	Fair	Good
2	MUD (CRAFBY)	27.3	7	Poor	Fair	Good	Fair	Poor
3	TILDYS	31.5	24	Good	Good	Good	Fair	Good
4	SHADOW (GLOVER)	217.3	139	Poor	Poor	Good	Fair	Poor
5	LITTLE HOSMER	178.8	9	Good	Fair	Good	Fair	Good
6	LONG (SHEFLD)	37.6	30	Good	Good	Good	Fair	Good
7	DANIELS	65.4	13	Good	Good	Poor	Fair	Good
8	ROUND (SHEFLD)	13.9	48	Good	Good	Good	Fair	Good
9	DANIELS-W;	19.3	3	Insufficient data	Good	Insufficient data	Fair	Insufficient data
10	GREAT HOSMER	146.5	57	Fair	Good	Poor	Fair	Fair
11	BEAN (SUTTON)	36.4	2	Fair	Good	Good	Fair	Good
12	HARTWELL	17.4	57	Insufficient data	Fair	Insufficient data	Fair	Good
13	VAIL	18.6	39	Good	Good	Good	Fair	Fair
14	PAGE	16.8	4	Insufficient data	Good	Insufficient data	Fair	Insufficient data
15	WHEELER (BARTON)	14.8	24	Insufficient data	Fair	Insufficient data	Fair	Good
16	PARKER	253.1	45	Fair	Fair	Good	Fair	Fair
17	CRYSTAL (BARTON)	771.6	115	Fair	Fair	Poor	Fair	Good
18	MAY	90.0	31	Good	Fair	Good	Fair	Fair
19	BAKER (BARTON)	56.1	30	Good	Good	Poor	Fair	Fair
20	ALBANY-NE;	22.2	NA	Insufficient data	Good	Insufficient data	Fair	Insufficient data
21	WILLOUGHBY	1733.6	308	Fair	Fair	Poor	Fair	Good
22	MUD (WESTMR)-W	14.1	30	Good	Good	Insufficient data	Fair	Insufficient data
23	LONG (WESTMR)	86.9	74	Fair	Fair	Good	Fair	Good
24	SUKES	11.4	NA	Insufficient data	Good	Insufficient data	Fair	Insufficient data
25	JOBS	40.5	18	Good	Fair	Good	Fair	Good
26	MUD (IRASBG)	15.3	NA	Insufficient data	Good	Insufficient data	Fair	Good
27	EVANSVILLE;	13.4	NA	Insufficient data	Insufficient data	Insufficient data	Fair	Insufficient data
28	SPECTACLE	101.5	15	Good	Good	Poor	Fair	Fair
29	ISLAND	614.2	63	Good	Poor	Good	Fair	Good
30	BEECHER	17.8	13	Insufficient data	Good	Good	Fair	Insufficient data
31	BACK	12.2	24	Insufficient data	Good	Insufficient data	Fair	Fair
32	HOPKINS;	10.1	NA	Insufficient data	Good	Insufficient data	Fair	Insufficient data

Map ID	Lake ID	Area (ac)	Depth (ft)	Nutrient Trend	Shoreland Condition	Aquatic Invasive Species	Mercury	WQ Status
33	TOAD (CHARTN)	25.9	4	Insufficient data	Good	Good	Fair	Good
34	ECHO (CHARTN)	546.5	129	Fair	Fair	Good	Fair	Good
35	KIDDER	19.9	13	Insufficient data	Good	Insufficient data	Fair	Fair
36	PENSIONER	169.6	39	Good	Good	Good	Fair	Good
37	BROWNINGTON	137.5	33	Good	Good	Poor	Fair	Good
38	SEYMOUR	1777.2	167	Fair	Poor	Good	Fair	Good
39	CHARLESTON	44.1	30	Good	Good	Good	Fair	Good
40	SOUTH BAY	709.7	18	Good	Fair	Poor	Fair	Fair
41	COBB	18.7	17	Insufficient data	Good	Insufficient data	Fair	Fair
42	MUD (MORGAN)-W	14.3	3	Insufficient data	Good	Insufficient data	Fair	Insufficient data
43	WALKER (COVNTY)	20.0	9	Insufficient data	Fair	Insufficient data	Fair	Poor
44	SALEM	776.4	70	Fair	Fair	Poor	Poor	Good
45	MUD (MORGAN)-N	38.0	3	Insufficient data	Good	Good	Fair	Good
46	CLYDE	186.0	20	Good	Fair	Poor	Fair	Good
47	NORTON	658.6	30	Poor	Fair	Good	Fair	Poor
48	MUD (HOLLND)	13.2	NA	Insufficient data	Good	Insufficient data	Fair	Insufficient data
49	STEARNS;	14.1	NA	Insufficient data	Good	Insufficient data	Fair	Insufficient data
50	DERBY	211.6	19	Good	Fair	Poor	Fair	Fair
51	LITTLE AVERILL	470.2	115	Poor	Good	Good	Fair	Poor
52	MEMPHREMAGOG	5929.3	351	Fair	Fair	Poor	Fair	Poor
53	HALFWAY	21.8	4	Insufficient data	Good	Good	Fair	Poor
54	GREAT AVERILL	835.0	108	Fair	Fair	Good	Fair	Poor
55	HOLLAND	329.1	39	Fair	Good	Good	Fair	Fair
56	TURTLE	25.5	34	Good	Good	Good	Fair	Good
57	ROUND (HOLLND)	15.1	39	Insufficient data	Good	Good	Fair	Fair
58	BEAVER (HOLLND)	38.9	80	Good	Good	Good	Fair	Fair

Beyond nutrient impairment, Vermont has acid impaired waterbodies, including 2 in Basin 17. Three main airborne pollution types affect lakes and ponds in Vermont: sulfur oxides, nitrogen oxides, and mercury. These pollutants are attributable to the prevailing weather pattern that carries mid-west air pollution through the region, the proximity to those pollution sources and to the lack of buffering capacity of the bedrock geology.

Mercury contamination has resulted in fish consumption advisories in nearly every lake in Vermont. Dramatic shifts in water level, due to the way reservoirs are managed for hydroelectrical production, cause the release of bio-available mercury that is otherwise sequestered in the sediments. This mercury is more easily transferred up the food chain to fish and loons and other larger birds and mammals. All lakes in the Basin get a fair condition score for mercury except for Salem Lake which is rated as poor and considered impaired (Figure 10, Table 3).

Sulfur and nitrogen oxides transported to Vermont from out of state air emissions results in acid forming pollutants raising in-lake acid concentrations. Lakes and ponds in are regularly monitored for low pH (high acidity), which impacts biological communities. Thirty-nine lakes and ponds are included in the VT Acid Impaired Lake Total Maximum Daily Load (TMDL). Since the USEPA began enforcing the Clean Air Act and its amendments, nationwide emissions and deposition of acid forming pollutants have declined. As a result, Vermont's in-lake acid concentrations have improved. Duck Pond in Holland and Halfway Pond in Norton are the only acid-impaired waterbodies in the Basin. More information about long term monitoring of VT's acid lakes can be found at: https://dec.vermont.gov/watershed/map/monitor/acid-rain

Thirteen lakes out of the 43 lakes that have been surveyed for aquatic invasive species have identified aquatic invasive species.

Lake Memphremagog

Unlike other lakes in the Basin, Lake Memphremagog is only partly within the boundaries of the Basin and also receives runoff from tributaries in Quebec. In 2020, the international Joint Commission published a reference report Nutrient Loading and Impacts in Lake Champlain – Missisquoi Bay and Lake Memphremagog. The report describes several ongoing needs and challenges:

- The amount of nutrients delivered to the Lake from the Basin each year must be reduced to meet water quality goals across all watershed sectors.
- This would best be supported through establishing watershed nutrient loading reduction goals through a binational watershed model and strengthen the cooperation through Quebec Vermont Steering Committee to implement a long-term strategy for nutrient reduction efforts.

In addition to nutrients, Lake Memphremagog has several AIS including Curly leaf pondweed, Eurasian water milfoil, Starry stonewort, Banded mystery snails, and Chinese mystery snails. Also, Zebra mussels that were initially found in the northern Quebec portion of the lake, have been increasing in density and potentially migrating south. Surveying and monitoring the population that includes plankton-net tow sampling and environmental DNA sampling have detected the first evidence in 2022 that the mussels may be present in Vermont, but no physical adult specimen have been found yet. Ongoing surveying and monitoring for Zebra mussels will continue.

Lake Memphremagog has also been impacted by industries along its shore with contamination from a rail yard and other nearby industrial and urban developments. There have been community concerns around levels of Per- and Polyfluoroalkyl Substances (PFAS) in Lake Memphremagog which was included in many of the Basin 17 planning survey responses. A water quality monitoring effort was completed in 2021 to evaluate levels of PFAS in Lake Memphremagog and tributaries. Surface water samples were collected at ten sites within the Lake Memphremagog watershed including three sites on the Main Lake: a US/Canada border site, a mid-lake site, and a southern site; South Bay; and four major tributaries: the Johns, Clyde, Black, and Barton Rivers were all sampled near the mouths of the river with additional upstream sites on the Clyde and Black Rivers. The results of monitoring are included in an April 2022 report and included only one detection in the lake of Perfluorooctane sulfonic acid (PFOS) at less than 3 ppt which is a level frequently found in both developed and remote locations. Perfluorobutanoic acid (PFBA) was detected at four tributary sites (Johns River, Clyde River, and both Black River sites) at concentrations ranging from 1.84 ppt to 2.74 ppt and is commonly detected in rivers downstream of towns and cities.

In addition to surface water sampling, largemouth bass, yellow perch, brown bullhead, and rock bass were all sampled for PFAS in South Bay, Clyde River, and Lake Memphremagog and the results were considered low relative to national fish tissue studies (ANR, 2022).

Wetlands

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 heavy agricultural use and high development pressure often exhibiting habitat loss.

Wetland Bioassessment and Vermont Rapid Assessment Method

A total of 43 wetlands in the Basin have been assessed using the Vermont Rapid Assessment Method (VRAM). The VRAM assigns each wetland a score ranging from 15 to 100 with higher numbers representing more intact ecological condition and higher levels of wetland functions and values. The highest scoring wetland, Pensioner Pond, scored a 90. Eleven other wetlands scored above 80, indicating excellent condition and/or very high levels of function and value. Only eight wetlands scored below 50. Note that the VRAM assessments in this watershed may not necessarily

be representative of the Basin's wetlands as a whole, as random sampling was not conducted and a full inventory of all the wetlands in the Basin is not possible at this time.

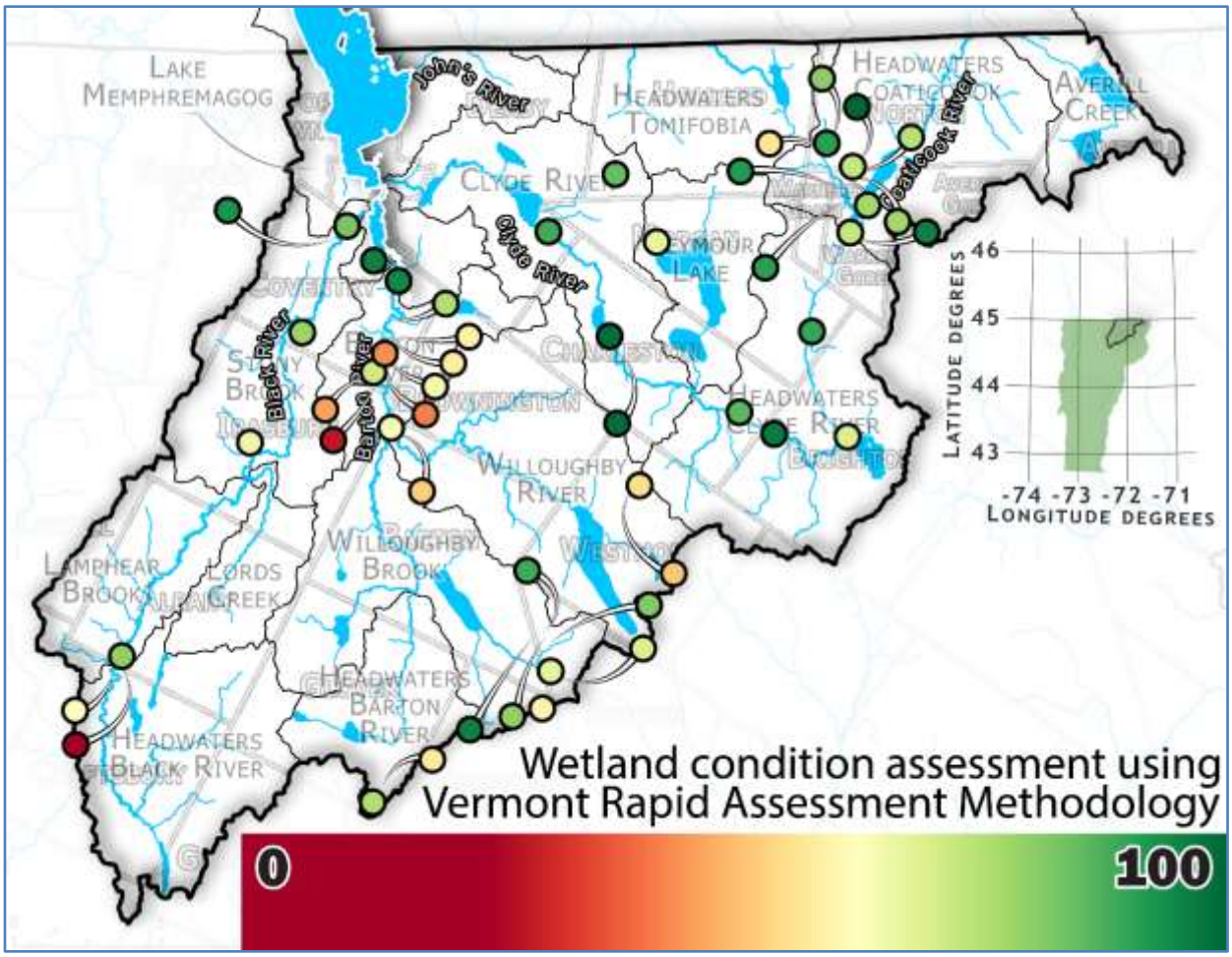


Figure 11. Wetland VRAM assessments Completed (Red = poor Green = excellent condition..)

Recreational Fisheries

The Vermont Fish & Wildlife Department (FWD) assesses fishery populations and important nursery areas to document biological and habitat conditions to manage for high-quality recreational fisheries. Basin 17 includes celebrated populations of steelhead rainbow trout, brown trout and landlocked Atlantic salmon that annually travel from Lake Memphremagog into tributaries to spawn. The fish that live in Lake Memphremagog travel up the Black, Barton, Clyde and Johns rivers and smaller tributaries of the lake. In these areas of the watershed aquatic organism passage (AOP) is essential to providing the habitat these fish species need for natural reproduction.

A recent salmon strain evaluation resulted in a change to use Sebago Salmon strain for breading salmon for stocking in the Clyde River. A creel survey was done on Lake Memphremagog from 2019 through 2020 in coordination with partners in Quebec which was used to change the

regulations in Quebec reducing the number of salmon that anglers could be harvested daily from 30 per person per day to two per person per day. The FWD is monitoring to see if these changes have increased the populations of younger salmon in the Lower Clyde River, but initial surveys have shown lower rates of Salmon recruitment on the Clyde. These evaluations are still early but suggest a need to evaluate water quality conditions that may impact salmon recruitment which is one reason Agency has identified a priority for monitoring tributaries to the Lower Clyde for chemistry. This area of focus overlaps with Lake Salem which has increasing nutrient trends and low dissolved oxygen levels in deeper depths providing multiple reasons to target monitoring in this area.

In addition to Lake Memphremagog, most lakes and ponds in Basin 17, especially Willoughby, Crystal, Salem, Echo, and Seymour lakes and Island, Norton and Great and Little Averill ponds support fish species that move into tributaries to spawn. AOP is critical on the minor tributaries to these waterbodies to allow for natural reproduction to sustain fish populations and the valuable fisheries they support. Other species of fish and wildlife including native Brook Trout also depend on stream continuity for their survival especially as surface water temperatures rise and trout need to find cold water refugia. The lack of in-stream wood is one of the main factors limiting Brook Trout biomass in northeastern Vermont (Kratzer J. F., 2013). FWD has identified Number 5 & 6 Brooks and Big Valley Brook on state lands or where the state has an easment, and where levels of wood are limiting Brook Trout populations and so strategic wood addition is recommended as a strategy in this plan. In addition to streams on state lands, there may be streams on private lands where strategic wood addition could support increased trout populations.

Lake Memphremagog is also home to a significant population of Brown Bullhead where the FWD had identified high levels of malignant melanomas which were first reported 2012 and were later confirmed in surveys in 2014 and 2015. The FWD in collaboration with the USGS completed a study on these populations in 2019 (Blazer et al. 1999) and FWD led a fish tissue monitoring effort that didn't identify any specific contaminant of concern and levels were generally typical of similar watersheds around the USA. The study also included sediment samples from major tributaries and the lake which were analyzed for Polycyclic aromatic hydrocarbons (PAHs) and priority metals. Secretary Moore presented this information at a tell-me-more presentation on March 17th, 2020. The FWD is working with geneticists at UVM and experts with the USGS to further identify the cause of the malignant melanomas using a Next Gen Sequencing approach.

Chapter 2 – Priority Areas for Surface Water Protection

The state protects lakes, wetlands, and rivers by establishing and supporting surface water management goals. Tactical Basin Plans identify surface waters that consistently attain a higher level of quality and value based on physical, chemical, and biological criteria. These waters are prioritized for reclassification or designation. This allows for the establishment of enhanced management objectives and supports implementation of strategies to protect these surface waters.

Additional pathways such as land stewardship programs, local protection efforts, conservation easements, and land acquisition are also used to increase protection of priority waters. These are described in Chapter 4, Strategies for Protection and Restoration. Four lakes and 24 streams in this Basin meet or exceed standards for very high-quality condition and are prioritized for reclassification.

A. Surface Water Reclassification and Designation

Vermont's surface water classification system establishes management goals and supporting criteria for designated uses in four classes of water. Designated uses include aquatic biota and wildlife, aquatic habitat, aesthetics, fishing, boating, swimming, public water supply, and irrigation. The VWQS begin classification with two broad groups based on elevation:

- All waters above 2,500 feet in elevation 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 in elevation, are designated Class B(2) for all uses, unless specifically designated as Class A(1), A(2), or B(1) for one or more uses.

Current classifications of surface waters and their uses are published in the VWQS and are identified through the tactical basin planning process or on a case-by-case basis. Table 4 lists the possible classes for each designated use.

Table 4. Uses of Waters by Class

Classification	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

Surface waters may be protected by the anti-degradation policy of the Vermont Water Quality Standards (DEC, 2022) or through one of the following pathways:

- Reclassification of surface waters
- Class I Wetland designation
- Outstanding Resource Waters designation

The tactical basin planning process includes the review of ANR monitoring and assessment data to identify and document surface waters that meet the criteria for a higher classification or designation. (10 V.S.A. § 1253).

Public involvement is an essential component of protecting river, wetland, and lake ecosystems. 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." The public, watershed partners, and stakeholders are encouraged to make recommendations for additional monitoring and research where very high-quality waters may exist.

In addition, the public may petition DEC to reclassify streams and lakes, and to designate Outstanding Resource Waters. DEC has developed procedures and documents for Class I wetland designations and stream reclassification. When the public is involved in developing proposals regarding management objectives, the increased community awareness can lead to protection of uses and values by the community and individuals.

Further information on reclassification and the petition process can be found on the following WSMD webpages: Stream Reclassification, Lakes and Ponds Reclassification, and Class I Wetlands. Strategies for enhanced protection of waters are described in further detail in the following sections. Surface waters in need of supplemental monitoring to determine their potential for enhanced management are included in Chapter 5 in the Monitoring and Assessment Table.

A(2) Public Water Sources

Five waters in the Basin are designated as A(2) public water sources (Table 5). Three are actively being used, including two streams which are used for the Brighton water supply and May Pond which is the water supply for the town of Barton. Two are no longer being used as a public water source including the abandoned water supply for the Coventry fire district, and an unnamed stream and reservoir that has been used as a water supply for the Village of Derby Line (Table 5).

A(2) waters that are no longer used as water supply are candidates for reclassification to A(1) or B(1) for better long term management.

Table 5. Class A(2) Public Water Sources

Waters	Water Source	Description
Unnamed Tributary to Island Pond	Village of Brighton	Permanent - Town of Brighton (WSID 5105) water source. An unnamed tributary to Island Pond and all waters within its watershed in the Town of Brighton above the water intake at approximate elev. of 1544.0' MSL. The tributary flows northerly

Waters	Water Source	Description
		to Island Pond. Locally known as Brook #1.
Unnamed tributaries to unnamed tributary to Lightning Brook	Village of Brighton	Permanent - Town of Brighton (WSID 5105) water source. Two unnamed tributaries to an unnamed tributary to Lightning Brook and all waters in their watersheds in the Town of Brighton above the intakes. The main intake is at approx. elev. 1526.0' MSL, and the upper, more northerly intake is diverted to the main intake. Locally known as Brook #2.
May Pond Brook watershed above water intake	Town of Barton	Permanent - Village of Barton (WSID 5189) water source. May Pond Brook and all waters within its watershed in the Town of Barton above and including the water source reservoir and May Pond. The reservoir is located approximately ¾ mile upstream of the brook's confluence with Crystal Lake.
Unnamed tributary to the Black River	Coventry fire district #1	Abandoned - Coventry water source. An unnamed tributary to the Black River and all waters within its watershed above the water intake in the Town of Coventry.
Unnamed reservoir near Derby Line	Village of Derby Line	Abandoned - Reservoir and all waters in its watershed in the Town of Derby on Reservoir Road off of Herrick Rd.

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

Biomonitoring assessments by the WSMD identified five surface waters, Shalney Branch in Albany, Wheeler Mountain Brook in Westmore, Oswegatchie Brook in Brighton, Hurricane Brook in Holland, and Number 5 Brook in Norton as consistently and demonstrably attaining a higher level of quality than Class B(2), meeting Class B(1) draft criteria for aquatic biota.

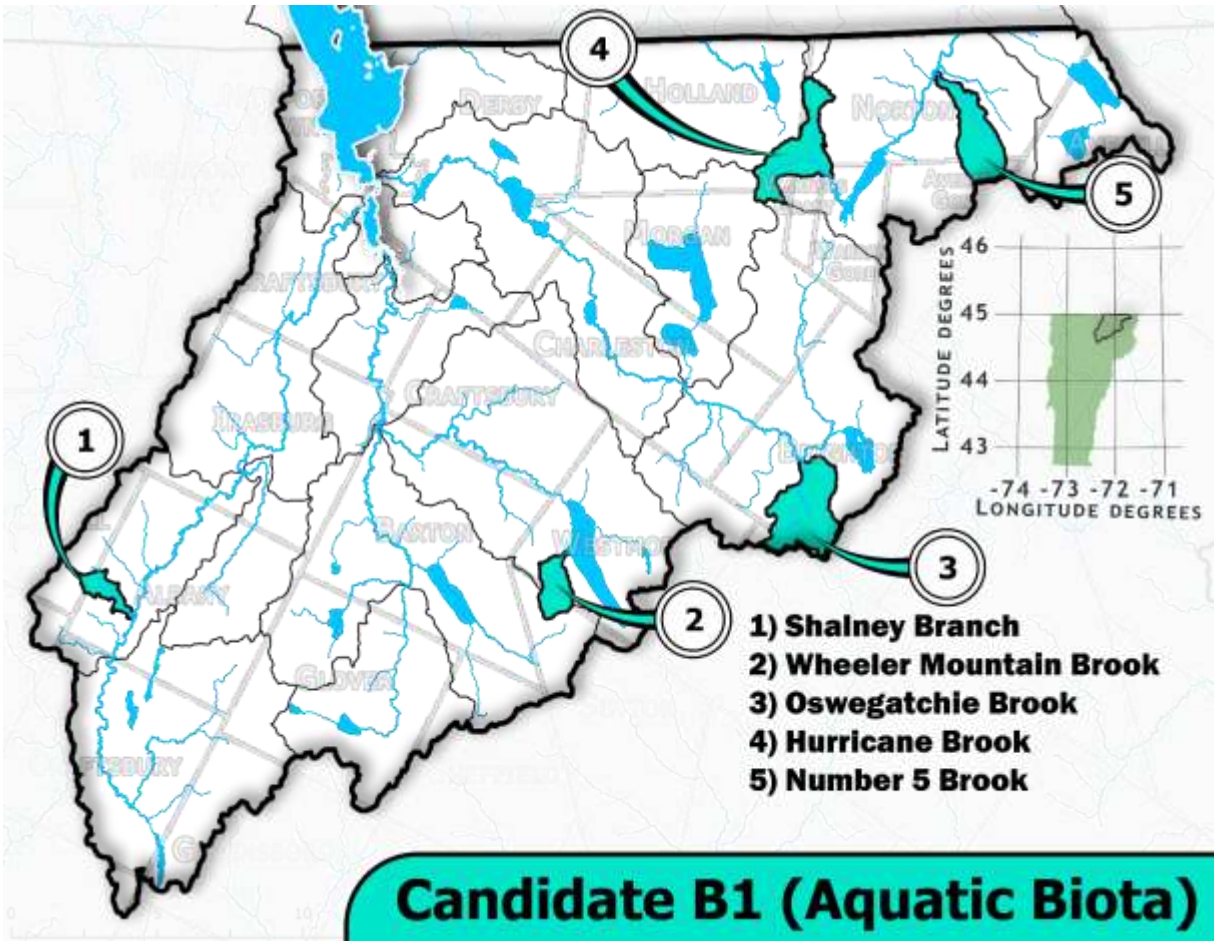


Figure 12. River Aquatic Biota candidates for Reclassification.

Waters In Need of Further Assessment

Thirteen rivers and streams are in need of supplemental monitoring to determine their potential for enhanced protection (Table 6 and Figure 12). These waters are included in Chapter 5 in the Monitoring and Assessment Table.

Table 6. Monitoring Needed to Confirm Reclassification

Map ID	Name	Sample By:	
		Macro	Fish
1	Whitney Brook, 4.4	2025	2025
2	Shadow Lake Brook, 3.1	2025	2023
3	Duck Pond Brook Trib # 3, 0.2	♦	♦
4	Annis Brook, 0.5	2025	♦
5	Roaring Brook, 5.3	♦	♦
6	Rogers Branch, 1	♦	♦
7	McCleary Brook, 2	♦	♦

8	Lamphear Brook, 1.1	2025	2025
9	Brighton Brook, 0.9	♦	♦
10	Brownington Branch, 1.3	♦	2025
11	Pherrins River, 2	2025	2025
12	Webster Brook, 4.6	♦	♦
13	Crystal Brook, 0.3	2025	2025

♦ = old data meets B1/A1 criteria - new data required

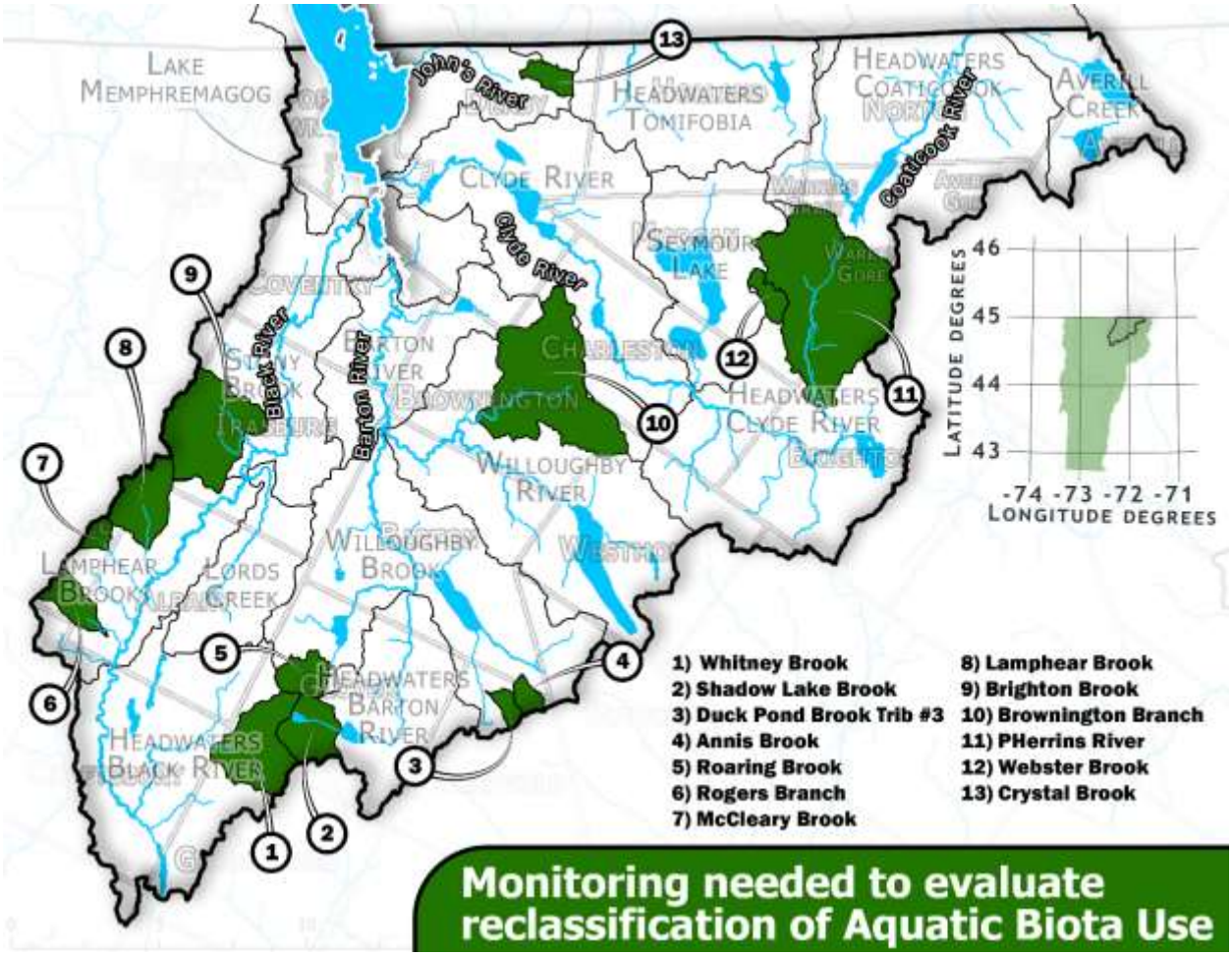


Figure 13. Monitoring Needed to Evaluate Reclassification Opportunites

B(1) Waters for Fishing Use

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). The nineteen streams that meet B(1) criteria for recreational fishing (§29A-306 of the VWQS) are listed in Table 7. These waters shall be managed to achieve and maintain the documented quality of fishing. It is important

to note that all waterbodies that would naturally support fish populations are protected and maintained for this use in perpetuity.

Table 7. Streams that meet B(1) criteria for recreational fishing

Stream	Latitude	Longitude	Proposed B(1) reach
Barton River	44.77056	-72.20913	From sample location to headwaters
Clyde River	44.93733	-72.18467	From Clyde Street Bridge to Clyde Pond dam
Creemee Brook	44.78614	-72.21361	Barton River confluence to headwaters
Crystal Brook	44.98946	-72.10708	From sample location to headwaters
Fallow Brook	44.89795	-72.06247	From sample location to headwaters
Greens Brook	44.93496	-72.10258	From sample location to headwaters
Hogtrough Brook	44.77119	-72.21321	From sample location to headwaters
Houser Brook	44.94857	-72.13766	From sample location to headwaters
Trib. to Salem Lake	44.93998	-72.10582	From sample location to headwaters
Hurricane Brook	44.93882	-71.88648	From sample location to headwaters
Johns River	44.99593	-72.1338	From sample location to headwaters
Mad Brook	44.80628	-71.98888	From sample location to headwaters
Pherrins River	44.8255	-71.90083	From sample location to headwaters
Pine Brook	44.88271	-71.8961	From sample location to headwaters
Roaring Brook	44.73971	-72.18934	From sample location to headwaters
Stony Brook	44.89241	-72.25929	From sample location to headwaters
Utility Brook	44.93951	-72.18632	From sample location to headwaters
Whitney Brook	44.66053	-72.35293	From sample location to headwaters
Willoughby River	44.81116	-72.16167	From sample location to Willoughby Lake

There are also 13 streams where an additional sampling event may be able to demonstrate that these streams meet the B(1) criteria for fishing use. These streams are: Day Brook, Lamphear Brook, Lang Brook, Mill Brook, Outlet Brook, Pukwudgie Brook, Seaver Brook, Southern Johns River trib, Trout Brook, Valley Brook, Ware Brook, Webber Brook, and Webster Brook.

A(1) Waters for Aesthetics Use

The VWQS includes a designated use for aesthetic conditions. DEC has developed numeric nutrient criteria for lakes and ponds in relation to this use which are reflected in the VWQS (Table 3 of VWQS). Seymour Lake, Echo Lake, Lake Willoughby and Shadow Lake meet the nutrient criteria for A(1) aesthetics (Figure 14). In 2021, lake associations from Echo Lake and Shadow Lake submitted administratively complete petitions to DEC requesting reclassification to A(1) status.

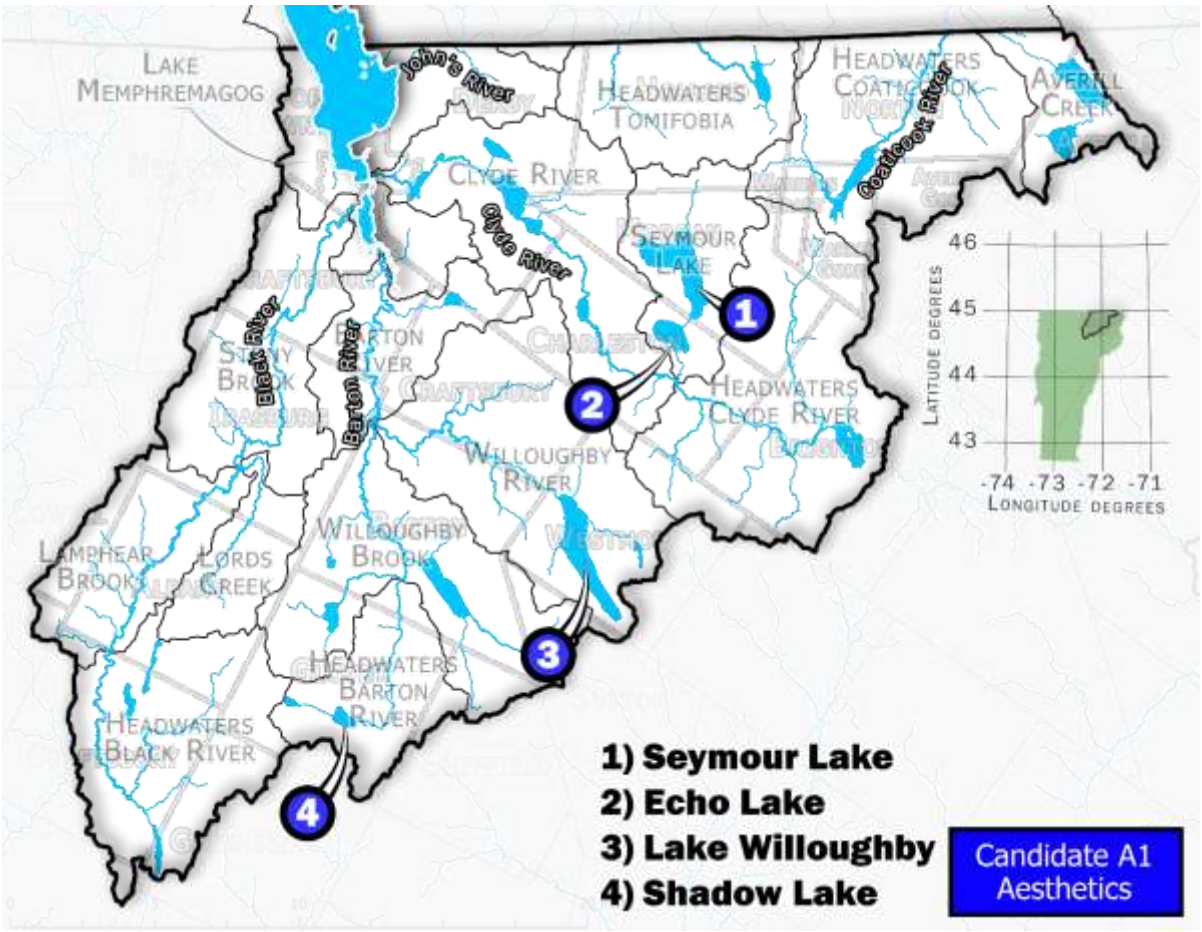


Figure 14. Lake reclassification candidates for A(1) Aesthetics

B. Class I Wetland Designation

The State of Vermont identifies and protects the functions and values of significant wetlands to achieve no net loss of wetlands. Based on an evaluation of the extent to which a wetland provides functions and values, it is classified as:

- **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-Wetlands Program Class I Wetlands website highlights the designated Class I wetlands statewide and lists those recommended for Class I designation.

Three wetlands have been identified for further study for Class I wetland designation including the wetlands at the outlet of the Black and Barton Rivers, and the Upper Clyde River wetlands complex shown in Figure 15.

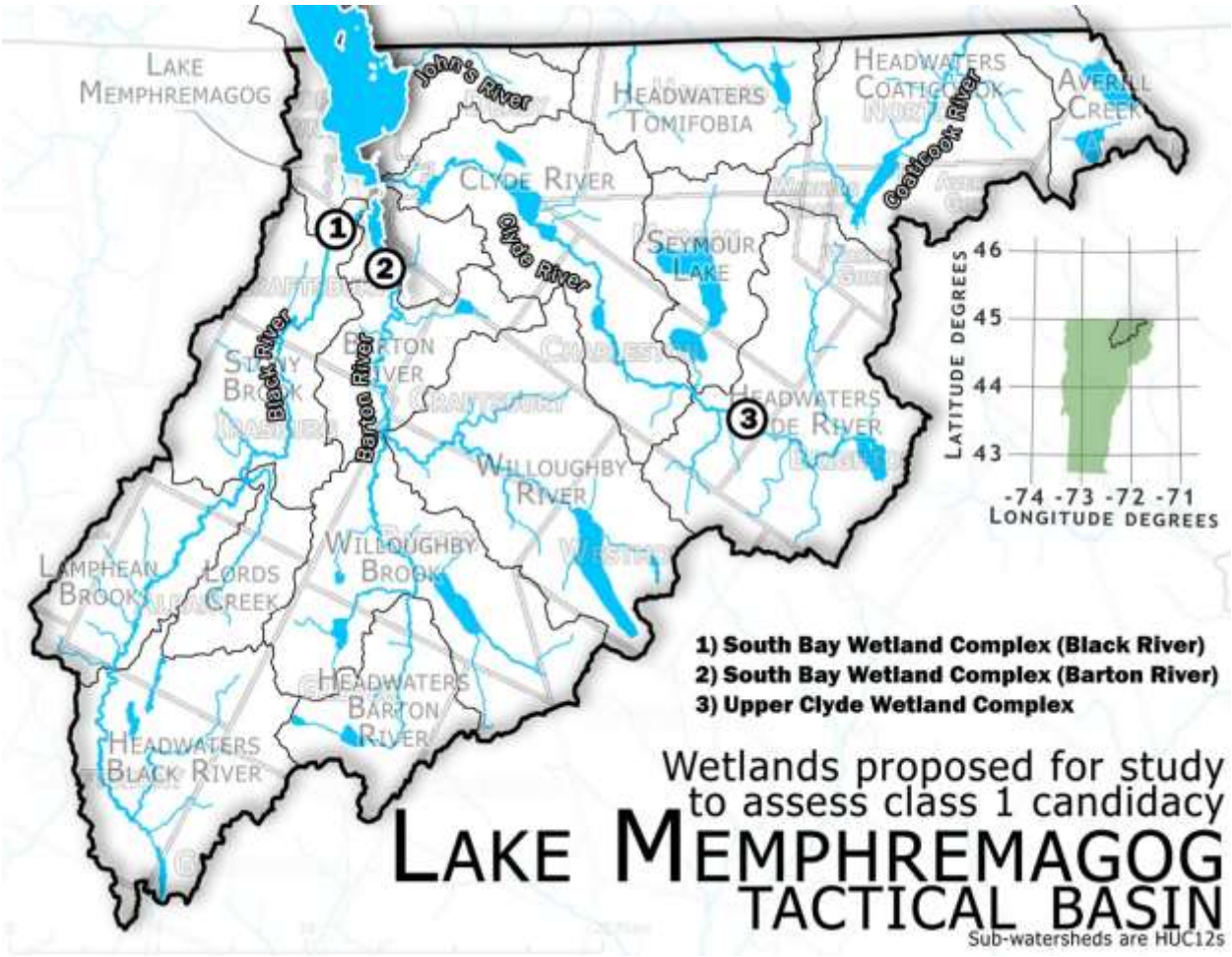


Figure 15. Wetland Protection Priorities

DEC supports the further study and designation of Class I wetlands and the Wetlands Program welcomes recommendations for Class I candidates. Wetlands found to meet criteria for Class I designation may be proposed for reclassification through petition or departmental rulemaking authority, consistent with the Vermont Wetland Rules.

C. Outstanding Resource Waters Designation

Rivers, streams, lakes and ponds that have "exceptional natural, cultural, recreational, or scenic values" can be protected through designation as Outstanding Resource Waters (ORW; 10 V.S.A. § 1424a). ORW designation protects exceptional waters through permit conditions for in-stream alterations, dams, wastewater discharges, aquatic nuisance controls, solid waste disposal, Act 250

projects, and other activities. ORWs can be designated by the ANR through a public petition process.

There are currently no waters with ORW designation in the Basin. There are several waters in the basin which may merit this designation and for which ORW status could be pursued. Water quality on the Willoughby River and its exceptional recreational (primarily fishing) and scenic values make this a potential water for this designation, as was recommended by the prior basin plan (2017). Lake Willoughby is renowned for its exceptional scenic beauty and recreational values along with water quality and so may also merit ORW designation, as was recommended by the prior basin plan (2017). Similarly, Little and Great Averill Lakes are also known for their exceptional scenic beauty and recreational values along with water quality and so may also merit ORW designation.

D. Identification of Existing Uses

Existing uses of waters and the level of water quality necessary to protect those existing uses shall be maintained and protected regardless of the water's classification (DEC, 2022).

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 state 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 the Basin. 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 listed in the basin plan 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 the Basin of swimming, boating, fishing, and public water source are found on the Basin webpage: https://dec.vermont.gov/water-investment/watershed-planning/tactical-basin-planning/basin17.

The public is encouraged to recommend waters for the existing uses of swimming, boating, fishing, public water source, and ecological significance given that they provide evidence of such use.

Chapter 3 – Priority Areas for Surface Water Restoration

A. Impaired and Altered 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 2022 Vermont Surface Water Assessment and Listing Methodology (DEC, 2022). Surface waters are assessed as: full support, altered, or impaired.

The assessment results are the basis for the biennial statewide 303(d) List of Impaired Waters and List of Priority Surface Waters Outside the Scope of 303(d) (Table 8 and Table 9) as well as the priority waters for protection for the aquatic life support (Chapter 2). The lists identify impaired or altered waters and includes preliminary information on responsible pollutant and/or physical alterations to aquatic and riparian habitat and identifies the problem, if known. Altered and impaired waters become a priority for restoration.

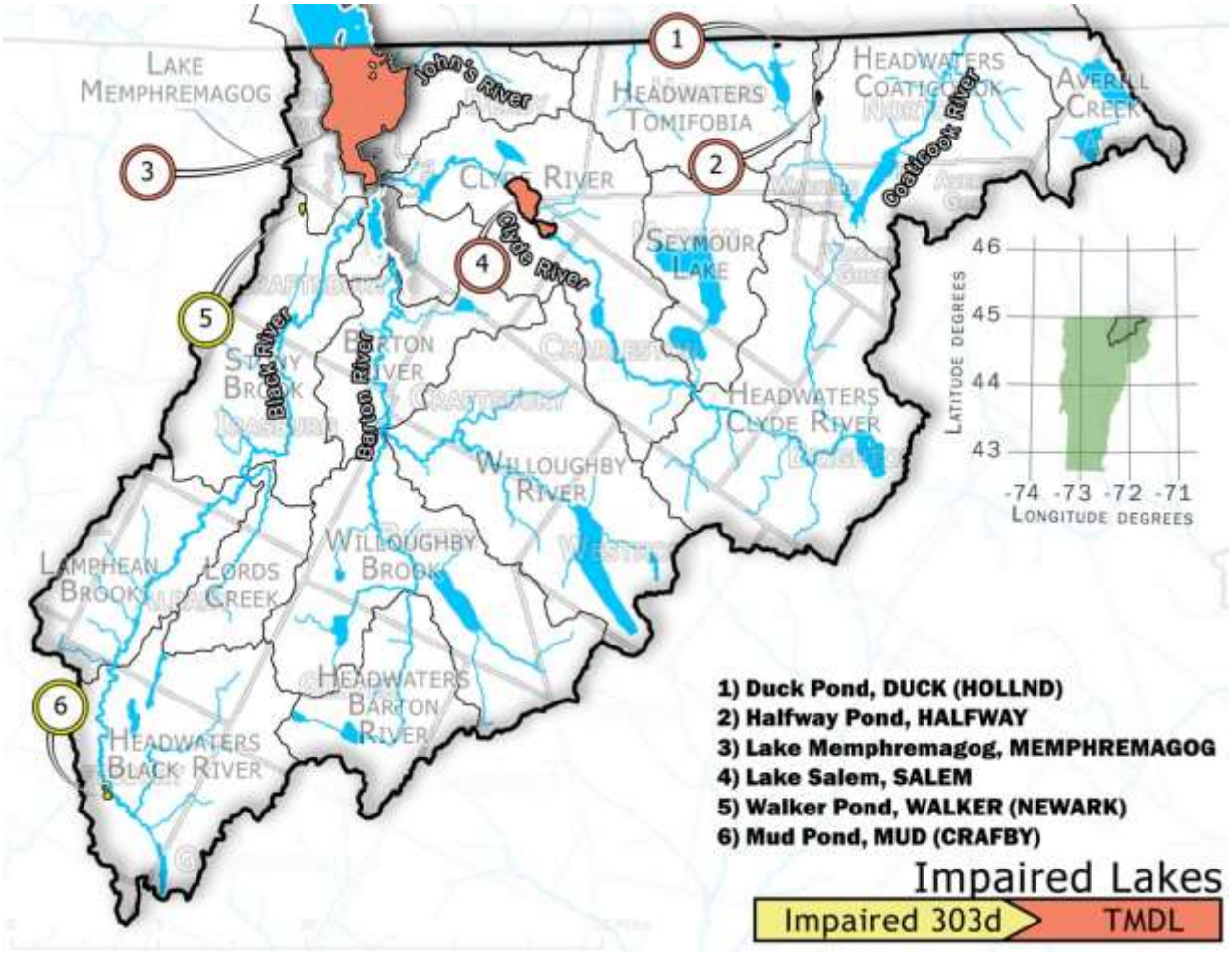


Figure 16. Impaired Lakes in Basin 17

Table 8. Impaired Lakes in Basin 17

Map #	Name	Pollutant	Problem	List
1	Duck Pond (Holland)	Atmospheric deposition: extremely sensitive to acidification; episodic acidification	ACID	D
2	Halfway Pond (Norton)	Atmospheric deposition: critically acidified; chronic acidification	Acid	D
3	Lake Memphremagog (Newport)	Excessive algae growth, nutrient enrichment	Phosphorus	D
4	Lake Salem (Derby)	Elevated levels of mercury in walleye	Mercury	D
5	Mud Pond (Craftsbury)	Extremely elevated tp; agricultural influences	Phosphorus	A
6	Walker Pond (Coventry)	Extremely elevated tp; agricultural influences	Phosphorus	A

The Vermont Lake Score Card also identified 16 lakes and ponds that have increasing nutrient trends and therefore are a priority for nutrient reduction strategies.

The strategies proposed in the Chapter 5 Implementation Table are prescribed based on the land use sector-specific practices outlined in the Vermont Surface Water Management Strategy.

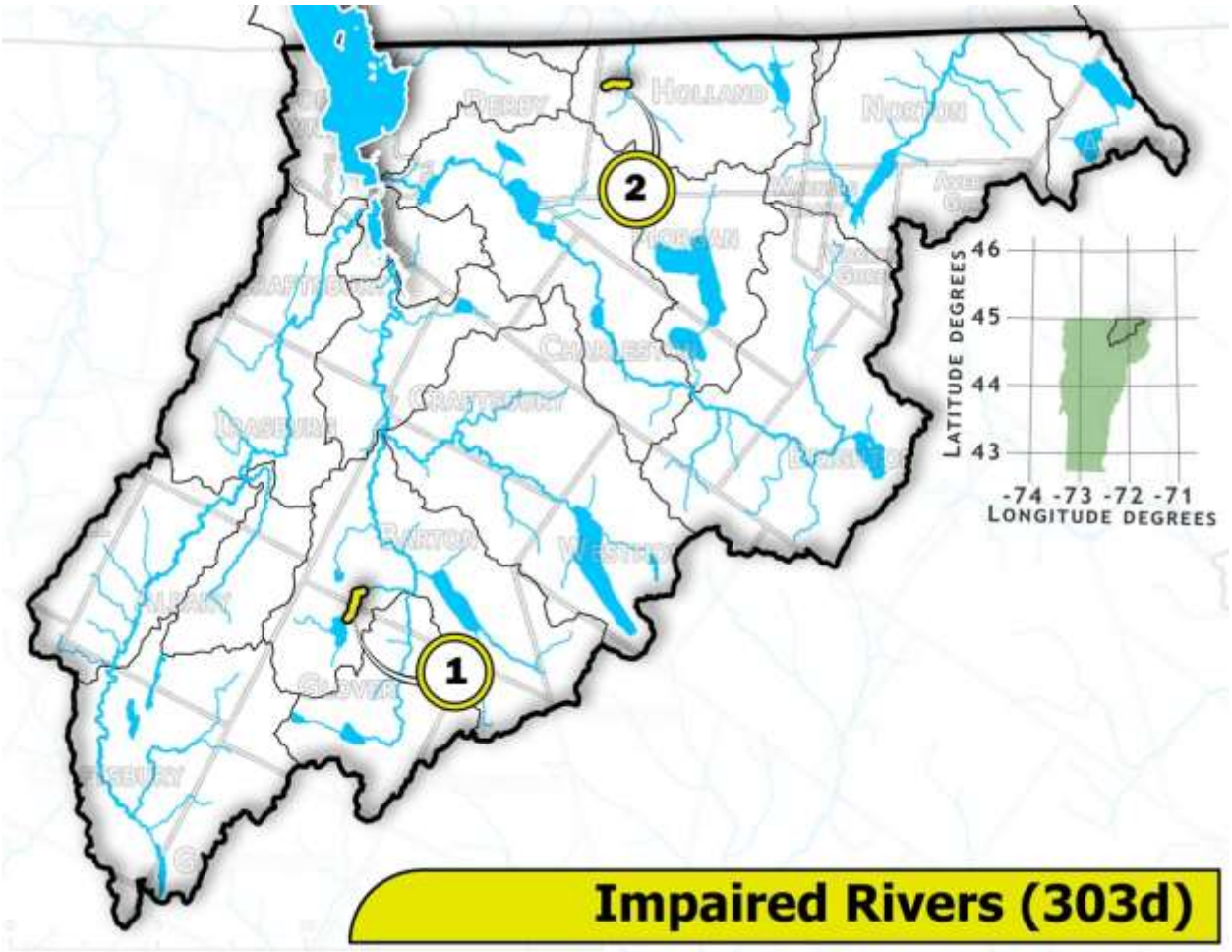


Figure 17. Impaired streams in Basin 17

Table 9. Impaired streams in Basin 17

Map #	Name	Pollutant	Problem	Impaired Use	List
1	Roaring Brook, rm 2.4 to Lake Parker	Nutrients	Agricultural runoff	Aquatic Biota	A
2	Stearns Brook Tributary (Holland)	Nutrients	Agricultural runoff	Aquatic Biota	A

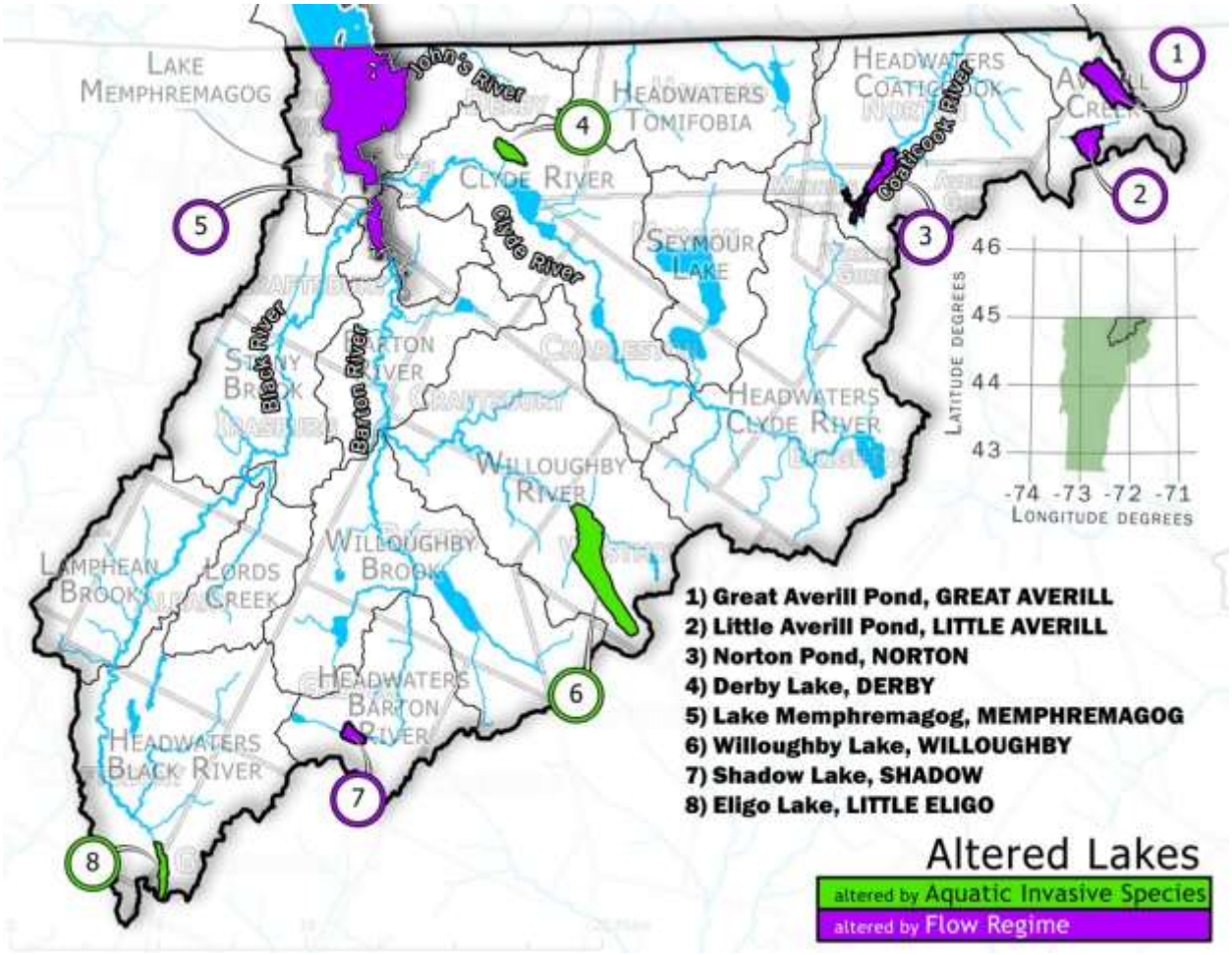


Figure 18. Altered lakes in Basin 17

Table 10. Altered lakes and streams in Basin 17

Map #	Name	Problem	Status	List
1	Great Averill Pond (Norton)	Water level fluctuation by hydro alters aquatic habitat, recreation	ANR, Coaticook, and other parties have reached a tentative settlement; Coaticook currently implementing conditions	F
2	Little Averill Pond (Averill)	Water level fluctuation by hydro alters fishery, recreation & endangered species	ANR, Coaticook, and other parties have reached a tentative settlement; Coaticook currently implementing conditions	F
3	Norton Pond (Norton)	Water level fluctuation by hydroelectric facility alters aquatic habitat, recreation, aesthetics	ANR, Coaticook, and other parties have reached a tentative settlement; Coaticook currently	F

Map #	Name	Problem	Status	List
			implementing conditions	
4	Derby Lake	Locally abundant Eurasian water milfoil & Stary Stonewort growth.	Ongoing management plan that includes DOSH, benthic barriers, and hand-pulling.	E
5	Lake Memphremagog	Water level fluctuation by hydro may alter aquatic habitat and dewater wetlands and shoreline	Dec is a party to regular meetings which includes international joint commission, Canadian environmental regulatory authorities and municipalities to discuss ways to improve the water quality of the lake	F
6	Lake Willoughby	Locally abundant Eurasian water milfoil growth.	Ongoing management plan that includes DOSH, benthic barriers, and hand-pulling.	E
7	Shadow Lake (Glover)	Water level fluctuation (seasonal drawdown) may alter aquatic habitat and aesthetics	Ongoing studies of dam	F
8	Lake Eligo	Locally abundant Eurasian water milfoil growth.	Ongoing management plan that includes DOSH, benthic barriers, and hand-pulling.	E
	Averill Creek Downstream from Dam on Great Averill Lake (5.4 Miles)	Artificial flow condition by hydroelectric facility creates poor flow regime	ANR, Coaticook, and other parties have reached a tentative settlement; Coaticook currently implementing conditions	F
	Averill Creek Downstream from Dam on Little Averill Lake (1 Mile)	Artificial flow condition by hydroelectric facility creates poor flow regime	ANR, Coaticook, and other parties have reached a tentative settlement; Coaticook currently implementing conditions	F
	Coaticook River Below Norton Pond Dam (3 Miles)	Artificial flow condition by hydroelectric facility creates poor flow regime	ANR, Coaticook, and other parties have reached a tentative settlement; Coaticook currently implementing conditions	F
	Unnamed Brooks, Tribs to Clyde River	Possible lack of minimum flow below water supply withdrawal point (Lightning Brook)	WSID #5105; Brighton	F

Nine rivers and streams including the Barton River, Mad Brook, Trout Brook, Black River Trib #1 & #2, Stony Brook, Clyde River Trib #1, Stearns Brook and Johns River have biomonitoring data that indicates fair or poor condition, but there is not enough data to fully evaluate the attainment of Aquatic Biota use, or monitoring results show volatile condition year to year.

B. Total Maximum Daily Loads (TMDLs)

For waters that are listed as impaired, the Federal Clean Water Act requires a plan that identifies the pollutant reductions a waterbody needs to undergo to meet Vermont's Water Quality Standards and it must identify ways to implement those reductions. A Total Maximum Daily Load (TMDL) is the calculated maximum amount of a pollutant that a waterbody can receive and still meet VWQS. 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 pollution reductions needed. TBPs are implementation plans guiding the execution of actions necessary to meet TMDL reduction targets specific to each planning basin.

TMDLs in the Basin include:

- 2003 TMDL for 30 Acid Impaired Lakes in Vermont
- Northeast Regional Mercury TMDL
- Lake Memphremagog Phosphorus TMDL

The Acid 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.

Lake Memphremagog Phosphorus TMDL

Figure 19. Cyanobacteria Bloom in Lake Memphremagog

Phosphorus levels in the Vermont portion of Lake Memphremagog average nearly 18 ug/l which is higher than the water quality criterion set for the lake of 14 ug/l. Elevated levels of phosphorus contribute to occasional cyanobacteria (also called Blue Green Algae) blooms but also support excessive plant and algae growth that occasionally limits the quality of the lake for recreational use. A Total Maximum Daily Load (TMDL) is required by the Clean Water Act to set a limit of phosphorus that can enter the lake from its watershed and still meet this criterion and the Lake Memphremagog phosphorus TMDL was approved by EPA in November 2017.

Lake Memphremagog is an international waterbody with over 73% of its surface area in Quebec, while 27% is in Vermont. Lake Memphremagog meets its phosphorus guideline in Quebec however, through the Quebec Vermont Steering Committee on Lake Memphremagog, collaborative efforts have supported modeling and efforts to reduce loading in both Vermont and Quebec. In addition to this, in 2017 the International Joint Commission was asked to examine nutrient loading in Lake Memphremagog and recommend ways to reduce loading within the watershed. A report titled Nutrient Loading and Impacts in Lake Champlain – Missisquoi Bay and Lake Memphremagog was completed in April of 2020 with several recommendations on how to coordinate nutrient reduction efforts in both Vermont and Quebec (International Joint Commission, 2020).

A land use phosphorus export model was developed for the watershed to estimate phosphorus loading from each land use sector. The model estimates that much of the load is coming from agricultural lands (46%). Developed land (including 2.5% from septic) contribute 22%, with an additional 20.5% from stream channel instability and 12% from other sources.

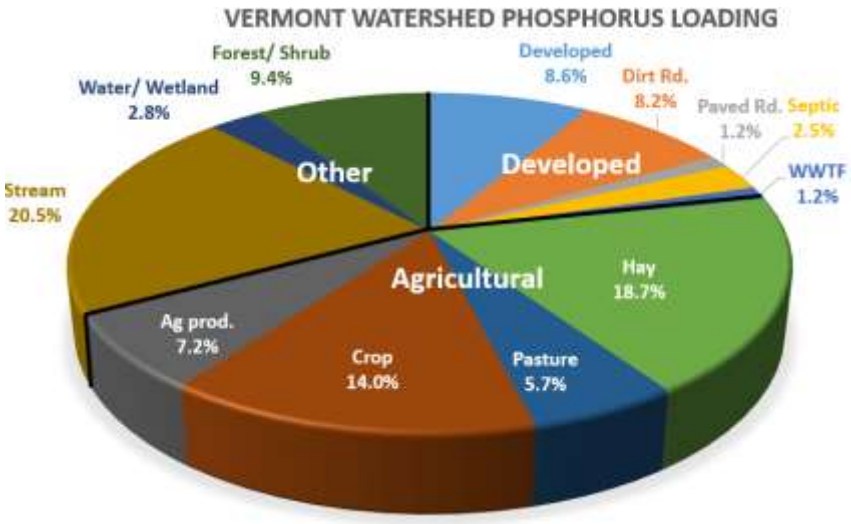


Figure 20. Estimated phosphorus loading from different land use sectors from the Vermont portion of the Lake Memphremagog watershed.

Wastewater treatment facilities contribute 1.2% of the total load. A breakdown of loads from various sectors is shown in Figure 20 and modeling details can be found in a modeling documentation report (DEC, 2017).

The land use export model accounted for phosphorus retention in upland lakes, which for some sub-basins was estimated to be as much as 90% as water flowed through a series of large lakes in portions of the Clyde River watershed, or as much as 80% for portions of the Upper Barton River watershed when factoring in retention in South Bay.

A lake model was developed using in-lake and tributary monitoring data to translate the watershed loading into resulting in-lake phosphorus concentrations. The lake was broken down into eight segments to describe the lake's unique characteristics of which South Bay and the Vermont Lake segments are in Vermont. Exchange between these segments, and the loss of phosphorus from each segment to lake-bottom sediments was also estimated, with a particularly large retention estimated for South Bay of 54%.

After calibration, this model suggests that a 21% phosphorus load reduction for the Vermont portions of the Lake Memphremagog watershed is necessary to bring phosphorus concentrations in Vermont waters to 14 ug/l. This percent reduction represents the overall loading reduction needed, but the TMDL allocations determine how much reduction is necessary from each sector, and also include a margin of safety of 8%, which increases the total load reduction required to 29%, to ensure attainment of the water quality standard in Lake Memphremagog (DEC, 2017).

Setting the Phosphorus Load Reduction Approach

Load reduction options were evaluated using the Lake Memphremagog scenario tool, which estimates the load reduction achieved by applying a combination of Best Management Practices (BMPs) across a percentage of a land use which is shown in detail in the TMDL.

Through the implementation of this BMP scenario is it possible to meet the phosphorus TMDL load allocations through reductions in loading of:

Table 11. Phosphorus Loading Summary (Source Load)

Source	Category	Allocation category	Total Load (kg/yr)	Total annual reduction goal (kg/yr)	% Reduction required for basin
Agriculture	Fields/pastures	Load	23,019	10,557	45.9%
	Barnyard Production Areas	Wasteload	4,504	2,883	64.0%
Developed Lands (Stormwater & Roads)	VTrans owned roads and developed lands	Wasteload	13,454	2,829	20.3%
	Roads MRGP				
	3-Acre General Permit				
Wastewater	WWTF discharges *	Wasteload	3,114	2,080	33.2%
Rivers	All streams	Load	10,761	2,487	23.1%
Forests	All lands**	Load	6,543	327	5.00%
		Total	***60,739***	***19,800***	***32.6%***

*This is the permitted load. The base load was 648 during the TMDL modeling timeframe.
**The TMDL also included loading from shrub, wetlands and water totaling 1880 kg from which no load reductions were included.

The key components of the scenario tool are 228 BMP's where phosphorus reduction efficiencies were estimated through modeling in the Lake Champlain watershed, based on EPA's published technical analyses (Tetra Tech 2015). Many of the practices contemplated are required through regulations passed with the Clean Water Act, Act 64 described in Table 14.

The Lake Memphremagog phosphorus TMDL includes one example of a BMP scenario that will achieve necessary load reductions, however the specific mix of BMPs that will be implemented over the next 15 years will ultimately reflect the specific practices that will be required by regulations, those that have landowner support and at the local level have been identified to have the highest potential to reduce phosphorus loading. Through the five-year iterative monitoring assessment and planning cycle, new information will be learned that will help to inform which BMPs will most efficiently meet target phosphorus load reductions and will allow for adjustments if loading reductions are not being met. This tactical basin plan identifies BMPs that will maximize phosphorus load reductions over the next five years, however further assessments will be completed which will allow the identification and prioritization of additional projects that will become a priority for the next five-year planning cycle. This adaptive management approach ensures that the practice requirements implemented by landowners, municipalities, and other entities will be as cost-effective as possible and allows for adjustments to be made to respond to changes in rainfall patterns expected with climate change along with other uncertainties. The load reductions achieved through these practices will be tracked through the BMP Accounting and Tracking Tool, a component of the Watershed Projects Database.

The proposed sector by sector approaches to reducing phosphorus loading to Lake Memphremagog are described in the following chapter with summary implementation strategies listed in Chapter 5, and a detailed list of potential projects listed in the watershed projects database. Phosphorus load reductions achieved though project implementation will be tracked so progress in meeting TMDL loading reduction targets can be evaluated at the beginning of the next five-year planning cycle with a goal of meeting load reduction targets and in-lake water quality standards in 20 years.

Measuring Progress Toward TMDL Targets

The Clean Water Initiative Program (CWIP) developed tracking and accounting methods to measure progress toward meeting the TMDL. CWIP also produces the annual Vermont Clean Water Initiative Performance Report (ANR, 2023) to document progress made toward statewide pollution reduction goals. A report card to document progress on the implementation table in Chapter 5 will be included in the next Basin 17 TBP. This section of the TBP reports on the progress made in meeting the annual reduction needed to reach the load allocation for this Basin.

Table 12 provides tracked progress for each sector from 2017 to 2022. The annual reductions have generally increased each year for each sector. This upward trend can be more clearly observed in Figure 21. Each year in the bar chart (Figure 21 shows the percent of the final target total TMDL reduction due in 2037) achieved. The totals are not cumulative, and the same volume of reduction must be achieved each year to maintain the 2037 target. Within the first six years, the agriculture sector is meeting 16.7% of their final targets and the developed lands sector is meeting 5.9% of their final target. The substantial reductions seen in phosphorus load in the agricultural sector in contrast to the minimal reductions seen in the others may be due to earlier regulatory compliance dates and focused efforts by partners, and limitations in tracking and accounting methodologies for many of the lake, river and forest practices. New phosphorus reduction acounting methodologies have been developed with the interim phosphorus calculator tool and are in development for the forest sector.

Table 12. Estimated Total Phosphorus Reductions by sector

Sector	Kg of TP Reduced Annually (by state fiscal year)						
	2016	2017	2018	2019	2020	2021	2022
Field/Pastures	144	433	738	1524	1569	1513	1632
Barnyard Production Areas	0	9	220	318	519	590	606
Stormwater	-	0	23	36	36	36	36
Road	-	-	4	19	46	70	124
Lake/River	1	8	15	22	23	24	24
Forest	-	-	-	-	-	-	-
Total	145	450	1000	1919	2193	2233	2422

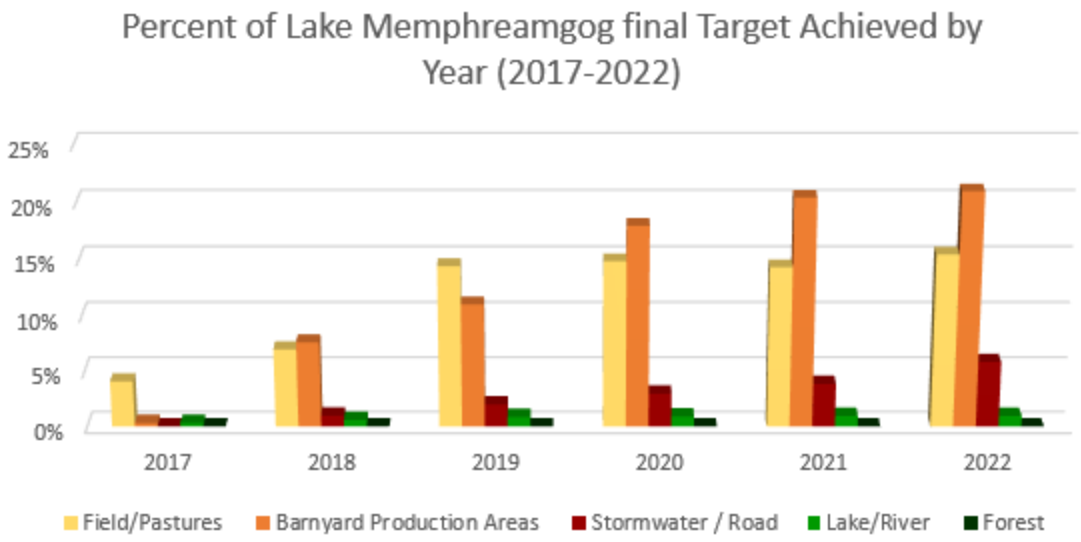


Figure 21. Percent of TMDL Final Phosphorus Target Achieved by Sector by Year

Table 13. Interim and Final Phosphorus TMDL Reduction Targets by Sector

Sector	2027 Target (kg)	Final Target (kg)
Fields/Pastures	2975	8925
Barnyard Production Areas	759	2277
Stormwater /roads	856	2569
Rivers	821	2463
Forests	109	327

The five-year targets for 2023-2027 are suggested in Table 13 for each sector as they relate to achieving the TMDL. The five-year target setting for each sector is obtained by subtracting the current-year reduction estimates from the overall TMDL goal and dividing it into five-year increments. The next Lake Memphremagog Tactical Basin Plan will report progress made on target attainment and address any challenges or gaps in achieving those targets.

Commitment and Strategy to Meet Targets

To meet TMDL targets, Vermont has implemented both regulatory and non-regulatory initiatives. These include the creation of the State's engagement strategy to develop, maintain, and enhance the Agency's partnerships; support for those partnerships, support for project prioritization, funding, and implementation; and advanced accounting methods for each sector to obtain an accurate reflection of phosphorus reduction through land use practices.

State Programs to Meet Regulatory Targets

Regulatory programs play a significant role in ensuring that pollutants and stressors responsible for degraded water quality are addressed. Table 14 describes the regulatory processes that support the attainment of annual TMDL reduction targets in each sector. These regulatory programs are also described in further detail in Chapter 4 along with information on priority sub-basins and towns for outreach, technical and funding support, and implementation.

Table 14. Regulatory Programs for Phosphorus Reduction

Source Sector*	Permit Program	Reporting Scale	Efficiency	TP Loading Scale	Implementation Timeline Information
Agriculture	Required Agricultural Practices (RAPs) / Large Farm Operation (LFO) & Medium Farm Operation (MFO) Rules and Permits	HUC12	SOP (to be developed in November 2021)	Implemented and tracked at HUC12 scale	Estimates completed at HUC12 scale per farm size inspection cycle. Certified Small Farm Operations (CSFOs) at least once every 7 years, MFOs at least once every 3 years, and LFOs annually.
Stormwater	Operational 3-acre Permit	HUC12	35% reduction	Can estimate once 3-acre GIS layer is finalized	Stormwater Program has list of when each parcel is due for permitting; once issued, site will have five-year period to implement.
Roads	Municipal Roads General Permit (MRGP)	Town, but have access to GIS road segments; should be possible to aggregate at HUC12 scale	SOP	Stormwater Program will provide estimate of total expected reduction Q1 2021	Towns must report road erosion inventories (REI) by 12/31/2020; all work to be completed by 12/31/2036; reduction timeline likely to be somewhat frontloaded due to focus on priority road segments.
	Transportation Separate Storm Sewer System (TS4) Permit	Lake Segment	TBD	TBD	Stormwater Program is currently reviewing Vtrans application for the new TS4 permit.
Forests	Acceptable Management Practices (AMPs)	HUC12	TBD/RFP	Completed at HUC12 scale	Assumes that lake segments with 5% forest reduction will be achieved via increased AMP compliance.

*While no river state regulatory programs have been promulgated to achieve TMDL targets, municipal River Corridor Bylaw adoption is encouraged for target towns in Chapter 4 and Chapter 5.

Act 76 Framework to Meet Non-Regulatory Targets

The Vermont Clean Water Service Delivery Act (Act 76) provides funding and a project delivery framework to achieve Vermont's clean water and TMDL goals by the Act:

- providing long-term funding through general fund revenue:
- supporting non-regulatory projects such as conservation easements, wetland and floodplain restoration, and riparian tree and shrub plantings;
- establishing Basin Water Quality Councils (BWQCs) led by regional Clean Water Service Providers (CWSPs) to identify, implement, operate, and maintain non-regulatory projects to meet TMDL reduction targets; and
- distributing funds for non-regulatory projects based on interim phosphorus reduction targets and a standard cost per unit phosphorus reduced, consistent with "pay for performance" models.

The CWSP for the Lake Memphremagog watershed is the Vermont Housing and Conservation board which has been provided a formula grant for FY 2023 for $643,644 to achieve a target phosphorus reduction of 44.2 kg through the identification, development, design and implementation of clean water projects. Additional funding and phosphorus reduction targets will be provided each year of the CWSP assignment through June 30, 2028 and as of the release of this Plan, the Clean Water Board has recommended an increased funding level of $700,000 for SFY 2024. VHCB will be developing an operation and maintenance program to ensure functioning of installed phosphorus reduction projects.

Engagement Strategy

The collaborative approach taken to engage stakeholders and communities in clean water planning and implementation efforts is crucial to the development and future implementation of the Lake Memphremagog Phosphorus TMDL. This approach focuses on water quality improvements through projects at the local level, with the state as a committed partner in the effort. Vermont's engagement strategy for ongoing as well as new approaches, includes:

1. Multi-partner collaboration across sectors and localities to assist with developing, writing, and implementing TBPs;

2. Strategic inclusion and engagement with different sectors and localities throughout the basin planning process to ensure that all concerns, needs, and goals are addressed throughout the planning process;

3. Strategic communication efforts (e.g., social media, newsletters, training videos) to ensure understanding of and support for the plan among key stakeholders as well as throughout the watershed, including from underserved and disadvantaged communities;

4. Assessing gaps to address financial and technical assistance needs and developing systems to expand capacity in our stakeholder networks; and

5. Adaptive management in tracking our progress and iterative process improvement.

As a function of Act 76 program delivery, DEC's statutory partners are now serving as CWSPs as well as members of recently established BWQCs. These groups will be enhancing community outreach and engagement for clean water project delivery efforts. These efforts will continue to promote widespread and improved understanding of the requirements for TMDL implementation efforts, support diverse and sustained collaboration, and help in building new partnerships. As a result, the TMDL implementation efforts will continue to enhance shared ownership and be well informed by those working on the ground, which will enhance reasonable assurance that Vermont will achieve improvements in local water quality and the Memphremagog TMDL reduction targets.

TBP partners can take advantage of training developed for Clean Water Service Providers and Basin Water Quality Councils through the WID Engagement and Training website.

Chapter 4 – Strategies to Address Pollution by Sector

ANR's approach to remediation of degraded surface waters and protection of high-quality waters includes the use of both regulatory and non-regulatory tools with associated technical and financial assistance to incentivize implementation. Tactical basin plans address water quality by land use sector (Figure 22). The following sections provide specifics about protection and restoration efforts underway or recommended for each source sector to meet water quality objectives. These recommendations support the development of the strategies in the Chapter 5 Implementation Table.

Figure 22. Land Use Sector Framework with practices used to enhance, maintain, protect, and restore water quality

A. Agriculture

Agricultural land use makes up approximately 14 percent of Basin 17. However, for the Lake Memphremagog watershed, which does not include the Tomifobia and Coaticook watersheds, agricultural land use makes up 17 percent of the land cover in the watershed of which two percent is cultivated crop, four percent is pasture, and 11 percent in hay land. The headwaters and lower section of the Black River, the Barton River except for headwaters, the lower Clyde and Tomifobia rivers HUC 12 watersheds have the most intensive agricultural land use (Figure 23). Runoff from agricultural lands is the largest phosphorus contributor to Lake Memphremagog estimated at 46% of the loading to the lake, and runoff from agricultural lands has been identified as a contributor to the agricultural-impaired tributary to Stearns Brook, Roaring Brook, Mud Pond, and Walker Pond.

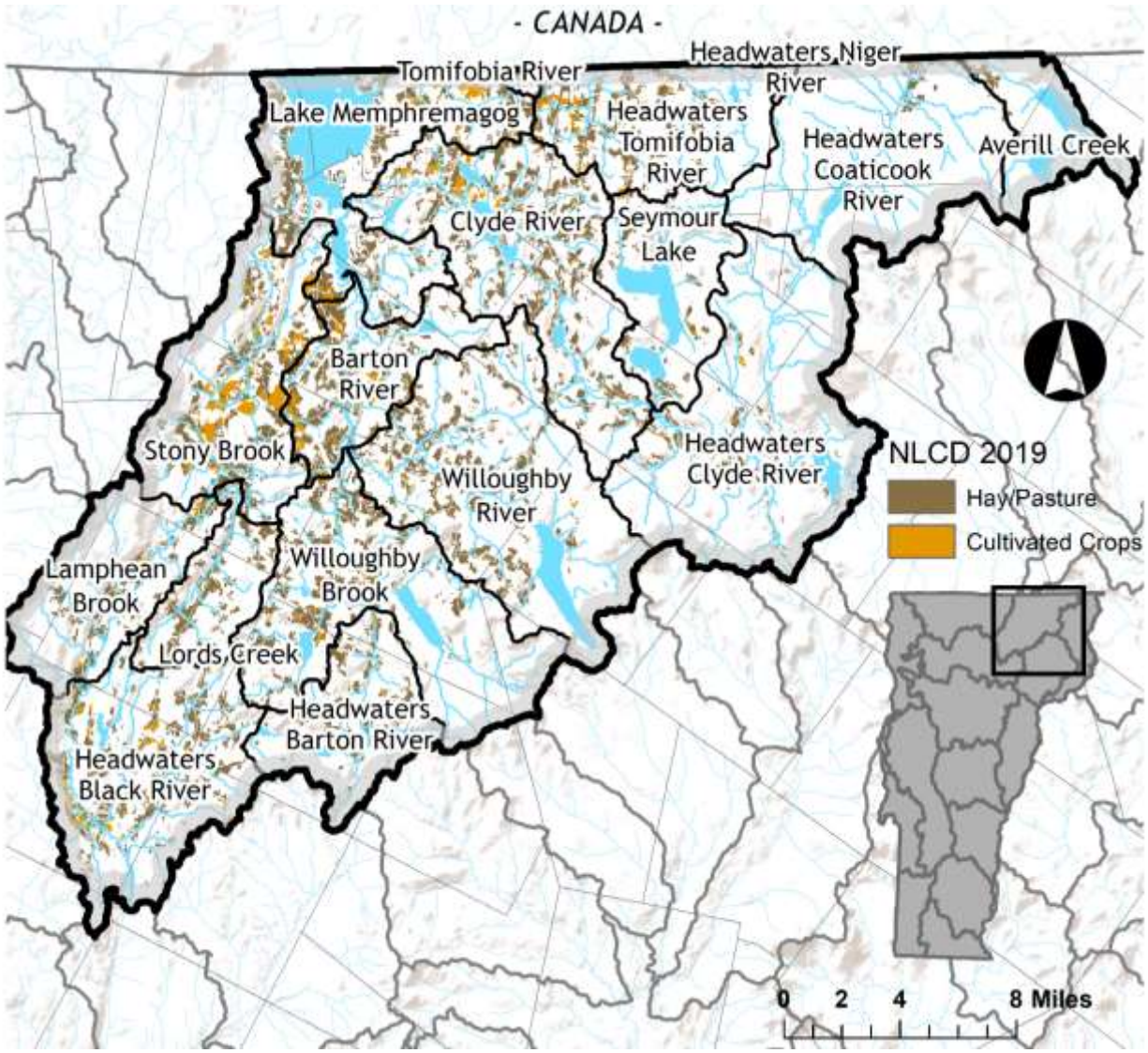


Figure 23 Agricultural land use in Basin 17

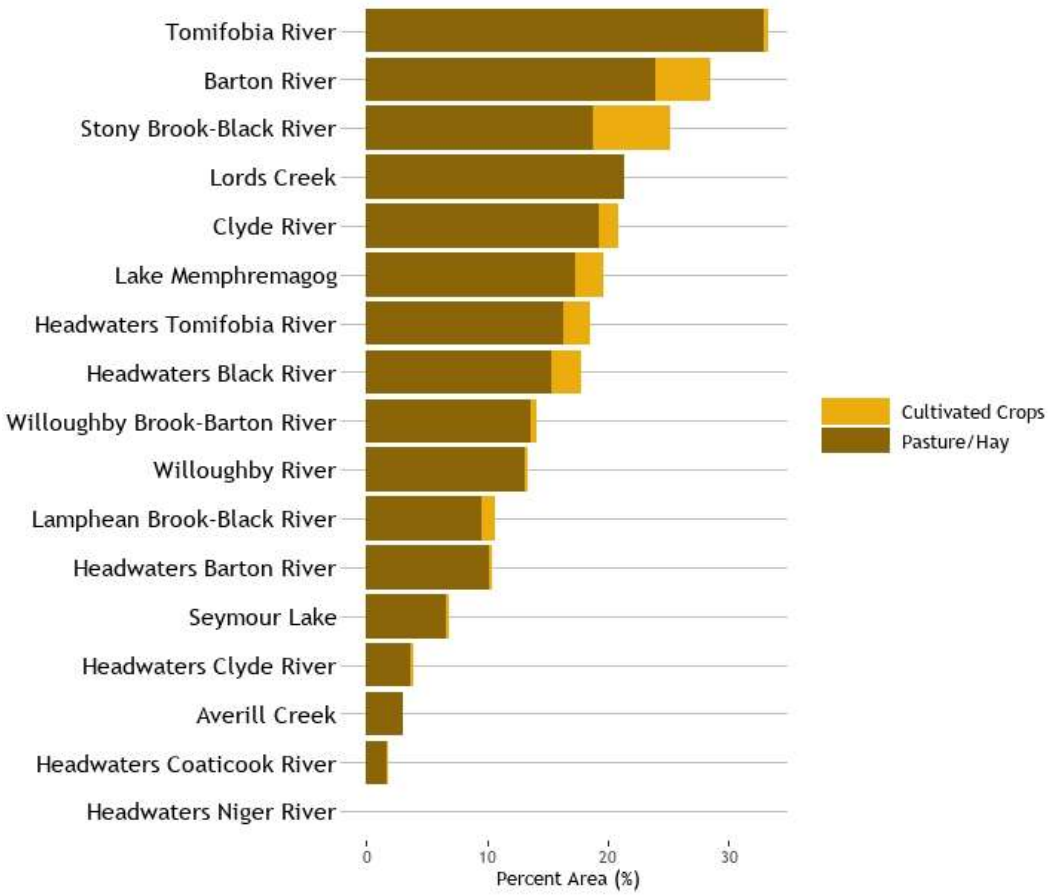


Figure 24 Agricultural land use in the Lake Memphremagog watershed by HUC 12 watershed

In addition to this, runoff from agricultural lands, may contribute to increasing nutrient trends on Lake Willoughby, Shadow Lake, Lake Parker, Echo Lake, Seymour Lake and Lake Salem, although increased developed land acreage in these watersheds and impacts from climate change are likely primary drivers for these trends.

Memphremagog TMDL Agricultural phosphorus reduction targets and progress

The lake Memphremagog TMDL includes a 46% reduction target across agricultural fields (10,557 kg/yr) and a 64% reduction from farmstead areas (2,433 kg/yr). Phosphorus loading from agricultural sources is currently being addressed by several state agencies, regulatory programs, and partner groups. These efforts include BMP implementation to reduce pollution, as well as the tracking and accounting of expected phosphorus reductions from management actions. Results from tracking and accounting efforts are used to measure progress in meeting state and federal phosphorus reduction goals. Examples of mitigation, tracking, and accounting efforts in the agricultural sector include:

- The AAFM Required Agricultural Practices (RAPs) Rule and AAFM Water Quality grant programs are designed to minimize agricultural impacts on water quality. These regulatory requirements and grant programs available to farms are expected to greatly reduce

phosphorus loading from agricultural sources. Tracking and accounting efforts are being recorded in a multi-partner planning database (Partner Database).

- Act 76 reserves 10% of agricultural phosphorus loading for mitigation by CWSPs. Act 76 also includes provisions for CWSPs to address phosphorus reduction targets not met by existing regulatory programs.

- The CWIP coordinates the funding, tracking, and reporting of clean water efforts for federal and state partners, including AAFM, agricultural technical service providers (including UVM Extension and NRCDs), and CWSPs. Tracking and accounting methods as well as standard operating procedures (SOPs) for phosphorus reduction estimation are described on the clean water project tracking and accounting website.

To date 16.7 percent of the required TMDL phosphorus reductions from agricultural lands have been tracked across the Lake Memphremagog watershed. This progress can be viewed in an online report and is shown in Figure 25. Most of these reductions have been in the headwaters of the Black River watershed with an estimated 90% of cropland with cover crops. On the other hand, the lower Black River, Lower and middle Barton River and Willoughby River, Lower Clyde River watersheds (highlighted in Figure 26) have less than 35% of croplands with cover crop and limited coverage of other practices. Significant progress in meeting TMDL targets can be made by increasing the levels of cover crop, conservation tillage, and crop rotation on croplands in these subwatersheds which will require outreach to large farms that manage much of the cropland in these subwatersheds. Information on the specific practices implemented by acreage and associated phosphorus reductions are available in this online report.

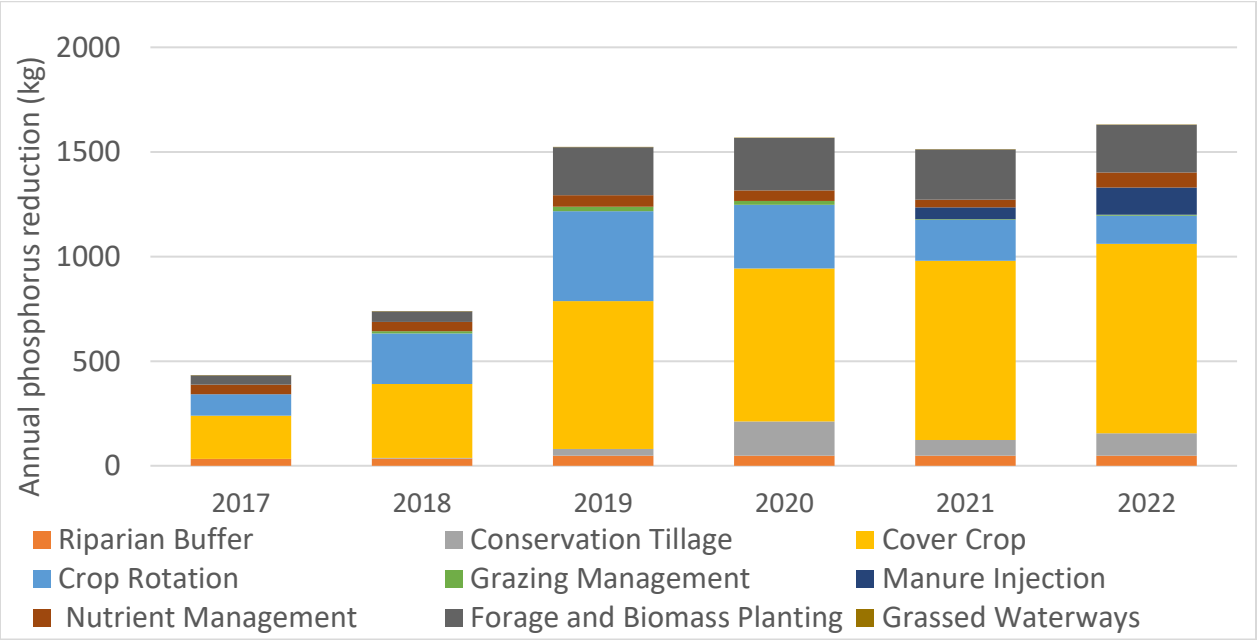


Figure 25. Phosphorus reductions from Field BMPs installed by State Fiscal Year

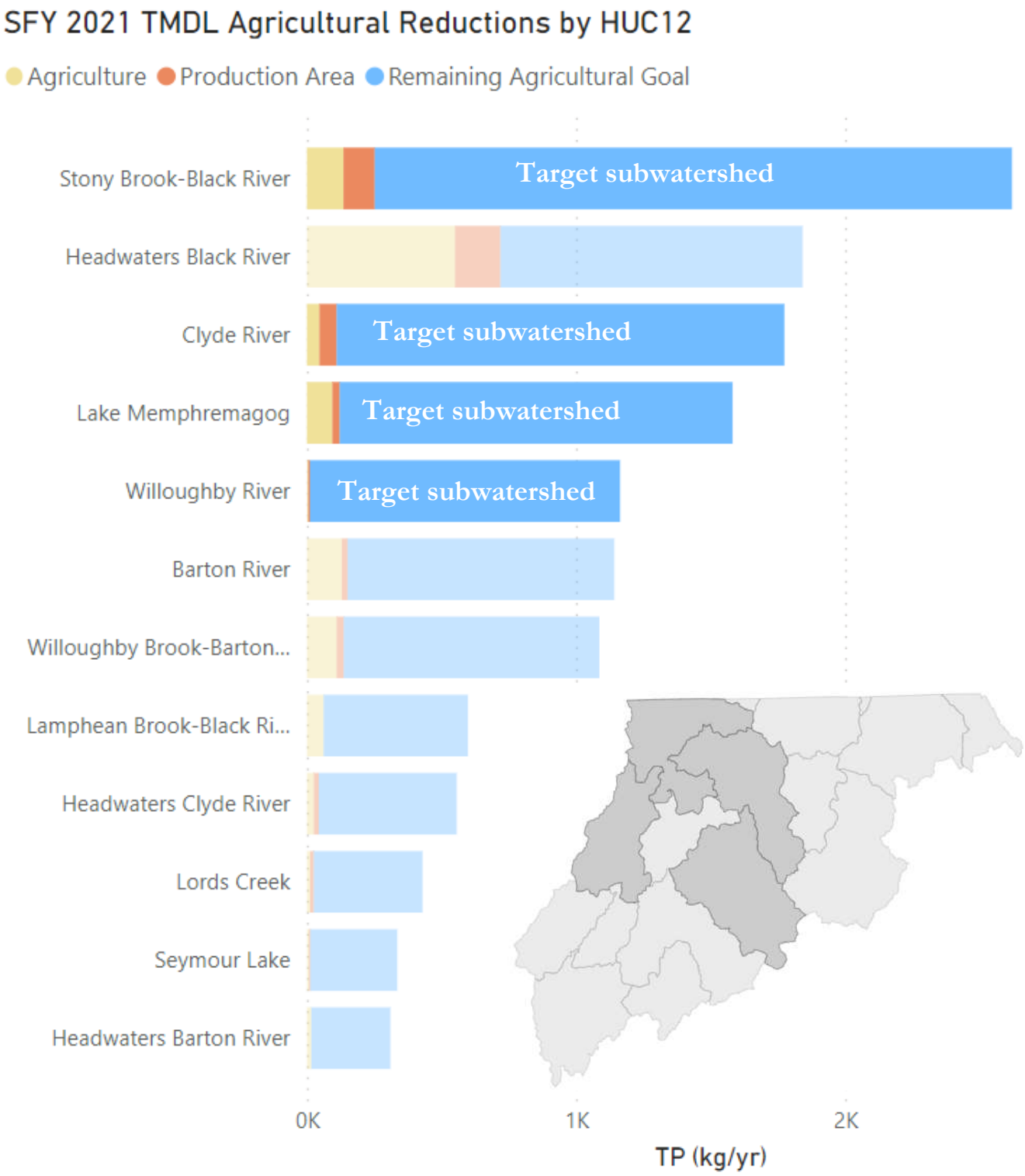


Figure 26. Agricultural phosphorus reductions as compared to TMDL targets in the lake Memphremagog watershed. Four "target watersheds" are a focus of implementation in this Basin Plan cycle.

In addition to the practices mentioned above, many fields will need multiple practices or additional edge of field or infield treatment practices such as riparian buffers, grassed water ways or water and sediment control basins (WASCOBS) to meet the 53% reduction target for croplands in the Lake Memphremagog watershed as was used in the TMDL scenario. In addition to this, the TMDL scenario included a 43% phosphorus reduction target for hay lands. Practices such as riparian buffers and manure injection are available for hay land currently, however innovative practices such as increasing cropping lengths and timing or adjusting timing of manure applications may be needed to meet phosphorus reduction goals. There is also limited data on conservation practices implemented on pasture lands, where practices such as fencing and intensive grazing management can improve water quality and soil health. Targeted efforts to track grazing practices in the watershed and implement where not in place will be important to meeting phosphorus reduction goals.

Compared to the field-based practice implementation and phosphorus reductions, there has been greater progress in meeting the production area reduction targets achieving 21 percent of the reductions required in the TMDL.

Regulatory programs

Vermont Agency of Agriculture, Food, and Markets (AAFM) regulatory programs work towards protecting surface waters by requiring 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.

There are currently four permitted Large Farm Operations (LFOs) in the Basin and 11 permitted Medium Farm Operations (MFOs). LFO's are inspected annually and MFOs are inspected once every three years by AAFM. These farms must comply with the Required Agricultural Practices (RAPs), LFO Rule and MFO permitting program requirements as applicable, and VWQS.

There are an estimated 45 Certified Small Farm Operations (CSFOs) in the Basin that are required to certify annually with the Agency and that will be inspected at least once every seven years, and need to comply with the RAPs.

The AAFM estimates there are 43 Small Farm Operations (SFOs) in the Basin that do not meet the thresholds of a CSFO and are not required to receive a routine inspection by AAFM, but still need to comply with the RAPs. Outreach will continue to help landowners understand where they fall within the RAP farm categories and the RAP requirements.

AAFM regulatory programs support farmers to ensure their clear understanding of the RAPs and program rules, while helping assess, plan, and implement any 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. As a result of regulatory farm inspections and technical assistance provided to farms in the Lake Memphremagog watershed, in SFY 2022 approximately 58% of farm facilities inspected were compliant with the RAPs. This is lower than the Statewide compliance rate in SFY 2022, in which approximately 70% of farm facilities inspected statewide were compliant with the RAPs. Information regarding farm inspections, compliance, and enforcement actions can be reviewed on AAFM's Water Quality Interactive Data Report.

Availability of technical and financial assistance throughout the Basin is provided by the Orleans County and Essex 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 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. These agricultural assistance and outreach programs are essential tools in promoting field and farmstead BMPs that protect water quality, improve soil health and increase farm viability.

AAFM and partners provide educational opportunities and technical assistsnace to farmers to promote and assist with conservation practice adoption. Between 2018-2022, AAFM and the Agricultural Clean Water Initative Program (AgCWIP) supported 27 education events in the Lake Memphremagog Basin, with 555 attendees. In Orleans country, which overlaps the Memphremagog watershed, approximately 258 on-farm technical assistance visits were conducted and tracked in the Partner Database by UVM Extension, Conservation Districts, and AAFM.

Memphremagog Regional Conservation Partnership Program

The Orleans County NRCD has an $850,000 regional conservation partnership program (RCPP) grant from NRCS to support the Memphremagog Long Term Water Quality Partnership to provide technical and financial assistance to farmers to implement water quality improvement practices. This funding supports the implementation of non-structural farmstead practices and field-based practices on all size farms in the watershed with water quality monitoring data results used to track the success of conservation plans. In addition to the NRCS funding, partners have committed to provide $950k for approved conservation practices for the purpose of addressing resource concerns that address water and soil quality including concentrated erosion, field sediment, nutrient and pathogen loss, and soil quality limitations.

The RCPP has focused outreach and technical assistance in coordination with the LaRosa Partnership water quality monitoring efforts which have identified phosphorus source areas and evaluated the effectiveness of BMP implementation efforts. This includes fourteen drainages where

best management practices have been evaluated before and after BMP implementation; nine of these have shown statically significant phosphorus reductions after BMP's were installed with an average reduction in phosphorus concentrations across these nine drainages of 63%. Several of the drainages where improvements have not been seen are areas of continued focus to address nutrient source areas. This program has been successful in supporting several small and medium sized farms implement BMPs and has shifted focus to support for some of the larger farms in the watershed that manage a large percentage of cropland in the Basin. With the expected increase in federal funding for installing BMPs there will be a need to increase local capacity to provide the outreach and technical support to farmers to support the use of these funds in a way that can maximize water quality benifits.

Agricultural Conservation Planning Framework (ACPF) toolbox

The Agricultural Conservation Planning Framework (ACPF) has been piloted in the Black River watershed in the Lake Memphremagog watershed. This tool identifies high risk areas for generation of phosphorus and sediment runoff and identified possible practices that may address these source areas. The outputs of this tool need to be evaluated in the field in coordination with resource professionals and local farmers to determine if the target areas are pollution source areas and to determine if practices in these locations are feasible and supported by the farmer. A strategy in this plan is to evaluate the high-risk areas flagged by the ACPF working with a supportive farmer to determine if this tool has wider application in the watershed and to evaluate practices that may be more viable in Vermont vs the Midwest where this tool was developed.

Formula grant funding for small scale practices on Non-RAP farms

Formula grants can fund agricultural practices on non-RAP farms in the watershed. These farms are very small in scale but there may be significant phosphorus loading if best management practices are not in place and costs for practices to reduce phosphorus loading may be lower than stormwater treatment type practices. Identification of these smaller farms that may need BMPs to address water quality issues is needed along with capacity to complete outreach to these smaller farms and the development of practices and a way to support operations and maintenance required for formula grant funding are all needed to support this work in the Lake Memphremagog watershed.

Farmer outreach

In September of 2022, the Orleans County Conservation District hosted an agriculture community meeting at Cornerstone Dairy in Irasburg. Topics covered included the effects of changing climate on Vermont's agriculture; carbon markets available in Orleans County; and progress in water quality. The meeting also had general information on related funding programs and worked through an eight-question survey and discussion with the audience of 14 farmers including all Orleans County LFOs. The results to the question about practices that are of most interest and most feasible to implement were: harvestable buffers, improved drainages with sediment retention and velocity control practices and support to spread manure on fields with low soil test phosphorus. Farmers

also indicated that cost-share rates for conservation practices are not high enough to justify the cost, and the risk and production loss and that the paperwork and process for accessing grants were significant barriers to BMP implementation. These results are being considered by OCNRCD for program development and helped to guide the strategies in the implementation table.

B. Developed Lands

Stormwater runoff from developed lands, including the road network, is a significant threat to water quality in Vermont. Stormwater runoff is any form of precipitation that flows over the land during or after a storm event or snowmelt. On undeveloped lands, such as forests and meadows, a portion of this runoff is absorbed into the ground through infiltration while 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 increase the velocity and volume of runoff into rivers and lakes. Along this route stormwater picks up and carries pollutants to the waterbodies it enters. This leads to an increased frequency and intensity of flooding as well as a greater likelihood that runoff will become contaminated with pollutants. The result is increased erosion and property damage, degraded aquatic and terrestrial habitats, and threats to public health via recreation sports and contaminated drinking water.

Developed lands make up about five percent of the land cover in Basin 17. Phosphorus loading from developed lands account for approximately 22% of all phosphorus loading from the basin to Lake Memphremagog. Developed lands include the general land use classes of urban, residential, and industrial areas, as well as paved and unpaved roads. The TMDL phosphorus reduction goals for developed lands are broken down by these general land use classes. In the basin, non-road developed lands will have a reduction target of 521 kg, paved roads have a reduction target of 60 kg, and unpaved roads have a target of 2150 kg to meet the TMDL. These developed lands targets represent percent reductions over the modeled baseline phosphorus loading estimates. The annual reduction achieved for 2022 was 160 kg which is 6% of the final target. Based on current year data, an annual increase in phosphorus reductions of 171 kg of phosphorus from developed lands is required from 2021 to 2037 to meet the TMDL goal. However, the rate of phosphorus reductions tied to the MRGP have been increasing each year by an average 11 kg per year since 2018 (an increase of 54kg between 2021 and 2022) so if this trend continues it will help to fill the gap in reductions for the developed lands sector in addition to the reductions expected through the 3-acre permit and through formula grants.

Stormwater

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 Best Management Practices (BMPs) to meet the state's clean water goals and TMDL targets. Basin stakeholders have been actively participating in voluntary actions and implementing priority projects and municipalities are working on meeting regulatory requirements and are working to remediate identified discharges.

Stormwater mapping, Indirect Discharge Detection and Elimination (IDDE) studies and Stormwater Master Plans (SWMPs) are the tools used to identify stormwater actions needed to address stormwater-related water resource impairments.

Regulatory requirements ensure proper design and construction of stormwater treatment and control practices as well as construction-related erosion prevention and sediment control practices, necessary to minimize the adverse impacts of stormwater runoff to surface waters throughout Vermont. Stormwater permits for developed lands in this basin include:

- Operational Stormwater Permits
- Construction Stormwater Discharge Permits
- Multi-Sector General Permit (MSGP)(Industrial)

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

General Permit 3-9050 addresses runoff from impervious surfaces. This permit covers all operational stormwater permitting, including new development, redevelopment, and permit renewal. It serves as the statutorily required "Three-Acre General Permit" under the Vermont Clean Water Act. Parcels in the Lake Memphremagog watershed will need to apply for permit coverage by 2023. There are 67 three-acre-sites within Basin 17, covering approximately 523 impervious acres. Of these, 20 three-acre-sites are in Newport City, 19 in Derby, 5 in Barton, 4 each in Brighton and Coventry, 3 in Irasburg, 2 each in Brownington, Newport Town and Craftsbury, and 1 each in Albany, Sutton, Westmore, and Warren's Gore. The Agency is presently making available grant funding in the form of rebates for individual landowners, while municipalities can access Clean Water funding and/or subsidized loans from the Clean Water State Revolving Loan Fund. Program development for SFY 2022-2025 will be supported by an infusion of American Rescue Plan Act (ARPA) funds. Two programs developed to address these sites are the Public Private Partnership project and grant incentive and the Green Schools Initiative.

As of July 1, 2022, projects that expand or redevelop one half-acre (0.5 acres) or more of impervious surface are required to apply for stormwater operational permit coverage. Additional information on the ½ acre threshold can be found on the stormwater program website.

Illicit Discharge Detection & Elimination Studies

Illicit discharges are discharges of wastewater or industrial process water into a stormwater-only drainage system. All towns in the Basin with stormwater systems have completed IDDE reports or except for the town of Coventry where one is planned (see map). The outcomes of these studies are listed in four reports:

- Detecting and Eliminating Illicit Discharges to Improve Water Quality in the Lake Memphremagog Basin (Barton, Orleans, Brighton, Newport City, Derby, Derby Line and Derby Village)
- Lake Memphremagog Basin Additional Advanced Investigations (Newport City, Barton, Orleans)
- Statewide Contract No 2 Illicit Discharge Detection and Elimination Study: Final Report (Albany, Craftsbury, Irasburg)
- Statewide Contract No 3 Illicit Discharge Detection and Elimination Study: Final Report (Barton, Charleston, Derby, Newport City)

Most of these illicit discharges have been identified and eliminated. Where sources were difficult to locate, compliance was difficult, or the infrastructure was no longer in use follow-up actions are identified in the reports. This plan recommends the completion of IDDE study for the town of Coventry and follow-up on recommended actions from previous studies, and the elimination of discharges identified by new studies.

Green Schools Block Grant

DEC is funding a Green Schools Block Grant to have stormwater design and permitting work completed on behalf of schools in the Lake Memphremagog basin. Public schools and colleges in the Lake Memphremagog basin that are required to obtain three-acre general permit coverage (3-9050) will be able to sign up to receive technical and financial assistance for stormwater design and permit obtainment. The three-acre schools Basin 17 include Lake Region High School, North Country Union High School, and the North Country Career Center.

The Memphremagog Watershed Association has begun developing green stormwater projects for schools in the Basin that are not eligible for the Green Schools Block Grant. Through Project Development and Design-Implementation Block Grants, MWA has worked with local municipalities and school districts to identify opportunities to implement green stormwater retrofits on elementary school campuses in Glover and Albany.

Stormwater Mapping and Master Planning

Stormwater infrastructure mapping projects are completed for municipalities by the Clean Water Initiative Program to supplement any existing drainage data collected by towns and with the intention of providing a tool for planning, maintenance, and inspection of the stormwater

infrastructure. Town reports can be found by clicking on the town on the left side of the municipal stormwater website.

The reports and maps from each town are meant to provide an overall picture and understanding of the connectivity of the storm drainage systems on both public and private properties to raise the awareness of the need for regular maintenance and to identify potential stormwater retrofit opportunities. These reports identify potential priority projects and provide information necessary to develop a stormwater master plan.

Projects identified as high priority in the stormwater mapping reports and master plans may be implemented by towns with the aid of watershed partners. All towns in the Basin with significant development adjacent to surface waters were part of basin wide stormwater master plan or stormwater planning efforts in the town of Brighton. The priority projects in those plans should be pursued. In the town of Brighton, two priority stormwater projects have been implemented. Other priority projects from the basin wide SWMP include:

- Newport City Turn out project final design completed (town support for implementation and funding needed)
- Newport City Marina treatment project with implementation planned in 2023.
- Barton Village stormwater treatment practice, to be designed in 2023
- Glover town office and elementary school GSI retrofit project, to be designed in 2023

There are another fifteen stormwater projects that were identified in the SWMP and through riparian lands assessments and are listed as proposed for design in the watershed project database. These include many smaller stormwater treatment projects for downtown village areas, large impervious lots, and town office buildings. These projects are a priority for continued project development, design and, where feasible, implementation efforts.

A gully erosion assessment undertaken by the Memphremagog Watershed Association identified 42 erosive gullies in the watershed. Of these, eight were related to stormwater outfalls where improved stormwater treatment along with gully stabilization may reduce significant sediment sources to surface waters in the basin. Many of these sites are related to roads and ditches that fall under the MRGP. As such, funding opportunities for design and implementation may include Block Grants, Formula Grants, and Better Roads grants.

Vermont Green Infrastructure Toolkit

Many of the stormwater issues associated with developed lands can be prevented or mitigated using Low Impact Development (LID) and Green Stormwater Infrastructure (GSI) systems and practices. These concepts strive to manage stormwater and pollutants by restoring and maintaining the natural hydrology of a watershed. Rather than funneling stormwater off site through pipes and infrastructure, these systems (gardens or permeable materials) focus on infiltration,

evapotranspiration, and storage as close to the source as possible to capture runoff before it gets to surface waters.

The Vermont Green Infrastructure Toolkit is a project of the ten Regional Planning Commissions of the Vermont Association for Planning and Development Agencies (VAPDA) and the Agency of Natural Resources' Water Investment Division. The toolkit is a clearinghouse of information useful to 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.

Roads

It is estimated that more than 75% of Vermont roads were constructed prior to any requirements for managing stormwater runoff (ANR, 2012). Where road networks intersect stream networks, roads and their ditches effectively serve as an extension of the stream system. Runoff from roads can increase stormwater runoff and, in this basin, unpaved roads are an important source of sediment to receiving waterbodies. Unpaved roads were estimated to contribute 48% of the phosphorus loading across developed lands, but in the TMDL scenario were targeted for over 80% of the reductions from developed lands or 2150 kg. Roads can also impinge on stream floodplains and be a barrier to aquatic organism passage (AOP) due to undersized or perched culverts. Road runoff results in sediment that may contribute to elevated phosphorus levels or increasing phosphorus concentrations for lakes in the watershed including, Little and Great Averill, Bean, Crystal Lake, Echo Lake, Holland Pond, Parker Pond, Lake Salem, Lake Willoughby. Roads around Willoughby, Shadow, Holland, Echo and Seymour lakes will be targeted for assessment and sediment reduction projects in 2023-2024 through Lake Watershed Action Plans and LakeWise efforts.

Tactical basin planning engages local, regional, and federal partners to accelerate the implementation of transportation-related practices to meet the state's clean water goals. Two regulatory programs, the Municipal Roads General Permit (MRGP) and the Transportation Separate Storm Sewer System Permit (TS4) are driving road water quality implementation efforts in the basin.

Municipal Roads General Permit

Road Erosion Inventories (REI) are used by Vermont municipalities to:

- identify sections of local roads in need of sediment and erosion control,
- determine individual road segment compliance with MRGP required practices,
- prioritize road segments that pose the highest risks to surface waters, and
- estimate costs to remediate those sites using Best Management Practices.

REI's are required by the Municipal Roads General Permit. The MRGP is intended to achieve significant reductions in stormwater-related erosion from municipal roads, both paved and unpaved. The permit is required by the Vermont Clean Water Act (Act 64) and is central to meeting phosphorus reduction targets for developed lands in the Lake Memphremagog watershed.

The implementation of the priorities identified in REI's will reduce sediment, phosphorus, and other pollutants associated with stormwater-related erosion generated from unpaved municipal roads. A secondary benefit of upgrading roads to MRGP standards is improving the flood resilience of the municipal transportation system from the increased frequency of localized high intensity rain events associated with climate change. 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 the towns in the Basin have completed baseline REIs required in the first MRGP 5-year permit cycle. Towns were 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 meet standards by December 31, 2025, for all road types, except for Class 4 roads, which will have to meet standards by December 31, 2028. Towns will report and manage their progress annually via the MRGP Implementation Table Portal database. For additional information see the DEC Municipal Roads Program.

DEC reissued the MRGP in January 2023. The new permit continues the implementation requirements of the previously issued permit, requiring towns to upgrade at least 7.5% of their non-compliant segments to meet MRGP standards annually. The re-issued permit requires a second, town-wide reassessment of all hydrologically connected segments by the Fall of 2027. After the updated REI is completed, 20% of total *Very High Priority* segments will be required to be upgraded to meet MRGP standards each year, as part of the 7.5% annual requirement mentioned above. One change in the reissued MRGP is that the active channel width is now required for new intermittent stream crossings, as well as replacements to existing non-compliant intermittent structures.

This plan recommends that technical and financial assistance be provided to towns to complete the new, required REIs and for towns interested in implementing road projects with water quality benefits. Priority projects for water quality are those projects that are "*very high priority*" and are in sub-basins with phosphorus impairments or with lakes that have increasing nutrient trends related to road stormwater runoff (Figure 27). Resources available from the Clean Water Fund (e.g., VTrans Municipal Grants-in-Aid, Grants-Aid-Small Equipment grant, VTrans 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.

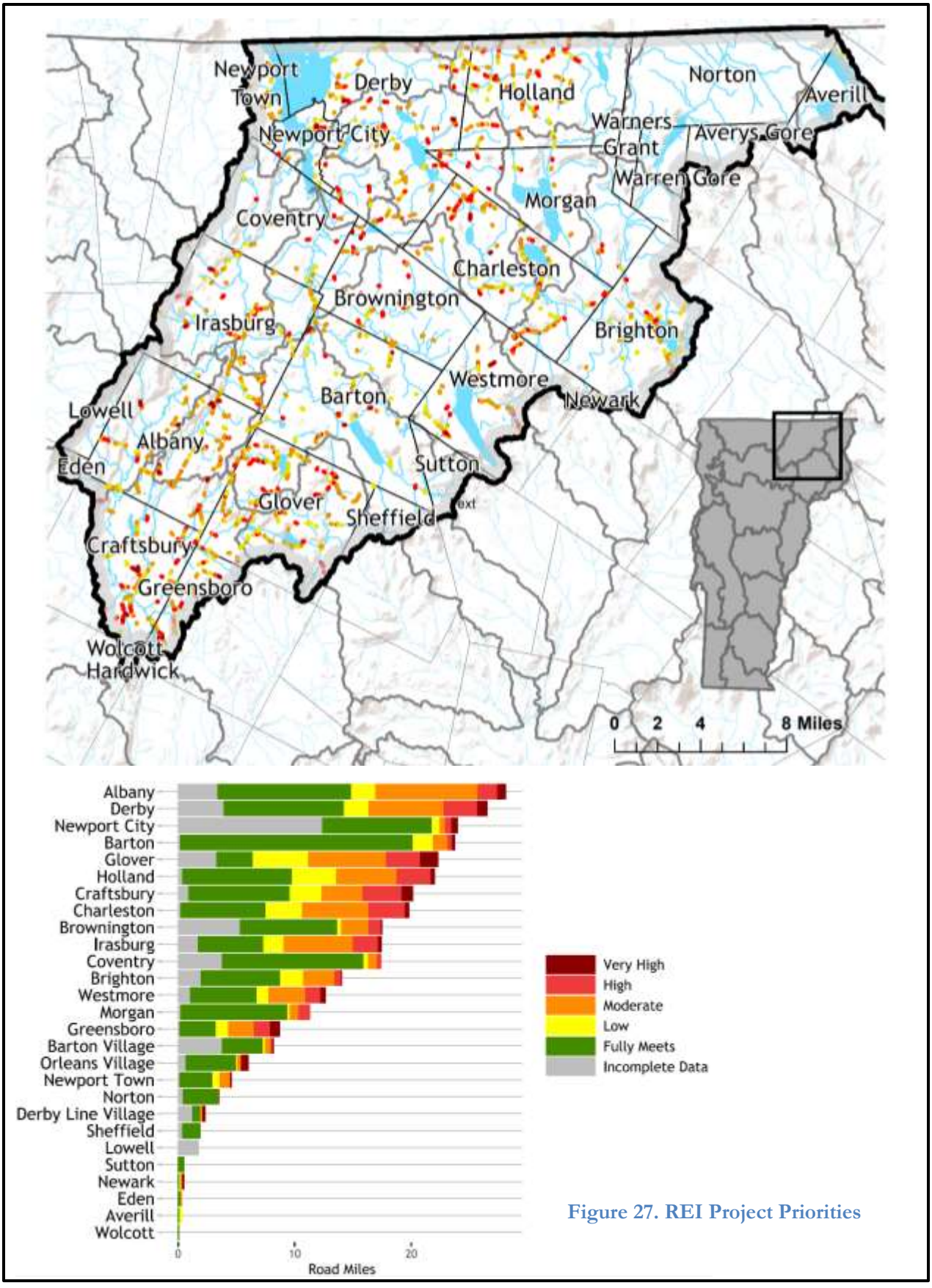


Figure 27. REI Project Priorities

Albany, Charleston, Craftsbury, Derby, Glover, Holland are priority towns for funding because they have the highest number of non-compliant roads to be improved. Priority for funding road improvements should also be targeted in towns with lake watersheds with increasing nutrient trends, which would add the towns of Morgan and Westmore with specific priority for road related projects identified in SWMPs and LWAPs.

VTrans Municipal Grants in Aid & Vermont Local Roads

The VTrans Municipal Grants In Aid Program provides technical support and grant funding to municipalities to promote the use of erosion control and maintenance techniques that save money, while ensuring best management practices are completed in accordance with the MRGP. The Vermont Local Roads team assists municipal highway departments and town governments to improve their road networks by providing training, technical assistance, communication tools and opportunities for information exchange. These programs help implement the strategies described here and listed in Chapter 5.

NEK Rivers and Roads Workgroup

Most towns in this basin have limited capacity and funding for road maintenance and so these towns rely heavily on the Vermont Agency of Transportation, NVDA, and OCNRCD and ECNRCD for technical support in meeting these MRGP standards. These organizations have joined together as the "Northeast Kingdom 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 and 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.

Transportation Separate Storm Sewer System General Permit – TS4

The Transportation Separate Storm Sewer System General Permit (TS4) covers stormwater discharges from all Vermont Agency of Transportation (VTrans) owned or controlled impervious surfaces. The TS4 general permit combines the stormwater requirements for VTrans associated with its designated regulated small MS4s; industrial activities, commonly regulated under the MSGP; and previously permitted, new, redeveloped, and expanded impervious surface, commonly regulated under State Operational Stormwater permits.

As required by the permit, VTrans will develop a phosphorus control plan that achieves an 18.2% reduction in phosphorus loading from VTrans properties in the Lake Memphremagog watershed. The plan will, by April 1, 2024:

1) Establish baseline phosphorus loading assessments for the TS4. Using this baseline, VTrans shall calculate the phosphorus load reduction needed to achieve a 18.2% percent reduction from the TS4.

2) Investigate phosphorus loading factors that will inform the prioritization of retrofit projects. Investigation shall include at least a GIS inventory of hydrologic connectivity and areas of active erosion for the TS4.

3) Based on the GIS inventory and established phosphorus baseline, develop coefficients for loading rates across the TS4 for the various transportation land uses.

By April 1 2025:

4) Develop a plan for the entire TS4 within the Lake Memphremagog watershed that at a minimum estimates the area (acreage or road miles) to be treated and the extent and type of BMPs to meet the entire phosphorus load reduction.

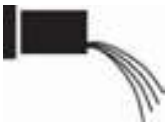
5) Plan to achieve, on average, a 25% load reduction in each 4-year phase, so that after all phases are completed the total reductions equal 100% of target reductions.

A VTrans Lake Champlain Basin Phosphorus Control Plan Story Map outlines the agency's process towards developing the PCP for the Lake Champlain basin and this VTrans factsheet provides additional information for the Lake Champlain PCP which is likely to be similar to the PCP for Lake Memphremagog once this is developed. Vtrans has also developed the Vermont Transportation Resilience Planning Tool as a web-based application that identifies bridges, culverts, and road embankments that are vulnerable to damage from floods, estimates risk based on the vulnerability, and criticality of roadway segments, and identifies potential mitigation measures based on the factors driving the vulnerability.

Vermont Road and Bridge Standards

In addition to the MRGP, towns can voluntarily adopt the most current version of the Vermont Road and Bridge Standards. These standards are administered by VTrans 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 may be entitled to higher cost share rates in federally declared flood event reimbursements.

Managing road runoff in the upper watershed catchments will lessen the pressure on the downstream areas receiving larger contributions of runoff. Waters being stressed or impaired lower in the watershed does not negate the need for action high up in the watershed. Lack of good management in the upper parts of the sub-basins can often be the cause of water quality issues further downstream due to cumulative impacts. For this reason, road BMPs for water quality are recommended basin wide and on steep slopes.



C. Wastewater

Most municipal wastewater, originating from a combination of domestic, commercial, and industrial activities, is collected, and conveyed to wastewater treatment facilities (WWTF), and treated to established standards identified in permits before being directly discharged into a receiving water. There are four direct discharge municipal wastewater treatment facilities that are subject to National Pollutant Discharge Elimination System (NPDES) permits in the Basin (Table 15). The Barton and Orleans facilities were issued new permits effective on June 1, 2019, with an expiration date of March 31, 2024. Newport City and Brighton facilities are scheduled to have their permits renewed in 2023. The Newport City permit was delayed until after the New England Waste Services of Vermont permit was finalized.

An overarching consideration for the issuance of permits in the Basin is the Lake Memphremagog TMDL for phosphorus which set a WLA for the four facilities in the basin of 4587 lbs./yr. or 2081kg/yr. The facilities have been reducing actual loading to receiving waters since 2017 with an average loading of 615 kg/yr. from 2017 through 2021 compared to an average loading of 783 kg/yr. from 2011 through 2016. This is a reduction of 168kg/yr and is far below the WLA set for facilities. This does not eliminate requirements for ongoing operation and maintenance of these facilities, nor scheduled engineering performance reviews required of all WWTF in Vermont. The municipal permits in place in the Lake Memphremagog Basin are shown in Table 15.

Limitations must control all pollutants or pollutant parameters (either conventional, nonconventional, or toxic pollutants) which are or may be discharged at a level that will cause, have the reasonable potential to cause, or contribute to an excursion above any state water quality standard, including state narrative criteria for water quality. At each renewal, permit writers in use this "reasonable potential analysis" to determine whether a discharge, alone or in combination with other sources of pollutants to a waterbody and under a set of conditions arrived at by making a series of reasonable assumptions, could lead to an excursion above an applicable water quality standard. If the expected receiving water concentration determined exceeds the applicable Vermont Water Quality Standard at critical conditions, limits are included in the permit. A permit writer conducts a reasonable potential analysis using effluent and receiving water data, and the findings are included in the permit issuance documentation, which can be viewed on the Wastewater Program's discharge permit database.

Table 15. Wastewater Treatment Facilities

Facility (Permit ID)	Permit effective date	Permit expiration date	Permitt edflow (MGD)	Current percent of flow design*	TMDL WLA** (lbs P/yr)	Treatment type	Receiving water

Barton (3-1202)	6/1/2019	3/31/2024	0.265	48%	542	Aerated lagoon with filtration	Barton River
Orleans (3-1201)	6/1/2019	3/31/2024	0.190	35%	388	Activated sludge with chemical addition and filtration	Barton River
Brighton (3-1213)	7/1/2007	6/30/2012	0.150	33%	1532	Aerated lagoon	Perrins River
Newport City (3-1241)	12/2/2004	6/30/2009	1.30	46%	2125	Extended aeration with chemical addition	Clyde River

** This was calculated using the average values for the annual average flow for the period 1/1/2016 to 1/1/2021.*

***The TMDL Waste Load Allocation (WLA) is the same as the current permitted load (kg P/yr) for Barton and Orleans and will be the new permitted load for Brighton and Newport City facilities in new permits.*

Additionally, the three towns are served by municipal sewer located outside of the town. Glover is served by Barton WWTF, having formerly converted the Glover WWTF to a pump station that conveys wastewater to the Barton wastewater collection system. Derby Center has a wastewater collection system that discharges to the Newport City WWTF. Lastly, Derby Line Village has a wastewater collection system that discharges via a siphon under the Tomifobia to the wastewater collection system for the Rock Island WWTF located in Stanstead, Quebec.

Facility-specific information

Barton

The Barton WWTF has a permitted flow of 0.265 MGD. The facility discharges to the Barton River. The treatment system consists of two aerated lagoons in a series, a "Roberts" filter for phosphorus removal, sodium hypochlorite addition for disinfection followed by sodium bisulfite for dechlorination. The Barton WWTF is due for some refurbishment work and the municipality is in the process of selecting an engineer in order to start this process.

Brighton

The Brighton WWTF has a permitted flow of 0.15 MGD. Brighton is an aerated lagoon facility constructed in 1977. The facility discharges treated, chlorinated/dechlorinated wastewater to the Pherrins River. The collection system consists of approximately 0.8 miles of force mains, six pump stations and six miles of gravity sewers. The Brighton WWTF is currently in final design for a refurbishment project. Bid advertisement is anticipated in 2023 with funding provide by USDA Rural Development and Vermont DEC.

Newport City

The City of Newport WWTF has a permitted flow of 1.3 MGD and discharges to the Clyde River. The facility is a secondary treatment WWTF with conventional activated sludge treatment process

and phosphorus removal. The facility chlorinates and dechlorinates the effluent before discharge. The City prepared a Long Term Control Plan for the remaining 6 CSO's associated with the system and the projects and schedule to address these CSOs have been codified with a 1272 Order dated May 22, 2022. ANR has recently awarded Newport City $748,000 in American Rescue Plan Act support to address CSOs related to the Gardner Park Interceptor Sewer and Bluff Rd Pump Station. The City is also due to start the 20-year evaluation process based on the age of the facility.

Orleans

The Orleans WWTF has a permitted flow of 0.19 MGD and discharges to the Barton River. The WWTF is a tertiary facility consisting of activated sludge followed by filtration units. Phosphorus removal is achieved by biological removal, chemical precipitation and filtration. Sodium hypochlorite is used for disinfection followed by sodium bisulfite for dechlorination. The Orleans WWTF has a 20-year evaluation and asset management plan. A series of repairs were recommended, and the Village is making repairs in accordance with the asset management plan.

Soil Based Wastewater Disposal Systems (Septic Systems)

The State of Vermont has regulatory 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 under 6,499 gallons per day must 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; repair and/or replacement of a failed wastewater system or water supply; and
- 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 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 near a river, lake, or wetland. Failed systems often discharge untreated sewage that can reach the surface and runoff into nearby waters. If signs of a failed septic system are observed, the Town Health Officer should be contacted. State programs provide financial assistance to qualifying homeowners that need to upgrade their systems if the costs are prohibitive.

Systems of 6,500 gallons per day and over are permitted through the Indirect Discharge Program. Indirect discharge systems are soil-based disposal systems, which also include primary treatment, and may include additional secondary or tertiary treatment levels depending on discharge requirements. Water quality related indirect discharges is monitored. Systems can be municipality or privately owned. There are four permitted indirect discharge systems in Basin 17 with total flows of 47,500 gallons per day.

Many historic villages as well as lake communities do not have municipal treatment facilities. Closely spaced on-site septic systems adjacent to waterways can be the source of elevated levels of contamination. Failed or poorly functioning systems can contribute *E. coli*, phosphorus, or nitrogen to surface waters. Additionally, failed systems can cause cross-contamination of nearby drinking water wells. The Lake Memphremagog TMDL estimated loading from Septic systems to contribute 1325 kg of phosphorus per year to surface waters which was estimated to be about 2% of the overall loading to the lake.

Momentum has been growing in rural villages to explore options to deal with concerns about pollution from septic systems and the need for economic growth in village centers that is limited by the lack of centralized shared wastewater systems.

DEC provides direct funding and technical assistance to small communities without municipal treatment to help evaluate and plan for wastewater needs. It is anticipated there will be a steady demand by small communities for wastewater evaluations and planning in the coming years. These communities have not been identified in the past as being the sources of surface water pollution, but with small lots and older on-site sewage systems, without municipal treatment infrastructure, re-development or the re-sale of property may require expensive upgrades. Another factor is the economic viability of small communities which cannot support commercial or residential growth due to the lack of wastewater treatment options. Alternative treatment systems are available to communities not wishing to build large waste treatment facilities, including several advanced technologies for small community scale systems that have been approved for use in Vermont.

The Vermont Engineering Planning Advance Program is a loan program available to municipalities without existing municipal water or sewer systems for conducting a feasibility study for community based drinking water and/or wastewater solutions. Consulting engineers assess the town's needs and goals offering treatment options that can include:

- Soil-Based, Small Scale, Incremental Wastewater Disposal Systems
- Sewer extension to a nearby wastewater collection system
- Decentralized community wastewater disposal systems
- Cluster septic systems
- Waste diversion systems
- Media filters
- Aerobic treatment systems
- Composting toilets

The Village Wastewater Solutions Initiative offers these resources for further information:

- Organizing Village Wastewater Solutions
- Wastewater Solutions for Vermont Communities

An example of a decentralized wastewater disposal systems can be found in 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. Funding is the most common barrier to identifying and remediating *E. coli* sources, however significant federal funding has become available through the American Rescue Plan Act (ARPA) and is available to help address this issue.

The Memphremagog watershed has several communities that have discussed doing projects, but have not yet started a village wastewater study.

Wastewater Workshops (AKA Septic Socials)

Concerns around failing septic systems is especially important in river and lakeshore communities. Many camps along shorelines were built before 2007, and many were built for only seasonal occupancy. If a lake or river is experiencing an increase in nutrients or *E. coli*, it is often difficult to pinpoint the exact sources. Septic systems could be a source.

One way to inform people about the health of their systems is to host a Wastewater Workshops. Wastewater Workshops 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, talk about the importance of water quality protection, and hear a septic system specialist discusses operation and maintenance of septic systems. Attendees are provided with resource materials to take home. Wastewater Workshops are beneficial in areas with old septic systems that may be having an impact on water quality such as around lakes with old camps or buildings built for seasonal use that are now seeing more activity year-round. Areas in the Basin that would benefit from septic socials are the larger populated lakes including Lake Seymour, Echo Lake, Lake Parker, Shadow Lake, Crystal Lake, Lake Willoughby and Lake Salem, but other interested river and lake communities are encouraged to participate. More information about septic socials canbe found at the Wastewater Workshop website.

D. Natural Resources

Forests, lakes, ponds, rivers, floodplains, and wetlands are all examples of natural systems that provide continuing benefits both socially and ecologically. Natural resource restoration and protection projects help to prevent and reduce nutrient and sediment pollution, improve flood resiliency by mitigating flood hazards, enhance habitat function, and support Vermont's outdoor recreational opportunities. These projects are also the most economical and have a long-term benefit with little to no maintenance requirements. Restoration and protection of natural systems offer a cost-effective, long-term means to mitigate water quality and the effects of climate change and enhance the ecosystem services - flood control, wildlife habitat, filtration of pollutants - these natural resources provide.

While Agency regulatory programs protect natural resources, the Agency's also works to support landowner interest in natural resource protection and restoration and depends on partners to provide some of this assistance.

Rivers

In response to historic intensive channel management, floodplain and riparian corridor encroachments, and watershed land use changes, most Vermont rivers are actively adjusting their shape, size, and course as they seek to re-establish equilibrium (i.e., balance). Human activities can prevent or disrupt this balance by changing flow inputs to the channel (e.g., deforestation, increasing impervious surfaces and runoff, or water withdrawals) or by changing the sediment regime (e.g., dams, dredging). Legacy and present-day impacts, such as development within riparian corridors, channel straightening, berming, damming, removal of riparian vegetation, and construction of undersized crossing structures, have contributed to stream instability state-wide. A key consequence of these activities is the loss of resilience and the ecosystem services provided by rivers that fully achieve dynamic equilibrium.

Improving longitudinal, lateral, vertical, and temporal connectivity encourages river equilibrium. Equilibrium 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. Tactical basin planning engages local, regional, and federal partners in the development of strategies needed to accelerate practices to move toward equilibrium and increase river connectivity to meet the state's clean water goals. River corridor plans, planting projects, strategic wood additions, Aquatic Organism Passage (AOP) restoration, and community efforts to regulate floodplain and river corridor development, are the tools used to increase river connectivity.

Stream Stability Restoration through the Functioning Floodplains Initiative

Assessing stream and floodplain function supports the valuation of ecosystem services and the potential for natural resource restoration opportunities. Societal benefits such as safe swimming, fish and wildlife, public safety and property protection may be categorized under the general ecosystem services of water quality, ecological integrity, and flood resilience.

The Functioning Floodplains Initiative (FFI) is being developed to provide practitioners, program managers, and policymakers with the maps and data they need to protect and restore highly valued streams, wetlands, riparian areas, and floodplains. This FFI has been developed for the Lake Champlain Basin but will be expanded to the Lake Memphremagog basin in future years.

The FFI team is developing methodology for a project credit scoring system that rewards phosphorus load reducing practices, as derived from the TMDL baseload allocations. This will result in a phosphorus crediting system that quantifies the gains made towards river system equilibrium.

There are three types of river and floodplain load reduction credit types for river instability. They are:

1. Stream stability reconnection credits for projects at reach and watershed scales.
    - Reductions over time (e.g., 10 lbs./yr. over 10 years).
    - River Corridor Easement (RCE) projects to achieve equilibrium and pollution reduction credits over time.
2. Storage attenuation credits for projects that reconnect floodplains and wetlands.
    - Driven by the deposit of sediment/nutrients when floodplains flood.
    - Longer-term pollution reduction credits may diminish over time.
3. Sediment removal credits for projects that physically remove sediment when a floodplain feature is constructed, especially along incised channels (first year credit only).

The river instability baseload will be distributed to the reach scale by using TMDL sub-watersheds as the components of each HUC-12 to develop the total HUC-12 allocation. The HUC-12 load allocation then gets downscaled to the reach level using an "area weighted" reach assignment.

The FFI project team established a relationship between connectivity score and phosphorus allocation, whereby the higher the connectivity score, the more the phosphorus reduction target is achieved. This relationship demonstrates that repairing the most disconnected reaches will achieve the most phosphorus reduction. From a target-setting perspective, project implementers should target those reaches that will address the highest pollution reductions. This crediting system will consider "stacked" practices (e.g., protection + riparian buffers). DEC will devise how this will be quantified and reported on in the tracking and accounting systems.

Going forward, the river instability phosphorus scoring and crediting system will be based on the increments of restored and protected connectivity, with the highest project credits awarded in areas with higher baseload allocations. Meaning, the size of the connectivity credit awarded to a project is commensurate with the degree to which geomorphic equilibrium is restored. Before a Memphremagog specific FFI tool is available an average of the median reductions for different project types will be used as part of the interim phosphorus reduction calculator tool available on the CWIP grant resources website.

River Corridor Plans

A River Corridor Plan (RCP) is a synthesis of the physical data collected during Phase I and II Stream Geomorphic Assessments (SGAs) based on protocols and guidelines developed by the River Management Program. These plans identify causes of channel instability and make recommendations for restoration and protection. All SGAs and RCPs can be found at: anrweb.vt.gov/DEC/SGA/finalReports.aspx. These are completed for the Clyde River, Black River,

and a combined assessment for the Barton and Johns Rivers. Where funding, local support, and interest exists, priority projects and objectives identified in these plans should be pursued. In 2022 the Memphremagog Watershed Association competed a review of basin 17 stream geomorphic assessments and evaluated sediment stressed conditions in Stearns Brook. The review identified several reaches that are a top priority for additional assessment including:

- Stony Brook T1.01-T1.03 and T1.05-T1.05.
- Lamphere Brook T5.01
- Shanley Branch T7.01-T7.02
- Cass Brook T10.01
- Valley Brook T1.08 – T1.13
- Sucker Brook T1S5.01 - T1S5.04
- Black River in Craftsbury M30-M34
- Seaver Branch T9.01 – T9.02
- Willoughby River T3.05-T3.12
- Brownington Branch T3S4.01 - T3S4.02
- Mad Brook T2.01 – T2.08

This assessment also included a windshield survey of the Stearns River watershed which was identified as a lower priority for further assessment, along with Brighton Brook, Lords Creek, Whetstone Brook, Roaring Brook and trib and the Barton River in Glover. The windshield survey identified several potential project areas in the Stearns Brook Watershed, many of which deal with agricultural operations and BMPs.

In 2022 the Memphremagog Watershed Association also completed Phase 2 lite assessments on Mad Brook and Valley Brook as part of the Vermont Fish and Wildlife Riparian lands assessment process. This Phase 2 lite approach may be used to assess some of the priority reaches identified above for the Black River watershed or dedicated funding may be sought to complete a full Phase 2 SGA of the priority reaches in this basin.

While overall water quality in the Basin is satisfactory, degraded geomorphic conditions (shown in Figure 9) of the basin's streams may impact:

- wildlife and fish habitat (e.g. riparian buffer removal increases water temperature, reduces shading and habitat for insects that feed fish, and channel alteration destroys aquatic habitat);
- public safety (e.g. loss of floodplains that store floodwaters, accelerated streambank erosion which results in infrastructure damage, and channel straightening that increases flow velocity during rain events);
- water quality (e.g. higher phosphorus loading from bank soil erosion stormwater runoff from encroachment of impervious surfaces and agricultural land).

Rivers are in a constant balancing act between the energy they produce from the slope of the channel, and the volume and weight of the moving water and the energy they expend to carry the water, sediment, and debris produced in their watersheds downstream. A change in any one of these factors will trigger adjustments of the other variables until the river system comes back into equilibrium (balance). These changes can be caused by natural events such as storms and by human activity such as channel manipulation. The impact of these changes may be seen immediately and for decades after the activity occurred.

The legacy from Tropical Storm Irene in 2011 and more recent flood events will be felt for years to come. The goal of managing toward, protecting, and restoring the equilibrium condition of Vermont rivers is to resolve or avoid conflicts between human investments and river dynamics in a manner that is technically sound, and both economically and ecologically sustainable. In addition, it will help to mitigate impacts of increased runoff and streamflow from climate change.

Riparian Lands Partnership

The Riparian Lands Partnership is a collaborative effort among local, state, and federal organizations in Vermont to enhance and protect existing riparian habitats, especially those on the state-owned Riparian Lands and adjacent parcels. Collaborators conduct assessments, engage in public outreach and implementation projects to fulfill these goals. This partnership has been active since 2019, initially assisting in assessment and outreach endeavors and now in project implementation. Project types include seed collection, processing, and storage; invasive species removal and site revegetation; low-tech process-based restoration projects; and river accessibility improvements via stone steps and trail construction.

The Fish and Wildlife Department has extensive one rod (16.5 ft) floating ownerships along the Black, Barton, Willoughby and Clyde rivers in the basin. Elsewhere, FWD owns several larger parcels and the Willoughby and South Bay WMAs that include extensive riparian areas along the Black and Barton Rivers. The narrow width of many of the one rod ownerships and lack of up and downstream continuity limits the ability for the Fish and Wildlife Department to create fully functional buffers to provide water quality and habitat benefits, and so the Department has partnered with several local organizations and state and federal partners to expand this ownership and riparian restoration efforts. These efforts have largely been funded through the Great Lakes Fisheries Commission, which provides up to one million dollars annually in funds for this work. Much of this funding was initially used to support a creel survey on Lake Memphremagog that was instrumental in better aligning fishing regulations in Quebec and Vermont on this international waterbody.

In recent years, this funding has focused on building capacity of local organizations to assess riparian lands, identify water quality project opportunities, and work with landowners to restore lands or to purchase or otherwise conserve lands along rivers in the Lake Memphremagog watershed. Several large-scale and many smaller scale riparian restoration projects are being developed through these efforts. GLFC funding is expected to help support the implementation of many of these projects in coordination with other funding sources such as formula grants. Multiple properties in the Johns and Clyde River basins are being appraised for potential conservation acquisition by FWD. An assessment of riparian lands along the Barton River has also been completed and partners are exploring FWD riparian lands restoration and acquisition opportunities. The goals for this work focus on improving fishing access areas, protecting spawning and high-quality habitat, and allowing for active stream and floodplain restoration projects.

Aquatic Organism Passage workgroup

The US Fish and Wildlife Service has also pulled together several partners in the Lake Memphremagog watershed including MWA, OCNRCD, NVDA, FWD, and DEC staff to identify priority culverts for retrofit or replacement to restore aquatic organism passage. The group is initially focusing on the Clyde River watershed for identifying priory culverts for replacement, but this is expected to expand to other priority watersheds in future years. The TBP prioritized AOP projects identified by this group as high priority and those identified in Table 11 in the 2017 Basin 17 TBP.

River Restoration and Conservation

Active river restoration can include the reconnection of floodplains through berm removal, woody buffer plantings (trees and shrubs), and bank stabilization techniques with biological materials. Twenty-seven acres of buffer have been planted in the watershed since 2016 and 200 square feet of gully have been restored.

Scientific research strongly supports the value of planting trees and shrubs along stream and lake shorelines for both water quality and wildlife habitat. Shoreline vegetation filters and cleans dirty runoff from uphill land uses, provides shoreland and shallow water habitat, stabilizes banks, and increases lake and river aesthetics.

In addition, ANR prioritizes river reaches that are identified as high priority sediment and nutrient storage areas for conservation. One option for protection, outside of land acquisition, is purchasing river corridor easements to avoid future encroachment and flood damage as well as to restrict channelization. River Corridor Easements protect rivers from channel management that can degrade the functions of a river corridor.

Restoration and Strategic Wood Additions

Large woody material is a critical component of rivers. It improves fish habitat, stream stability, floodplain connection, nutrient processing, and sediment storage, but it is generally lacking in most Vermont streams due to past and present river management practices to accommodate land uses such as: logging, agriculture, and urban and residential development. Large wood has been identified as a missing component of habitat in Number Five and Number Six Brooks in Norton and Big Valley Brook in Willoughby State Forest where strategic wood addition is a priority. In addition to these state lands, there may be other streams on private lands that would benefit from strategic wood addition and other process-based restoration actions. The Memphremagog Watershed Association will be assessing the need for this work as part of a forest lands project development effort in the headwaters of Brownington Branch, Nutting Brook, Mad Brook, and Bald Mountain Brook. MWA continues to identify and develop process-based stream restoration projects in the Clyde, Barton, and Johns River basins, where restoration actions focus on improving sediment retention, floodplain connectivity, and reversing channel incision processes. Training and workshops on assessment and implementation using these techniques are needed to grow the knowledge base

needed to increase implementation where these practices may be cost effective for reducing phosphorus loading and improve aquatic and riparian habitat.

Dams and Dam Safety

There are records of 63 dams of different types, sizes, and condition in the Basin. While some dams are used to generate energy and recreational opportunities such as boating, fishing, and swimming, all dams also impede a river's ability to transport flow and sediment; cause streambank erosion and flooding problems; degrade and alter fisheries habitat; create barriers to fish and other aquatic organisms' movement and migration; alter downstream water temperature; degrade water quality; and impede river-based recreational activity.

Of the 34 inventoried dams, 24 are in-service, three are fully breached, one is partially breached and 3 have been removed. The 25 active in-service and partially breached dams may constrict the stream channel enough to reduce sediment transport, prevent lateral movement, and inhibit aquatic organism passage (AOP) if mitigating actions have not been taken (e.g., fish ladder).

The Vermont Dam Safety Rules are in place to protect public safety and provide for the public good through the inventory, inspection, and evaluation of dams in the State. The Dam Safety Program administers the rules which apply to all non-power dams (dams that do not relate to the generation of electricity energy for public use) and all non-federal dams (dams that are not owned by the US or are subject to Federal Energy Regulatory Commission license or exemption). The rules set requirements and standards on dam registration, classification, inspection, application and approval to construct, re-construct, alter, repair, breach, or remove a dam, as well as related standards including design standards, operation and maintenance standards, inspection standards, and Emergency Action Plans.

All dams, even small dams for backyard ponds, are significant structures that can have major public safety and environmental implications. Dam removals are pursued by private and public dam owners, often with the help from watershed groups and partners. The Vermont Dam Task Force is an interdisciplinary team of natural resource professionals that collaborate to share and investigate current dam removal protocols, watershed science, funding, and dam removal opportunities. The group meets bi-monthly to collaborate on projects. There are not any current dam removal efforts in this basin and no priorities have been identified in this basin, but these may be flagged though the work of the AOP workgroup. While no dams are called out as active projects for removal and restoration, opportunities for restoration at high priority sites may exist upon further discussion with dam owners as the risk to public safety and ownership liability associated with aging and deteriorating dams becomes more evident. Dam owners are encouraged to contact the Vermont Dam Safety Program and their Watershed Planner if they are interested in discussing dam removal. Dam removal is a priority basin-wide where the removal will result in restoration of stream equilibrium and habitat, fish passage, and sediment reduction.

FEMA Mapping Updates

The Federal Emergency Management Agency (FEMA) is currently updating the Flood Insurance Rate Maps (FIRMs) in Vermont for the National Flood Insurance Program (NFIP). This will be the first map update for many towns since the 1970s or 1980s. This new update will cover the entire state in stages and may become effective in some counties as soon as 2025 as part of FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) program. Towns in Orleans County had an initial discovery meeting with FEMA in 2017. During the meeting, stakeholders, including FEMA, state, and community officials, discussed areas of flooding concern and project goals, milestones, and products. Draft updated maps for Orleans County may be ready in 2023 for towns to review.

Most high-risk flood hazard areas in the basin will be mapped as Zone A, using a new Baseline Engineering (BLE) strategy that combines computer modeling and high-resolution ground data (Lidar). Other areas with existing detailed flood studies will be labeled as Zone AE, with the older studies aligned with current topography. The new FIRMs will include aerial photographs that show houses and roads.

Flood Insurance Rate Maps are the basis of floodplain regulations and the NFIP. When the new maps go into effect, FEMA requires that town bylaws meet current standards for participation in the NFIP**.** Towns will need support from partners in the basin to update flood hazard bylaws to ensure they meet minimum NFIP requirements. This update may also be a good time for communities to consider higher standards to protect floodplains and river corridors. As such this TBP recommends targeted outreach to communities to adopt model flood hazard bylaws and consider river corridor adoption as part of the map update process.

Lakes

A lake's physical characteristics are driven by its watershed size, topography, geology, soil fertility and erodibility, and vegetation. A lake's water quality is impacted by human activities and the land uses on the immediate shoreland and farther up into the watershed. The loss of native vegetation at the shoreline, the locations of roads, the development pressures around the shoreline and along tributaries, and into the watershed, and activities such as agriculture and forestry all contribute to overall lake and pond health. All these activities impact how water moves across the landscape and ultimately into the lake and ponds.

Preventing and mitigating water quality degradation, preserving and enhancing lake habitat and shoreline stability and ensuring recreational uses of lakes and ponds are priorities for the Basin. Recommendations included are guided by data from the VT Inland Lakes Scorecard depicting the condition of lakes and ponds, along with input from the Lakes and Ponds Management Program and Basin stakeholders.

Lake Watershed Action Plans

Lake Watershed Action Plans (LWAPs) are assessments to identify pollution sources in the lake watershed that result in water quality and habitat degradation. LWAPs result in a prioritized list of projects and strategies to address the sources of pollution and habitat degradation identified in the assessment. The plan may also contain recommendations to preserve natural features and functions, encourage use of low impact green stormwater infrastructure, and maintain the aesthetic and recreational uses of lakes. Four lakes in the Basin are in the process of LWAPs being developed, Lake Willoughby, Shadow Lake had LWAPs initiated in 2022 while Seymour and Echo LWAPs were funded in early 2023.

Several other lakes in the basin are priorities for getting an LWAP completed because of increasing nutrient trends, active lake associations, and local support for lake and watershed restoration implementation. These include Lake Parker and Lake Salem as the top priorities followed by Crystal Lake, Great Averill Lake and Little Averill Lake and Norton Pond. The development and then implementation of LWAP's takes substantial capacity on the part of local partners and so one strategy in this plan is to develop a regional lake coordinator position based at a partner organization to manage lake shoreland outreach, assessments, project identification, development, and implementation.

Lake Tributary LaRosa Partnership Program

Several lakes in Basin 17 have been part of the LaRosa Parentship Program (LPP) community science water quality monitoring to support the identification of tributaries that have higher phosphorus concentrations to focus assessment and implementation efforts. Currently monitoring is taking place on tributaries to Echo Lake, Lake Willoughby, Shadow Lake, Parker Pond and Little Averill Lake. Past monitoring has focused on smaller tributaries to Lake Memphremagog and tributaries to Lake Seymour. Average phosphorus concentrations of tributary watersheds are shown in Figure 8. Lake Salem tributaries have been included as part of the Orleans County NRCD LPP monitoring in 2023. In addition, if there is local support to take on community monitoring on tributaries to Great Averill, Crystal and Norton Ponds this is a priority to help to identify tributaries that may be a factor in increasing nutrients trends which can then be a focus for assessment and implementation efforts.

Protecting and Improving Lakeshore Condition

The Shoreland Protection Act (Chapter 49A of Title 10, §1441 et seq.), 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.

The Lake Wise Program encourages lakeshore owners to implement practices that improve and protect lake water quality conditions and habitat. A Lake Wise Award certifies a property is well managed, using shoreland Best Management Practices, and is maintained to protect the lake. Lake Wise assessments review shoreland practices for their benefit to water quality and wildlife habitat and suggest actions if improvements are needed. Lakes with a Fair shoreland score will benefit from implementing Lake Wise Program best management practices.

Four lakes in the Basin were identified as a priority for Lake Wise in addition to those that are identified as priorities for LWAPs. These include Island Pond, Holland Pond, Bean Pond, and Lake Memphremagog. Holland Pond does not have a lake association but has two active road associations and mailing lists to these associations will be used for outreach on Lake Wise assessments and opportunities to address road runoff will be evaluated. Three lakes in the Basin have a poor shoreland habitat condition rating from the VT Lake Scorecard, but sixteen are rated fair. If communities are interested in pursuing Lake Wise, they can contact the Lake Wise Program. Watershed partners are currently working with some of these lake communities and outreach will be planned for the additional lakes in the next five years. There have been several efforts to improve management of lakeshores on state and municipal lands including projects at the Shadow Lake Beach, Lake Salem, Prouty Beach, and on the South End of Lake Willoughby. Additional practices could be implemented at Prouty Beach and Crystal Lake State Park as well as the North Beach at Lake Willoughby and Seymour Lake.

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

Aquatic invasive species (AIS) have been confirmed in 13 lakes in the Basin. Additional aquatic invasive species populations may exist but have not been confirmed with recent lake surveys. Twelve lakes in the basin have confirmed populations of Eurasian watermilfoil, two have populations of starry stonewort, and three have curly leaved pondweed. Zebra mussels were identified in Canadian waters in 2019 through physical surveys, environmental DNA (eDNA) and veliger analysis from plankton net tow samples. In 2022, eDNA and veligers of Zebra mussels were found in samples from Vermont waters, though physical evidence of specimens were not found. It is likely that the Canadian population will expand to south Lake Memphremagog where there is rocky substrate to support Zebra mussels growth. The movement of Zebra mussels into Vermont waters can be monitored though the Zebra Mussels Citizen Science Monitoring Project and the Vermont Invasive Patrollers for Animals Program.

New AIS introductions occur mainly in waterbodies that have launch sites for motorboat watercraft, are in close proximity to infested waters, and lack spread prevention programs. Incoming motorboats from AIS infested waters are a high risk for introducing AIS in and on motors, propellers, trailers, and boating equipment. The VT Public Access Greeter Program and the

Vermont Invasive Patrollers (VIP), and the Vermont Invasive Patrollers for Animals (VIPA), are spread prevention programs that incorporate AIS identification training, surveying and monitoring, watercraft inspection, and decontamination programs. VT Public Access Greeter Programs are supported by DEC's Aquatic Nuisance Control Grant-in-aid funding. Greeters interact with boaters at boat access areas, inspect watercraft, identify and remove any suspicious matter, and collect and report AIS data. Greeters also distribute educational material on aquatic invasive species. Vermont Invasive Patrollers Program trainings are offered on an annual basis.

The Aquatic Nuisance Control Grant-in-Aid Program provides financial assistance to municipalities and agencies of the state for aquatic invasive and nuisance species management programs. Seven lakes in the basin have active lake greeter programs including Crystal Lake Salem, Seymour Lake, Echo Lake, Island Pond, Lake Willoughby, and Lake Salem. To continue their work, these lake protection volunteers need a continuity plan for long-term success. Lake Memphremagog has had greeter programs in the past and is a priority for the development of future greeter programs with the use of a boat washing station to prevent the spread of zebra mussles, stary stonewort, and Eurasian watermill foil that are present in this waterbody. In addition, several lakes have diver-assisted suction harvesting programs or hand pulling efforts including Lake Willoughby, Shadow Lake, Great Hosmer Pond, and Derby Pond. Hydro-raking and benthic barriers have been used on Lake Memphremagog near Strawberry Acres and the town docks. A map of active greeter and control efforts is available online.

Wetlands

Wetlands cover about eight percent of the Basin and are important for safeguarding many of its high-quality surface waters. As recently as the 1950s, wetlands were seen as obstacles to development, agriculture, and transportation, and consequently, were systematically drained and altered. These losses and alterations diminish the important ecosystem services provided by wetlands such as sediment and nutrient attenuation, wildlife habitat, and flood water storage. Protecting the wetland resources remaining is an important strategy in the basin. Additionally, restoring degraded wetlands is essential to improving water quality.
Wetland conservation and restoration and identifying sites with the greatest potential for improving water quality are priority recommendations.

Wetland Assessment and Protection

The Wetlands Program regulates wetlands in accordance with the Wetlands Rules which are focused on protecting wetland functions and values. The Program also monitors and assesses wetland conditions. The Program relies on wetland mapping to help preliminarily identify the locations of regulated wetlands (Class II and Class I). Enhanced wetland mapping is being developed by basin and will eventually cover the entire state. Current maps can be found at Wetland Inventory Map.

Protection, in the form of a Class I wetland determination, can be afforded to wetlands determined to be exceptional or irreplaceable in their contribution to Vermont's natural heritage, based on their functions and values. Three wetlands have been identified as candidates for Class I assessment and support for reclassification. These wetlands include the Black River and Barton River wetlands along South Bay in the town of Coventry and the City of Newport, and the upper Clyde River wetlands complex in the towns of Charleston and Brighton.

This plan recommends conducting these wetland assessments and evaluating interest in reclassification in the prioritized areas. Stakeholders are encouraged to reach out to their basin planner and Wetlands Program staff for technical support to research and submit Class I wetland designation petitions for review, including for additional wetlands not mentioned here which may qualify.

Wetland Restoration

Wetland restoration is the process of returning a degraded wetland to an approximation of its pre-disturbance condition. The United States lost over half of its wetlands through ditching and filling between 1780 and 1980, and Vermont has lost as much as 35 percent. While conservation and protection of wetlands are critical for preventing continued loss of remaining intact wetlands, wetland restoration is essential for rehabilitating those that have historically been degraded or lost. Clean water goals for wetland restoration include assessing areas of degraded and prior converted wetlands and areas of hydric soils for restoration potential and implementing restoration as sites and opportunities are identified. This plan recommends that wetland restoration and conservation be explored where water pollution reduction and flood protection is evident.

The Memphremagog Watershed Association completed an assessment of potential wetland restoration sites that was initiated by Fritz Gerhardt. This effort has identified 42 potential wetland restoration sites across the Lake Memphremagog basin which have been added to the watershed project database. The Memphremagog Watershed Association worked with the Orleans County NRCD and Vermont Land Trust to identify contacts for properties where these potential wetland restoration sites exist on farmlands and conduct outreach to landowners, resulting in several projects moving forward. MWA is also working to develop smaller scale process-based restoration techniques such as beaver dam analogue structures and has implemented a series of wetland restoration efforts at the Willoughby Falls WMA. MWA is working with FWD to develop a restoration plan for the newly conserved Farrow Farm Streambank Management Area on Valley Brook in the Lake Seymour watershed where wetland restoration will be one restoration practice considered.

Wetland restoration has the potential to reduce downstream phosphorus loading but there are not simple ways to estimate the magnitude of phosphorus reductions. One need for this basin is to develop phosphorus reduction estimates for wetland restoration projects in the Lake Memphremagog basin. Currently, process-based restoration projects lump in-stream improvements with floodplain wetland enhancement to estimate phosphorus reduction credits using the Interim

Phosphorus Calculator Tool. This approach needs to be further explored to devise more accurate estimates of stream versus wetland-based phosphorus reduction capacities using the Functioning Floodplain Initiative Tool and empirical data.

Forests

Forest lands cover approximately 65% of the Basin. As the dominant land cover, forests are important for safeguarding many high-quality surface waters. Yet, 10% of phosphorus runoff is estimated to originate from forestlands in the Lake Memphremagog watershed, although a smaller percentage is estimated to make it to Lake Memphremagog as much of the forestland runoff is buffered by the many lakes and ponds in the basin which retain sediment and phosphorus. Reducing runoff and erosion from forests is important to meeting the state's clean water goals. Forest management activities offer many benefits, such as maintaining healthy forest communities, improving wildlife habitat, addressing non-native invasive species, contributing to the working landscape economy, and remediating poor legacy road infrastructure. Improving management and oversight of harvesting activities by following the Acceptable Management Practices and providing educational outreach and technical assistance to forest landowners and land managers are Basin priorities. Providing funding to implement improvement practices will grow the practice of good stewardship and water quality protection.

Mapping Critical Source Areas & Identifying Legacy Erosion

As an outcome of the Clean Water Service Delivery Act (Act 76), ANR has contracted a consultant team to identify and map critical source areas of forestland erosion and establish a method to estimate the potential for phosphorus and sediment reductions associated with forestland BMPs and AMPs. This consultant will assist in identifying forestland phosphorus and sediment reduction potential using remote sensing, a GIS-based (LiDAR) landscape analysis of erosion risk potential, and critical source area (CSA) mapping of forest roads, trails, and log landings. These features will be prioritized based on their erosion risk potential. An additional element of this work is to establish forestland BMP phosphorus and sediment accounting methods to estimate load reductions associated with forestland BMP and AMP implementation on lands in the Use Value Appraisal Program.

A second phase of this work will assess forestlands to identify and prioritize legacy erosion associated with the critical source areas and to ground truth and calibrate the analytical and prioritization tools. The ground truthing of the landscape analysis is intended to calibrate the prioritization framework of critical source areas, as well as to develop a prioritization framework to address legacy erosion in high priority basins (i.e., South Lake Champlain and Missisquoi Bay) to achieve target load allocations that will not meet reduction targets through Vermont AMP compliance alone. Until this work can be completed, the calibration of the phosphorus and sediment

accounting methods to estimate load reductions associated with forestland BMP implementation, will be in development. The focus of these efforts is in the Lake Champlain basin so there may be some need to do some analysis to apply this approch to the Lake Memphremagog Basin.

Forestry AMPs and Skidder Bridge Programs

Acceptable Management Practices for Logging Jobs are scientifically proven methods designed for loggers, foresters, and landowners to prevent soil, petroleum products, and excessive logging slash from entering the waters of the State and to minimize the risks to water quality.

Stream crossings can have a significant negative impact on water quality. These impacts can be minimized by making sure that stream crossing structures are properly sized and installed correctly before crossing streams with logging equipment. The VDFPR and watershed partners provide portable temporary bridge rental opportunities for use during timber harvests. These "Skidder" bridges reduce the occurrence of sedimentation, channeling, and degradation of aquatic habitat, allowing loggers to harvest timber in compliance with AMPs. When properly installed, used, and removed, Skidder bridges provide better protection from stream bank and stream bed disturbance than do culverts or poled fords. These reusable bridges are also economical, easy to install, and can be transported from job to job.

Specifications for building skidder bridges can be found at: https://fpr.vermont.gov/skidder-bridges. Information on the bridge rental program is found at: https://fpr.vermont.gov/forest/managing-your-woodlands/acceptable-management-practices/temporary-bridge-rentals. These bridges should be utilized on logging projects basin wide especially on steep slopes and areas with erodible soils adjacent to surface waters.

Additional guidance is available from the Vermont Department of Forests, Parks and Recreation (VDFPR) in the Vermont Voluntary Harvesting Guidelines to Protect Forest Health and Sustainability, and support for local skidder bridge programs, and forest land conservation efforts.

Use Value Appraisal Program & AMPs

Vermont's Use Value Appraisal Program (UVA) enables eligible private landowners who practice long-term forestry or agriculture to have their land appraised based on the property's value for the production of wood or food rather than on its residential or commercial development value. Compliance with UVA requires that the AMPs be employed to the maximum practicable extent. If 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. In addition to programs like the AMPs and skidder bridge rentals, County Foresters are available for consultation when questions arise about practices to protect water quality.

Forest Road and Trail Assessments and Management

The Agency of Natural Resources is in the process of assessing and prioritizing erosion issues along hydrologically connected forest roads on ANR-owned lands. State Forest roads in the basin are primarily found in the Bill Sladyk WMA and Willoughby State Forest. ANR is in the process of evaluating forest roads on these state lands as part of a statewide forest road erosion inventory on state lands. These inventories will identify potential road projects which can reduce sediment and phosphorus loading to surface waters in the basin. In 2022, several roads in the Bill Sladyk WMA were closed off and additional road drainage was addressed. These projects reduced sediment transport to surface waters and improved aquatic organism passage. The ANR Road Erosion Inventory App will become a resource for contractors and volunteers on private land in the future. The downloadable app can be used to assess and prioritize road segments in the field.

Landowners may also use this app to prioritize forest land projects and for supporting funding requests. This plan recommends piloting these tools on private lands to evaluate their use and to encourage increased forest land project implementation. ANR is also considering ways to identify potential phosphorus and sediment reduction projects on forest trails and to estimate phosphorus reduction potential for these projects. The Vermont Association of Snow Travelers has a extensive network of snowmobile trails in the basin where trail erosion control practices may help to reduce sediment and phosphorus loading in the basin.

Watershed Planning and Social Equity

Vermont's natural resources are held in trust for everyone and should be a source of inspiration and enjoyment for all. The Agency of Natural Resources is committed to ensuring that everyone living in and visiting Vermont has meaningful access and equal opportunity to participate in Agency programs, services, and activities and that everyone feels safe and welcome on Vermont's public lands.

ANR is committed to the work needed to engage our state's diverse population in shaping our shared work. As an Agency, we strive to be inclusive, both leading and supporting important work needed around diversity, equity and inclusion – in our land management practices, in our environmental policies and permitting, and in ensuring our public processes are accessible, equitable and transparent.

Goals for the Basin include:

- Clean surface water for consumptive and recreational uses
- Safe consumption of fish caught in Vermont for subsistence anglers
- Access to waters for recreation for all abilities and economic levels in all communities

- Open space availability and access in more densely populated areas
- Equitable implementation of clean water projects in all communities

Chapter 5 – The Basin 17 Implementation Table

A. Progress in the Basin

The previous Basin 17 plan was completed in 2017. A total of 66 strategies were identified in the plan. Nineteen (or 29%) have been completed and another 38 (or 58%) are in progress by ANR and watershed partners. Eight strategies are awaiting action and have been carried over to this plan in some form, and 1 has been discontinued as no longer relevant. The 2017 plan report card is available online on the Basin 17 webpage.

The TBP addresses all impaired and altered waters in the Basin as well as protection needs for high quality waters. The list of strategies in the Implementation Table (Table 16) and the Monitoring and Assessment Table (Table 17) cover future assessment and monitoring needs, as well as projects that protect or restore waters and related education and outreach.

The process for identifying priority strategies is the result of a comprehensive review and compilation of internal ANR and external watershed partner monitoring and assessment data and reports. The monitoring and assessment reports include SWMPs and stormwater mapping reports, SGAs, RCPs, bridge and culvert assessments, Hazard Mitigation Plans, flood modeling, agricultural modeling and assessments, REIs, biological and chemical monitoring, lake assessments, wetland assessments, fisheries assessments, natural communities and biological diversity mapping, farm assessments, land treatment plans and conservation planning through the NRCS nine step planning process.

The Water Investment Division's Clean Water Initiative Program (CWIP) funds, tracks, and reports on priority projects to restore Vermont's waters, and communicates progress toward meeting water quality restoration targets outlined in the TMDLs. CWIP also coordinates funding, tracking, and reporting of clean water efforts for state partners, including the Agencies of Agriculture, Food and Markets; Commerce and Community Development; Transportation, and other ANR Departments (FWD and VDFPR), and federal partners.

The Division's reporting on financial investments made and phosphorus loads addressed occurs annually in Clean Water Initiative Performance Report.

B. Public Participation

Public input is key to the development of the TBP and the strategies included in the Implementation Table. Public participation is sought throughout the planning process.

The planning process for the Lake Memphremagog Basin kicked off with a community meeting in June of 2022 with 19 community members in attendance and that included the sharing of an online story map. A survey was shared at this meeting and distributed through regional partners to get input on community water quality concerns and priorities for protecting and improving water quality across the basin. A total of 28 people responded to the survey, mostly watershed residents or part time residents that self-identified as landowners or associated with local non-profit and watershed groups. The Orleans County local work group also meet in the fall of 2022 hosted by the Orleans County NRCD to lead a discussion of 25 natural resource professionals on strategies for the basin 17 tactical basin plan. In addition to this several stakeholder meetings were held to discuss priorities for water quality projects related to agriculture, developed lands, streams, lakeshores and forestlands. Two public meetings were noticed and held by DEC and partner organizations in the watershed to receive public comment on the draft plan.

Input from the community helps inform the strategies and projects proposed in this plan. The top concerns through this survey were identified as water quality impacts of the New England Waste Services of Vermont landfill in Coventry, and concerns about Per- and Polyfluoroalkyl Substances (PFAS), phosphorus enrichment related to agricultural runoff, runoff form developed lands, septic systems, streambank erosion, and poor forestry and road practices, lake shore development and loss of lakeshore vegetation, high rates of lesions that have been observed on brown bullhead in Lake Memphremagog and South Bay and aquatic invasive species.

Recommendations offered by respondents include working to identify dams and culverts for removal and replacement, simplifying the language of model bylaws for municipalities to make them more accessible and enforceable, documenting wetlands and vernal pools for protection, mandating Class 4 road maintenance for water quality protection, continuing education efforts to municipal road crews for better road management and including PFAS information in the plan.

A lack of staff resources and funding were identified as the biggest obstacles to achieving water quality health in the basin followed by a lack of community interest and a lack of information available to explain the benefits of water quality projects and initiatives. Better communication of water quality information through diverse means was identified as a solution to this barrier in several surveys and was a focus of the community input at one of the public meetings. Public comment indicated the need for targeted programming for property owners to increase buy in to clean water efforts, paying farmers to host open houses and participate in workshops and programs, and overall increasing community engagement by hosting community get togethers, and conducting outreach and volunteer events in the basin. In response to these comments a strategy was added to develop a communications plan for watershed partners. In addition to this, increasing capacity for Lake Wise evaluations was also identified as a solution.

C. Coordination of Watershed Partners

There are several active organizations undertaking watershed monitoring, assessment, protection, restoration, and education and outreach projects in the Basin in coordination with the ANR. These

partners are non-profit, private, state, federal, or other organizations working on both private and public lands. Partnerships are crucial in carrying out non-regulatory projects to improve water quality. The Orleans County Natural Resources Conservation District (OCNRCD), Essex County Natural Resources Conservation District (ECNRCD), Northeastern Vermont Development Association (NVDA), Memphremagog Watershed Association (MWA), NorthWoods Stewardship Center (NWSC), Natural Resource Conservation Service (NRCS), UVM Extension Service, US Fish and Wildlife Service (USFWS), AAFM, Vermont Agency of Transportation (VTrans), Vermont Land Trust (VLT), Vermont River Conservancy (VRC), Trout Unlimited (TU), Vermont Natural Resources Council (VNRC), Vermont Housing and Conservation Board (VHCB), The Nature Conservancy (TNC), lake associations, and municipal groups are active in:

- providing outreach, education and community engagement 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).
- working with farms in the basin developing and implementing NMPs and BMPs for water quality,
- working with municipalities on implementing the Municipal Roads General Permit and municipalities and lake associations on Lake Watershed Action Plans.
- monitoring water quality (e.g., lay monitoring program on lakes and rivers).

The work necessary to meet water quality goals in this basin requires collaboration among all these groups to maximize the effectiveness of the watershed partners and the funding investments. Without funding or partners, little of this work would be possible. The Agency is grateful for the active engagement and long-term commitment of so many partner organizations and interested citizens.

D. Implementation Table

The Implementation Table (IT) (Table 16) provides a list of 67 priority strategies created as the go-to implementation guide for watershed action. The IT provides specificity for where each strategy should focus by identifying priority sub-basins and towns. A list of related individual project entries is found in the online Watershed Projects Database (WPD). The projects in WPD vary in level of priority based on the strategies outlined in the table. All projects in WPD are not expected to be completed over the next five years, but each strategy listed in the IT will be reported upon in future TBPs as part of the TBP report card as can be seen here for the 2017 basin 17 TBP.

In relation to the Lake Memphremagog Phosphorus TMDL, IT strategy progress will be measured against the5-year TP reduction targets for each sector, outlined in Chapter 3. These reduction targets are addressed through both the regulatory programs described in Chapter 3 and the prospective reductions assigned to Clean Water Service Providers and guided by the IT strategies. CWIP clean

water project tracking and accounting will estimate the mass of pollutants reduced by implemented projects supporting IT strategies and track progress towards achieving the 5-year target milestones. Progress achieved through outreach, technical assistance, and project funding will inform DEC's gap analysis related to each subsequent phase of TMDL implementation, each annual Clean Water Performance Report, and attendant interim and final TBP report cards.

As projects are developed, priority for CWIP funding is given to those projects that achieve the highest water quality benefits. Projects that provide cumulative benefits (i.e., flood resiliency, water quality improvement, water resource protection, aquatic organism passage) receive additional consideration for prioritization. For these priorities to be achieved, partners and stakeholders must help carry out the strategies identified in the basin plan.

Table 16. Implementation Strategies (See List of Acronyms on Page 101.)

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
Strategies to address runoff from Agricultural Lands				
1. Target increased outreach, technical assistance and funding to HUC 12 watersheds where field practice implementation has been lagging TMDL reduction targets to increase crop rotation, cover crop, no till practice implementation.	Lower Black, Lower Clyde, Willoughby, Direct to lake, Mud, Walker Ponds, Stearns Trib, Roaring Branch, Lake Parker, Shadow Lake, Lake Willoughby, Echo Lake, Lake Salem, Seymour, Lake watersheds, Figure 8 target watersheds.	Brownington, Coventry, Derby, Irasburg, Glover, Charleston, Holland, Morgan, Westmore	OCNRCD, NRCS, UVM ext, AAFM	NRCS, AAFM, RCPP, Pay for P, AGCWIP
2. Develop a pilot program to develop and implement trapping and control practices identified through Agricultural Conservation Planning Framework (ACPF) toolbox with high phosphorus reduction potential to increase practices including WASCOB's, filter strips, grassed waterways and harvestable buffers where these can have the largest impact and expand to other farms as feasible.		Brownington, Coventry, Derby, Irasburg, Glover, Charleston, Holland, Morgan, Westmore	OCNRCD, NRCS, UVM ext, AAFM	NRCS, AAFM, RCPP, Pay for P
3. Provide support to farmers to implement NMP's and reduce soil P levels by developing farmer friendly NMP implementation plans, hosting annual NMP implementation workshops, and increasing technical and financial support to improve nutrient utilization, such as supporting movement of nutrients to fields that need it and reducing application rates on fields with high soil phosphorus levels.	Basin wide	All towns	OCNRCD, ECNRCD, NRCS, UVM ext, AAFM	NRCS, AAFM, RCPP, Pay for P
4. Increase technical support for farmers to improve drainages to increase sediment retention and slow water velocities.	Priority watersheds listed above for strategy 1&2.	Brownington, Coventry, Derby, Irasburg, Glover, Charleston, Holland, Morgan, Westmore	OCNRCD, ECNRCD, NRCS, UVM ext, AAFM	NRCS, AAFM, RCPP, Pay for P
5. Work with AAFM to get generalized information on the percentage of fields with excessive and high soil P levels in the Lake Memphremagog watershed to help identify the opportunities and needs for this work.	Basin wide	All towns	OCNRCD, ECNRCD, NRCS, UVM ext, AAFM	NRCS, AAFM, RCPP, Pay for P
6. Continue targeted farm water quality sampling efforts in high phosphorus exporting watersheds to identify phosphorus source areas, guide implementation, and to evaluate water quality improvements based on BMP	Priority watersheds listed above for strategy 1&2.	Brownington, Coventry, Derby, Irasburg, Glover, Charleston, Holland, Morgan, Westmore	OCNRCD, NRCS, UVM ext, AAFM	NRCS, AAFM, RCPP, Pay for P

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
implementation through the LaRosa Water Quality Monitoring program.				
7. Produce Ag water quality success stories and newspaper articles in partnership with farmers where water quality data and farmer interviews provide a positive example for farmers and non-farmers of the results of restoration efforts.	Basin wide	All towns	OCNRCD, NRCS, UVM ext, AAFM	NRCS, AAFM, RCPP, Pay for P
8. Provide technical support for farmers to participate in the Pay for Phosphorus program to increase the adoption of Phosphorus reduction practices above the TMDL reduction targets for the Lake Memphremagog Basin. Work to identify and address barriers to participation in this program and share examples where this results in phosphorus reductions and improves farm viability.	Priority watersheds listed above for strategy 1&2.	Brownington, Coventry, Derby, Irasburg, Glover, Charleston, Holland, Morgan, Westmore	OCNRCD, NRCS, UVM ext, AAFM	NRCS, AAFM, RCPP, Pay for P
9. Develop a local program to provide technical and financial support to farmers to access and utilize conservation equipment necessary for effective implementation of Best Management Practices such as manure injection, cover cropping and no or minimal tillage.	Priority watersheds listed above for strategy 1&2.	Brownington, Coventry, Derby, Irasburg, Glover, Charleston, Holland, Morgan, Westmore	OCNRCD, ECNRCD, NRCS, UVM ext, AAFM	CEAP, VHCB, AGCWIP
10. 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.	Priority watersheds listed above for strategy 1&2.	Brownington, Coventry, Derby, Irasburg, Glover, Charleston, Holland, Morgan, Westmore	OCNRCD, ECNRCD, NRCS, UVM ext, AAFM	AGCWIP, RCPP, TBPSG
11. Develop additional capacity for farm teams to work with farmers on grant applications. This is identified by farmers as a service need for implementation of conservation practices.	Priority watersheds listed above for strategy 1&2.	Brownington, Coventry, Derby, Irasburg, Glover, Charleston, Holland, Morgan, Westmore	OCNRCD, NRCS, UVM ext, AAFM	AGCWIP, TBPSG
12. Develop a program to identify and implement clean water projects on non-RAP farm that have large phosphorus reduction potential through formula grants.	Basin wide	All towns	OCNRCD, UVM ext, AAFM	Formula grants, TBPSG,
Strategies to address runoff from Developed Lands - Stormwater				

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
13. Develop final designs and implement stormwater treatment projects identified in the Memphremagog Stormwater master plan and subsequent assessments.	Basin wide	All towns	MWA, VTrans	CWI, TBPSG, Formula grants
14. Support local organization to develop a communications, engagement, and funding plan among watershed partners to support individual and coordinated communication of water quality information in the basin and support partners in following through with the communication efforts identified in the plan	Basin wide	All towns	MWA, NWSC, OCNRCD, Lake Associations, DEC, VFWD	CWI capacity building block grant, TBPSG
15. Support the design and implementation of small-scale stormwater practices through formula grant funding.	Basin wide	All towns	MWA, NWSC	Formula grants
16. Provide outreach and technical support to landowners with 3 ac parcels to support early design and implementation of stormwater practices to meet 3 ac permit requirements.	Basin wide	All towns	MWA, NVDA, DEC	TBPSG
17. Develop a list of erosive stormwater outfalls and work with landowners and municipalities to stabilize and restore sites.	Basin wide	All towns	MWA, NVDA, VTrans, NWSC	Formula grants,
18. Develop a residential landowner stormwater BMP campaign/brochure to raise awareness of simple stormwater management solutions such as gutter downspout disconnection, lawn maintenance BMPs and Lawn Wise practices, and buffer strips.	Basin wide	All towns	MWA, OCNRCD, NVDA, NWSC	TBPSG
Strategies to address runoff from Developed Lands - Roads				
19. Coordinate the work of partners through the NEK Rivers and Roads 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 and install and maintain of road BMPs to meet MRGP standards.	Basin wide	All towns	ECNRCD, OCNRCD, VTrans, NVDA, DEC, Towns	TBPSG, River & Roads Training Program
20. Develop prioritization and design guidelines to address gully erosion from road cross culvert outlets and failed class 4 roads.	Basin wide	All towns	DEC, ECNRCD, OCNRCD, VTrans, NVDA, NWSC, DEC, MWA, Towns	TBPSG

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
21. Provide technical support to towns to implement MRGP projects that are identified as having significant water quality impacts through REIs, LWAP's, and gully erosion inventory.	Basin wide	All towns	OCNRCD, ECNRCD, VTrans, NVDA, DEC, Towns, MWA, NWSC	AOT MAB Grants, Grant-in-Aid
22. Develop private road phosphorus reduction estimates for the Lake Memphremagog watershed.	Basin wide	All towns	DEC, OCNRCD, ECNRCD, VNVDA, MWA	TBPSG
23. Complete private road REIs of priority private road segments in the Lake Memphremagog watershed, and design and implement priority restoration projects.	Willoughby, Shadow Parker, Salem, Echo, Seymour, Crystal, Great and Little Averill, Norton, Island, Holland, Bean, Memphremagog	Westmore, Glover, Derby, Morgan, Holland, Charleston, Brighton, Barton, Norton	NVDA, OCNRCD, ECNRCD, DEC, NWSC	CWI, formula grants,
24. Provide support to towns on BMPs to avoid invasive species spread along roads and implement invasive species control efforts.	Basin wide	All towns	All towns, ECNRCD, UCISMA, USFWS, Vtrans, Towns	USFWF, TBPSG
25. Develop a phosphorus control plan for state transportation infrastructure in the Lake Memphremagog watershed as required by the TS4 permit.	Basin wide	All towns	VTrans, DEC	
Strategies to address Wastewater				
26. Support towns in completing WWTF optimization efforts to reduce phosphorus loading from WWTF in the watershed	Barton, Brighton, Orleans, Newport City, Glover	Barton, Brighton, Orleans, Newport City, Glover	DEC, Towns	CWSRF
27. Provide technical and financial support for the town of Brighton to increase the level of phosphorus treatment for the Brighton WWTF as part of WWTF updates.	Brighton	Brighton	DEC, Brighton	CWSRF

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
28. Promote septic system maintenance through local outreach and education programs, such as septic socials.	Lake Watersheds with increasing nutrient trends	Westmore, Glover, Derby, Morgan, Holland, Charleston, Brighton, Barton, Norton	DEC, Towns, Lake associations, MWA	TBPSG
29. 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.	Craftsbury, Irasburg, Glover	Craftsbury, Irasburg, Glover	DEC	CWSRF, EPA Engineering Planning Advance, MPG, USDA-RD SEARCH grants
Strategies to support Natural Resource Protection and Restoration - Rivers				
30. Develop a Memphremagog specific functioning floodplains initiative (FFI) tool or alternative to estimate phosphorus reductions for river protection and restoration projects in the Lake Memphremagog watershed.	Basin wide	All towns	DEC, FFI team, MWA	GLFC, CWIP
31. Provide training on the use of the Memphremagog FFI tool for watershed partners.	Basin wide	All towns	MWA, OCNRCD, ECNRCD, NWSC, DEC	TBPSG, GLFC
32. Complete Phase 2 lite or full Phase 2 assessments on priority reaches in the basin as part of riparian lands assessment process.	Mad, Lamphere, Cass, Stony, Valley, Sucker and Shanley Brooks. Willoughby, Black and Brownington Rivers.	Albany, Brownington, Coventry, Craftsbury, Charleston, Irasburg, Morgan	MWA, OCNRCD, NWSC, FWD, DEC	GLFC, CWIP
33. Pilot the identification, design and implementation of low tech “process based” restoration projects to restore fluvial processes in small drainages.	Basin wide	All towns	MWA, OCNRCD, ECNRCD, NWSC, FWD, DEC	DIBG, Formula grants, GLFC
34. Develop riparian hydroseeding techniques and implement where there is sufficient area, soils and other features most likely to restore a functional buffer.	Basin wide	All towns	MWA, OCNRCD, NWSC, FWD, DEC	DIBG, Formula grants, NFWF, CREP, EQIP, GLFC
35. 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	MWA, OCNRCD, ECNRCD, NWSC, FWD, DEC	Formula grants, GLFC, TBPSG

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
36. Expand protections for riparian lands though acquisition or easements in priority reaches, as well as the implementation of riparian restoration projects to restore river geomorphic conditions and fish habitat.	Black, Barton, Clyde, Johns, Tomifobia Rivers and tributaries	All towns except Norton, Averill	MWA, OCNRCD, ECNRCD, NWSC, FWD, DEC	DIBG, Formula grants, NFWF, CREP, GLFC, TFS
37. Host local workshops to expand knowledge about the updates to the FEMA flood maps across Orleans County.	Basin wide	All towns	MWA, NVDA, DEC	TBPSG
38. Provide support for Municipalities to update flood hazard bylaws and to consider adoption of river corridor protections as new FEMA maps are developed for towns and towns are required to update bylaws to be FEMA compliant.	Basin wide	All towns	NVDA, DEC	FEMA, TBPSG
39. Target strategic wood additions to restore Brook Trout habitat in streams which were historically impacted by logging operations.	Number 5 & 6 Brooks, Big Valley Brook, Assessment for Mad Brook,	Norton, Sutton, Charleston	MWA, NWSC, FWD, TU	DIBG, Formula grants, NFWF, EQIP, GLFC
40. Develop a list of priority culverts for AOP and restoration potential and impact along with potential stream geomorphic benefits through the Memphremagog AOP workgroup.	Basin wide	All towns	MWA, OCNRCD, ECNRCD, NWSC, FWD, DEC, USFW	TBPSG, GLFC, SWIG
41. Work with towns and private landowners to retrofit or replace priority culverts to restore AOP and geomorphic capability.	Basin wide	All towns	MWA, OCNRCD, ECNRCD, NWSC, FWD, DEC, USFW	DIBG, RCPP Better Roads, SWIG, EBTJV, GLFC
42. Identify potential dam and legacy sediment removal projects in the basin.	Basin wide	All towns	MWA, OCNRCD, ECNRCD, NWSC, FWD, DEC, USFW	TBPSG, RCPP, NFWF, USFWS
Strategies to support Natural Resource Protection and Restoration - Lakes				
43. Complete Lake Watershed Action plans for Lake Willoughby, Shadow Lake, Lake Seymour and Echo Lake and seek funding for LWAPS for priority lakes where there is sufficient community engagement to make assessments successful.	Willoughby, Shadow Parker, Salem, Echo, Seymour (top priority) Crystal, Great and Little Averill, Norton (2nd priority)	Westmore, Glover, Derby, Morgan, Charleston, Barton, Norton	OCNRCD, ECNRCD, MWA, NWSC, Lake Associations	CWIP, Formula grant

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
44. Support Lake Wise assessments on lakes with community support.	LWAP lakes + Island, Holland, Bean, Memphremagog	Westmore, Glover, Derby, Morgan, Holland, Charleston, Brighton, Barton, Norton	OCNRCD, ECNRCD, MWA, Lake Associations	Formula grants, PDBG, TBPSG
45. Design and implement projects identified through Lake Wise assessments and through the Lake Watershed Action Plans.	LWAP lakes + Island, Holland, Bean, Memphremagog, public beaches.	Westmore, Glover, Derby, Morgan, Holland, Charleston, Brighton, Barton, Norton	OCNRCD, ECNRCD, MWA NWSC	CWI, TBPSG, Watershed Grant, EDDIBG &DIBG
46. Develop a Lake Wise BMP O&M program in coordination with the Memphremagog CWSP to monitor and evaluate the status of lakeshore BMPs with phosphorus reductions and maintain practices.	LWAP lakes + Island, Holland, Bean, Memphremagog	Westmore, Glover, Derby, Morgan, Holland, Charleston, Brighton, Barton, Norton	MWA, OCNRCD, DEC, Lake Associations	Formula grant
47. Support the development of a regional Lake Coordinator position based at a partner organization to manage lake shoreland outreach, assessments, project identification, development, and implementation.	Basin wide	All towns	MWA, OCNRCD, DEC	CWI, Formula grant
48. Build capacity locally to increase designers, contractors and landscapers in the region able to support lakeshore restoration projects.	Basin wide	All towns	MWA, OCNRCD, DEC	TBPSG, CWI
49. Support A(1) designation for aesthetics on lakes.	Shadow, Echo, Seymour, Willoughby	Holland, Charleston, Westmore, Glover	MWA, OCNRCD, DEC, Lake Associations	TBPSG
50. Support greeter boat washing stations on Lake Memphremagog to reduce spread to and from this potential vector lake in the basin.	Lake Memphremagog	Newport City, Newport Town	MWA, DEC, FWD	Aquatic Nuisance Control Grant
51. Develop a coordinated citizen science program though the VIPA program to monitor Zebra mussel spread in Lake Memphremagog and watershed lakes and ponds.	Basin wide	All towns	MWA, OCNRCD, DEC, Lake Associations	Aquatic Nuisance Control Grant, TBPSG
52. Coordinate aquatic invasive species spread prevention efforts throughout the basin among lake associations through collaboration on local Public Access Greeter Programs, hosting a VIP/A trainings in the watershed at priority lakes, installing signage on public accesses, and conducting aquatic plants surveys.	Basin wide	All towns	MWA, OCNRCD, DEC, Lake Associations	Aquatic Nuisance Control Grant, TBPSG

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
Strategies to support Natural Resource Protection and Restoration - Wetlands				
53. Develop wetland restoration phosphorus reduction credits for the Lake Memphremagog watershed.	Basin wide	All towns	MWA, OCNRCD, NWSC, DEC	CWI, Formula grants
54. Coordinate partner outreach to landowners of high and medium priority potential wetland restoration sites that have been identified in the basin to identify landowners supportive for wetland restoration projects.	Basin wide	All towns	MWA, OCNRCD, ECNRCD, NWSC, DEC	CWI, Formula grants, GLFC
55. Develop designs and implement wetland restoration projects through WRE or alternative funding models.	Basin wide	All towns	MWA, OCNRCD, ECNRCD, NWSC, DEC, NRCS	CWI, Formula grants, GLFC
56. Develop funding and stewardship model to support smaller scale wetland restoration projects (5-30 acres) in the basin.	Basin wide	All towns	MWA, OCNRCD, ECNRCD, NWSC, DEC, NRCS	CWI, Formula grants
57. Provide support to the Wetlands Program for publicizing updated wetland mapping for the Lake Memphremagog basin.	Basin wide	All towns	MWA, OCNRCD, ECNRCD, NWSC, DEC, NRCS	TBPSG
58. Develop technical resources for designing and implementing small scale process-based wetland restoration projects.	Basin wide	All towns	MWA, OCNRCD, ECNRCD, NWSC, DEC,	TBPSG, Formula grants
59. Support local efforts to reclassify identified wetlands as Class One wetlands.	Basin wide	All towns	MWA, OCNRCD, ECNRCD, NWSC, DEC,	TBPSG
Strategies to support Natural Resource Protection and Restoration - Forests				
60. Complete forest road erosion inventories on state lands in the basin and fix high priority forest road erosion problems that are identified.	Willoughby State Forest, Bill Sladyk WMA	Westmore, Barton, Norton, Holland.	VDFPR, MWA	CWI
61. Work with large forestland owners, especially those with roads that have access easements, to use the road erosion inventory to identify forest road restoration projects to address water quality issues.	Brownington Branch, Nutting Brook, Mad Brook, Rogers Brook, Seaver Branch, Shalney Branch	Brownington, Albany, Craftsbury, Charleston, Westmore, Lowell	MWA, OCNRCD, VDFPR	CWI, TBPSG

Strategy	Priority Area or Watershed	Town(s)	Partner(s)*	Funding*
62. Implement priority road projects identified through assessments on state lands and lands with state access easements.	Willoughby State Forest, Bill Sladyk WMA	Westmore, Barton, Norton, Holland.	VDFPR, MWA, FWD	CWI,
63. Implement private forest road restoration projects with NRCS or CWSP funding or through formula grants.	Brownington Branch, Nutting Brook, Mad Brook, Rogers Brook, Seaver Branch, Shalney Branch	Brownington, Albany, Craftsbury, Charleston, Westmore, Lowell	MWA, OCNRCD, ECNRCD, NRCS, VDFPR	RCPP, EQIP, Formula grant, CWI
64. Develop phosphorus load reduction estimates and assessment protocols for trail erosion inventories, including VAST trails.	Basin wide	All towns	MWA	TBPSG,
65. Continue efforts to identify gully erosion through remote sensing, identify which of these may be able to be remediated, where landowners are supportive and implement with formula grant funding.	Basin wide	All towns	MWA, OCNRCD, ECNRCD, VDFPR	Formula grant, CWI
66. Reinvigorate the Orleans County Skidder bridge program and increase the use of skidder bridges through direct grants to foresters to purchase skidder bridges.	Basin wide	All towns	OCNRCD, ECNRCD, VDFPR	CWI
67. Work with snowmobile and ATV clubs to identify eroding trails, undersized stream crossings, and related sources of sediment to streams. Coordinate with trail managers and landowners to implement phosphorus reduction projects.	Basin wide	All towns	MWA, VAST, VDFPR	Formula grant, TBPSG, CWI

E. Monitoring and Assessment Table

The Monitoring and Assessment Table (Table 17) provides a preliminary list of water quality monitoring priorities to guide monitoring over the next five years. The ANR's Water Quality Monitoring Strategy describes the monitoring programs supported by ANR and its partners, who are listed in Chapter 2. Common goals for monitoring efforts across programs include identifying water quality conditions, tracking water quality trends, identifying pollution sources and evaluating improvements over time. The table includes more sites than there is capacity to monitor and as such, will be further prioritized before monitoring occurs.

Table 17. Priorities For Monitoring and Assessment

Waterbody	Project Description	Location	Partner(s)	Purpose
Lakes and Ponds				
1. Lake Memphremagog	Chemical monitoring, AIS, Cyano	Newport/Derby	DEC – Lakes, Volunteers	Phosphorus monitoring to determine progress in reducing nutrient levels, monitoring for zebra mussel spread through EDNA and physical surveys, Cyanobacteria to evaluate trends
2. Mud Pond (Morgan) North	Chemical monitoring, Check Depth (listed as 3 ft in database but looks deeper)	Morgan	DEC - Lakes	Insufficient data to determine water quality status. Larger pond (38 ac) with a high percentage of agricultural land including barnyard in watershed. Previous sampling results above class B phosphorus standard on some dates.
3. Walker Pond (Coventry)	Chemical monitoring	Coventry	DEC - Lakes	Insufficient data to determine water quality trend. Waterbody impaired for phosphorus due to agricultural runoff.
4. Mud Pond (Craftsbury)	Chemical monitoring	Coventry	DEC - Lakes	Determine water quality status since this waterbody is impaired for phosphorus due to agricultural runoff.
5. Identified Lakes and Ponds	Complete AIS survey and plankton net survey.	Multiple	DEC - Lakes	Generate AIS status of lakes and ponds with no data.
Rivers and Streams				
6. Black River Tributary 1	Biological and chemical monitoring.	Coventry	DEC - MAP	Determine cause of *Poor* fish community
7. Black River Tributary 2	Biological and chemical monitoring.	Coventry	DEC - MAP	Monitoring needed to determine the status of potentially impaired stream.
8. Trout Brook	Biological and chemical monitoring.	Brownington	DEC - MAP	Determine cause of *Poor* fish community

9. Clyde River Tributary 1	Biological and chemical monitoring.	Orwell	DEC - MAP	Monitoring needed to determine status of potentially impaired stream.
10. Mad Brook	Biological and chemical monitoring.	Westmore, Charleston	DEC - MAP	Monitoring needed to determine B(2) status of aquatic biota.
11. Stearns Brook	Biological and chemical monitoring.	Holland	DEC - MAP	Monitoring needed to determine B(2) status of aquatic biota.
12. Greens Brook	Chemical monitoring.	Derby	OCNRCD, VFW	Monitoring needed to understand reduced recruitment of salmon in lower Clyde River system.
13. Coche Brook	Biological and chemical monitoring.	Derby	DEC – MAP, OCNRCD, VFW	Data Gap. Monitoring needed to understand reduced recruitment of salmon in lower Clyde River system.
14. Orcutt Brook	Chemical monitoring.	Derby	OCNRCD, VFW	Monitoring needed to understand reduced recruitment of salmon in lower Clyde River system.
15. Clyde River tributary (South tributary below Lake Salem)	Chemical monitoring.	Derby	OCNRCD, VFW	Monitoring needed to understand reduced recruitment of salmon in lower Clyde River system.
16. Tributaries to Lake Willoughby	Chemical monitoring.	Westmore	LaRosa, Westmore Association	Identify tributaries that may disproportionally contribute phosphorus.
17. Tributaries to Echo Lake	Chemical monitoring.	Pawlet	LaRosa, Echo Lake Protective Association	Identify tributaries that may disproportionally contribute phosphorus.
18. Tributaries to Little Averill Lake	Chemical monitoring.	Averill	LaRosa, Averill Lake association	Identify tributaries that may disproportionally contribute phosphorus.
19. Tributaries to Shadow Lake	Chemical monitoring.	Glover	LaRosa, Shadow Lake Association	Identify tributaries that may disproportionally contribute phosphorus.
20. Tributaries to Lake Parker	Chemical monitoring.	Glover	LaRosa, Lake Parker Association	Identify tributaries that may disproportionally contribute phosphorus.
21. Tributaries to Norton Pond	Chemical monitoring.	Norton	LaRosa, Local partner TBD	Identify tributaries that may disproportionally contribute phosphorus.
22. Tributaries to Great Averill Lake	Chemical monitoring.	Averill	LaRosa, Averill Lake association	Identify tributaries that may disproportionally contribute phosphorus.
23. Tributaries to Crystal Lake	Chemical monitoring.	Barton	LaRosa, Crystal Lake association	Identify tributaries that may disproportionally contribute phosphorus.
24. Agricultural BMP monitoring	Chemical monitoring.	BMP target watersheds	OCNRCD	Target BMP implementation efforts on farms and evaluate BMP effectiveness.
25. Holland Brook outflow	Biological monitoring	Holland	DEC - MAP	Data gap in 39 sq km watershed. May be lower priority due to upstream lake influence.

26. Sucker Brook	Biological and chemical monitoring.	Morgan	DEC - MAP	Data gap in 18 sq km watershed with active agricultural use that may benefit from restoration efforts.
27. Day Brook	Biological monitoring.	Coventry	DEC - MAP	Data gap in 17 sq km watershed. May be lower priority due to upstream lake influence.
28. Upper Seaver Brook	Biological monitoring.	Albany, Craftsbury	DEC - MAP	Data gap in 15 sq km watershed with active agricultural use and dirt roads.
29. Mill Brook	Biological and chemical monitoring	Westmore	DEC - MAP	Data gap in moderate sized watershed with greater than 30% agricultural and developed land use.
30. Mill Brook	Biological and chemical monitoring.	Westmore	DEC - MAP	Data gap in moderate sized watershed with greater than 30% agricultural and developed land use.
31. Lord Brook	Biological and chemical monitoring.	Barton	DEC - MAP	Data gap in moderate sized watershed with greater than 30% agricultural and developed land use.
32. Black River Trib (Leaf Hill Brook)	Biological monitoring	Irasburg	DEC - MAP	Data gap in watershed with greater than 50% agricultural and developed land use.
33. Clyde River Trib (Route 91 Creek/Rock Junkyard)	Biological monitoring	Irasburg	DEC - MAP	Data gap in watershed with greater than 50% agricultural and developed land use with elevated nutrients based on chemical monitoring.
34. Stearns Brook Trib 2 (Goodall Creek)	Biological and chemical monitoring	Holland	DEC - MAP	Data gap in watershed with greater than 50% agricultural and developed land use.
35. Lightning Brook	Biological monitoring.	Brighton	DEC - MAP	Data gap in moderate sized watershed with less than 5% agricultural and developed lands. Evaluate potential impact of water withdrawal.
36. Upper Coaticook Brook	Biological monitoring.	Norton	DEC - MAP	Data gap in moderate sized watershed with less than 5% agricultural and developed lands.
37. Station Brook	Biological monitoring.	Norton	DEC - MAP	Data gap in moderate sized watershed with less than 5% agricultural and developed lands.
38. Cold Brook	Biological monitoring.	Brighton	DEC - MAP	Data gap in moderate sized watershed with less than 5% agricultural and developed lands
39. Seaver Branch	Biological monitoring	Craftsbury	DEC - MAP	Data gap in moderate sized watershed with less than 5% agricultural and developed lands
40. Wheeler Brook	Biological monitoring.	Sutton/Barton	DEC - MAP	Data gap in moderate sized watershed with less than 5% agricultural and developed lands
41. Gaudette Brook	Biological monitoring.	Norton	DEC - MAP	Data gap in moderate sized watershed with less than 5% agricultural and developed lands

42. Whitney Brook 4.4	Biological monitoring.	Greensboro	DEC - MAP	Determine potential for enhanced protection as outlined in Table 6.
43. Shadow Lake Brook, 3.1	Biological monitoring.	Glover	DEC - MAP	Determine potential for enhanced protection as outlined in Table 6.
44. Duck Pond Brook Trib # 3, 0.2	Biological monitoring.	Sheffield	DEC - MAP	Determine potential for enhanced protection as outlined in Table 6.
45. Annis Brook, 0.5	Biological monitoring.	Sheffield	DEC - MAP	Determine potential for enhanced protection as outlined in Table 6.
46. Roaring Brook, 5.3	Biological monitoring.	Glover	DEC - MAP	Determine potential for enhanced protection as outlined in Table 6.
47. Rogers Branch, 1	Biological monitoring.	Albany	DEC - MAP	Determine potential for enhanced protection as outlined in Table 6.
48. McCleary Brook, 2	Biological monitoring.	Albany	DEC - MAP	Determine potential for enhanced protection as outlined in Table 6.
49. Lamphear Brook, 1.1	Biological monitoring.	Albany	DEC - MAP	Determine potential for enhanced protection as outlined in Table 6.
50. Brighton Brook, 0.9	Biological monitoring.	Irasburg	DEC - MAP	Determine potential for enhanced protection as outlined in Table 6.
51. Brownington Branch, 1.3	Biological monitoring.	Brownington	DEC - MAP	Determine potential for enhanced protection as outlined in Table 6.
52. Pherrins River, 2	Biological monitoring.	Brighton	DEC - MAP	Determine potential for enhanced protection as outlined in Table 6.
53. Webster Brook, 4.6	Biological monitoring.	Morgan	DEC - MAP	Determine potential for enhanced protection as outlined in Table 6.
54. Crystal Brook, 0.3	Biological monitoring.	Derby	DEC - MAP	Determine potential for enhanced protection as outlined in Table 6.
Wetlands				
55. Black River Wetlands	Wetland assessment, spatial data	Coventry Newport City	DEC - Wetlands	Assessment for Class I wetland considerations.
56. Barton River Wetlands	Wetland assessment, spatial data	Coventry	DEC - Wetlands	Assessment for Class I wetland considerations.
57. Upper Clyde River Wetlands	Wetland assessment, spatial data	Charleston	DEC - Wetlands	Assessment for Class I wetland considerations.

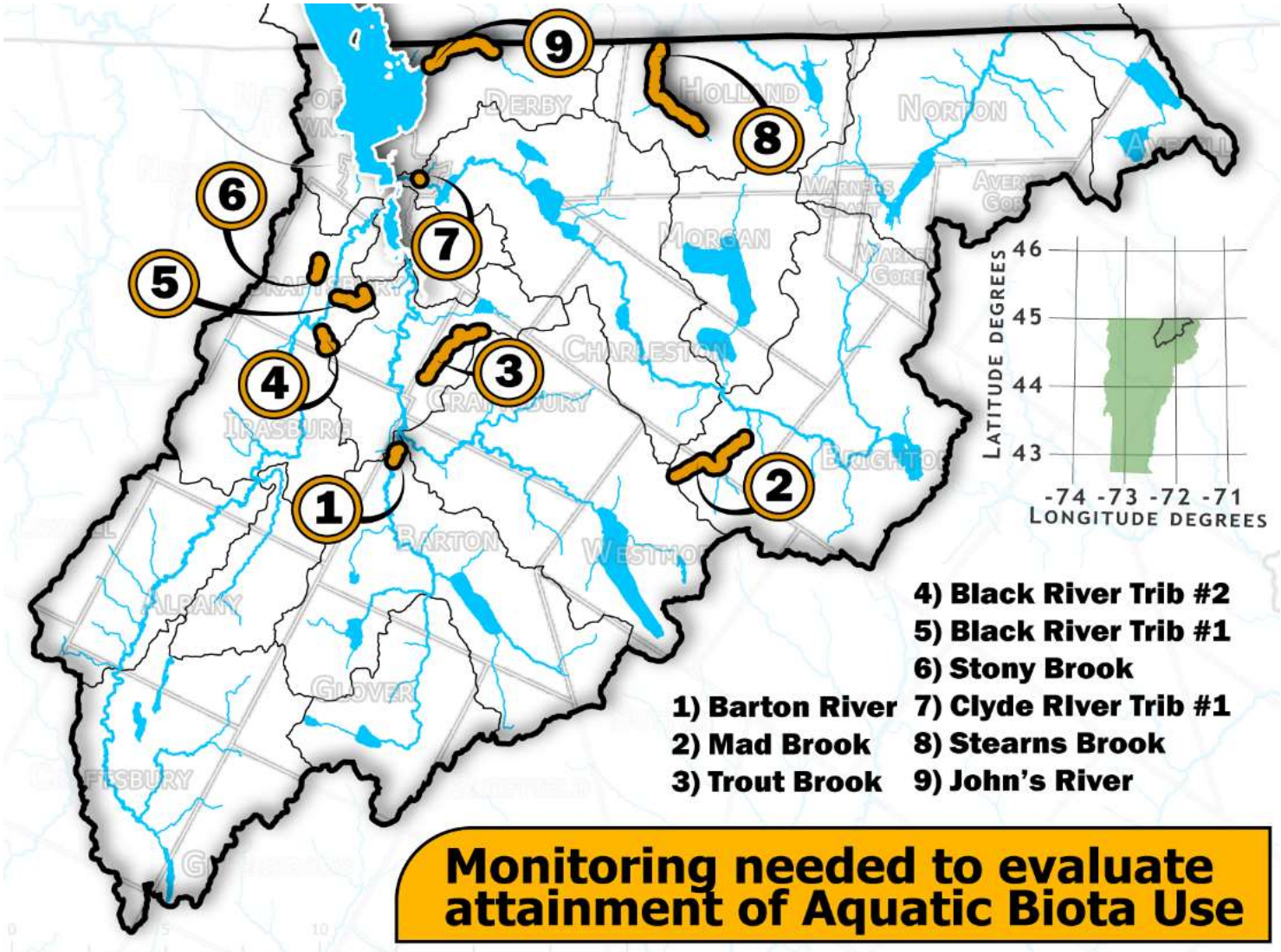


Figure 28. Maps of rivers where monitoring is needed to evaluate attainment of aquatic biota use.

List of Acronyms

319	Federal Clean Water Act, Section 319
604(b)	Federal Clean Water Act, Section 604b
A(1)	Class A(1) Water Management
A(2)	Class A(2) Water Management
AAFM	Agency of Agriculture, Food and Markets
ACEP-ALE	Agricultural Conservation Easement Program – Agricultural Land Easements
ACEP-WRE	Agricultural Conservation Easement Program – Wetland Reserve Easements
ACWIP	Agricultural Clean Water Initiative Grant Program
AIS	Aquatic Invasive Species
AMA	Agricultural Management Assistance Program
AMP	Acceptable Management Practice
ANR	Agency of Natural Resources
ANS	Aquatic Nuisance Species
ANR	Agency of Natural Resources
AOP	Aquatic Organism Passage
ARRA	American Reinvestment & Recovery Act
B(1)	Class B(1) Water Management
B(2)	Class B(2) Water Management
BMP	Best Management Practice
BWQC	Basin Water Quality Council
CISMA	Cooperative Invasive Species Management Area
CNMP	Comprehensive Nutrient Management Plans
CREP	Conservation Reserve Enhancement Program
CRP	Conservation Reserve Program
CWA	Federal Clean Water Act
CWIP	Clean Water Initiative Program
CWSP	Clean Water Service Provider
CWSRF	Clean Water State Revolving Fund
DEC	Department of Environmental Conservation
DIBG	Design-Implementation Block Grant
DPW	Department of Public Works
DWSRF	Drinking Water State Revolving Fund
EBTJV	Eastern Brook Trout Joint Venture
EQIP	Environmental Quality Incentive Program
ERAF	Emergency Relief and Assistance Fund
ERP	Ecosystem Restoration Program
FAP	Farm Agronomic Practices
FEH	Fluvial Erosion Hazard
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FFI	Functioning Floodplains Initiative
FIRM	Flood Insurance Rate Maps
FOVLAP	Federation of Vermont Lakes and Ponds
FRP	Flow Restoration Plan
FSA	Farm Service Agency (USDA)

FWD	Fish and Wildlife Department
GIS	Geographic Information System
HUC	Hydrologic Unit Code
ICAR	Interagency Committee on Administrative Rules
IDDE	Illicit Discharge Detection and Elimination
LCAR	Legislative Committee on Administrative Rules
LFO	Large Farm Operation
LiDAR	Light Detection and Ranging
LID	Low Impact Development
LIP	Landowner Incentive Program
LIS	Long Island Sound
LISFF	Long Island Sound Futures Fund
LTP	Land Treatment Planner
LPP	LaRosa Partnership Program
LWM	Large Woody Material
MAP	Monitoring and Assessment Program
MCM	Minimum Control Measures
MFO	Medium Farm Operation
MPG	Municipal Planning Grant
MRGP	Municipal Roads General Permit
MSGP	Multi-Sector General Permit
MS4	Municipal Separate Storm Sewer System
MWA	Memphremagog Watershed Association
NASS	National Agricultural Statistics Service
NFIP	National Flood Insurance Program
NMP	Nutrient Management Plan
NEAS	New England Agricultural Statistics
NEGEF	New England Grassroots Environmental Fund
NFWF	National Fish and Wildlife Foundation
NOAA	National Oceanic and Atmospheric Administration
NOFA	Northeast Organic Farming Association of Vermont
NPDES	National Pollution Discharge Elimination System
NPS	Non-point source pollution
NRCC	Natural Resource Conservation Council
NRCD	Natural Resource Conservation District
NRCS	Natural Resources Conservation Service
NWSC	NorthWoods Stewardship Center
OCNRCD	Orleans County Natural Resources Conservation District
ORW	Outstanding Resource Water
PDBG	Project Development Block Grant
PDM	Pre-Disaster Mitigation
PFAS	Per- and Polyfluoroalkyl Substances
PFW	Partners for Fish and Wildlife
R,T&E	Rare, Threatened and Endangered Species
RAP	Required Agricultural Practice
RCE	River Corridor Easement
RCP	River Corridor Plan
RCPP	Regional Conservation Partnership Program

REI	Road Erosion Inventory
RPC	Regional Planning Commission
SFO	Small Farm Operation
SGA	Stream Geomorphic Assessment
SPA	Source Protection Area
SWG	State Wildlife Grant
SWMP	Stormwater Master Plan
TFS	Trees for Streams
TBP	Tactical Basin Plan
TBPSG	Tactical Basin Plan Support Grant
TMDL	Total Maximum Daily Load
TNC	The Nature Conservancy
TS4	Transportation Separate Storm Sewer System Permit
TU	Trout Unlimited
USACE	United States Army Corp of Engineers
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
USFS	United States Forest Service
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
VABP	Vermont Agricultural Buffer Program
VACD	Vermont Association of Conservation Districts
VAPDA	Vermont Association for Planning and Development Agencies
VDFPR	Vermont Department of Forests, Parks and Recreation
VDHP	Vermont Department of Historic Preservation
VDOH	Vermont Department of Health
VEM	Vermont Emergency Management
VFB	Vermont Farm Bureau
VGS	Vermont Geological Survey
VINS	Vermont Institute of Natural Science
VIP	Vermont Invasive Patrollers
VLCT	Vermont League of Cities and Towns
VLRP	Vermont Local Roads Program
VLT	Vermont Land Trust
VNNHP	Vermont Nongame and Natural Heritage Program
VNRC	Vermont Natural Resources Council
VRC	Vermont River Conservancy
VSA	Vermont Statutes Annotated
VTrans	Vermont Agency of Transportation
VYCC	Vermont Youth Conservation Corp
WISPr	Water Infrastructure Sponsorship Program
WQS	Water Quality Standards
WSMD	Watershed Management Div., VT DEC
WUV	Watersheds United Vermont
WWTF	Wastewater Treatment Facility

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Appendix A. Dams in Basin 17

Table A1. List of dams in Basin 17. These dams are either in service, partially breached, breached, or removed. Source: Vermont Dam Inventory (accessed: 01/10/2023).

Dam Name	Stream	Dam Status	Dam Purposes
Paine Site No. 1	Willoughby River-TR	In Service	Recreation
Paine Site No. 2	Willoughby River-TR	In Service	Recreation
Barton Reservoir	May Pond Brook	In Service	Water Supply
May Pond	May Pond Brook	In Service	Water Supply
Crystal Lake	Barton River-TR	In Service	Recreation
Orleans	Barton River	Breached	
Barton-7	Barton River-OS	In Service	
Walker	Barton River -TR - OS	Removed	
Evansville	Willoughby River	Breached (Partial)	
Lake Parker	Roaring Brook	In Service	Recreation
Shadow Lake	Barton River-TR	In Service	Recreation
Lake Willoughby	Willoughby River	In Service	
Great Hosmer Pond	Black River-TR	In Service	
Little Hosmer Pond	Black River-TR	In Service	Recreation
Craftsbury-3	Black River	Removed	
Alexander	Black River	Removed	
Branch Brook	Branch Brook-TR	In Service	Recreation
Lacoss	Patch Brook-TR	In Service	Fish and Wildlife Pond
West Charleston	Clyde River	In Service	Hydroelectric
Pensioner Pond	Clyde River	In Service	Hydroelectric
Echo Lake	Clyde River-TR	In Service	Hydroelectric
East Charleston	Echo Lake Brook	Breached	
Seymour Lake	Clyde River-TR	In Service	Hydroelectric
Newport No. 1	Clyde River	In Service	Hydroelectric
Newport No. 11	Clyde River	Removed	Hydroelectric
Prouty Mill	Clyde River		
Jobs Pond	Cold Brook	In Service	Recreation
Little Averill Pond	Averill Creek	In Service	Recreation
Great Averill Pond	Averill Creek	In Service	Hydroelectric; Recreation
Swanson	Coaticook River	Breached	Hydroelectric
Norton Pond	Coaticook River	In Service	Hydroelectric; Recreation
Brown	Coaticook River-OS		
Tivoly	Tomifoba River	In Service	Hydroelectric
Holland Pond	Holland Brook	In Service	Water Supply

Appendix B. Responsiveness Summary

Vermont Department of Environmental Conservation

Agency of Natural Resources

Responsiveness Summary to Public Comment regarding:

Basin 17 Tactical Basin Plan

On May 10, 2023, the Vermont Department of Environmental Conservation (VDEC) of the Agency of Natural Resources (ANR) released a final draft of the Basin 17 Tactical Basin Plan for a public comment period. The public comment period commenced on May 10 and ended on June 10, 2023. Press releases were also sent out to regional publications by VDEC, and Natural Resource Conservation Districts (NRCDs) and partnering watershed groups. Additionally, two public meetings were noticed and held by DEC and the organizations.

Meetings for public comment:

May 18, 2023, at 12:00 PM

- In-person Site - Prouty Beach Pavilion, 386 Prouty Beach Rd Newport City, VT
- Virtual and Call-in Teams Meeting
- 35 participants

May 23, 2023, at 6:00 PM

- In-person Site – Gateway Center, 84 Fife Drive Newport City, Vermont
- Virtual and Call-in Teams Meeting
- 9 participants

The DEC prepared this responsiveness summary to address specific comments and questions and to indicate how the plan has been modified in response to public comment. Comments may have been summarized, paraphrased, or quoted in part.

Summary of comments from May 18th public meeting:

Comment: The plan should include a strategy to improve management of state lands with regards to water quality to set an example for good management for the public or private lands.

Response: There have been several projects implemented on state and private lakeshore lands in the watershed which were noted in the final plan and the final plan highlights potential state park projects (Crystal Lake) as well as municipal beaches (Prouty Beach, Willoughby north beach, Seymour beach) as areas for potential lakeshore projects that may also support community messaging around shoreland best practices. Additionally, the Plan identifies ongoing restoration and

protection efforts on state-owned lands, such as strategic wood additions in river corridors, forest road erosion inventories and implementation of priority road projects, and the Riparian Lands Partnership, which enhances and protects riparian habitats on state-owned riparian lands.

Comment: The plan should address the need for increased enforcement of environmental regulations to address rapid development in some areas of the watershed and a need to increase enforcement of local zoning bylaws where these support water quality protections.

Response: Enforcement of environmental regulations is an important element of the Agency's water quality restoration efforts. However, since the TBP is focused on non-regulatory efforts the enforcement of environmental regulations is not addressed in detail in the plan.

Comment: The plan should recommend the creation of a "Lawn Wise" program to encourage upland landowners to manage properties to minimize pollution runoff.

Response: The draft plan includes a strategy to: "Develop a residential landowner stormwater BMP campaign/brochure to raise awareness of simple stormwater management solutions such as gutter downspout disconnection, lawn maintenance, and buffer strips." This was revised to expand lawn maintenance to include: lawn maintenance BMPs and Lawn Wise practices.

Comment: The plan should address limitations in capacity of statewide land conservation organizations that is a constraint on land conservation efforts in the Basin that are important for protecting and restoring water quality.

Response: The public comment meeting was the first time this issue was raised during the planning process and so additional analysis of these limitations is necessary before investing limited resources or a strategy to address this concern. The agency encourages partners to flag when limited capacity of land conservation organizations may impact land conservation efforts that are important to water quality protection and restoration efforts. The Agency has released a capacity building block grant which could support the development of additional capacity for land conservation work if this can be shown to limit water quality restoration work in this basin.

Comment: The Plan should address the need for more outreach to the public on water quality issues in the basin. Examples include:

1) Educational programing for property owners to increase participation and buy into to clean water efforts.
2) Explaining phosphorus on an elemental level
3) Paying farmers to host open houses at local farms and to particpate in workshops and programs.

4) Increasing community engagement by regularly hosting community get-togethers to provide educational opportunities, to elicit help, and to listen to people's frustrations, helps bridge the gap.
    a. Provide town officials with educational opportunities related to water quality and natural resources protections.
    b. Develop peer to peer social marketing and influencing frameworks and campaigns.
    c. More events and volunteer opportunites such as News & Brews, River Clean Ups.
    d. Make education and outreach a part of the process.
    e. Accessible locations, free childcare, multiple communication methods (know how the community gets the word out)
    f. Tactical Basin Planning support workplans can be used to host public forums
    g. Plant sales and other events
    h. Art projects for new audience
    i. Outreach at parks & stores
    j. Outreach is NOT a one-time thing; it needs funding to be a continuous process with updates, new info, and options.
    k. Share success stories!
    l. Coordinated messaging across platforms; encourage different styles, methods & media.

Response: A strategy was added to the plan to "Support local organization to develop a communications, engagement and funding plan among watershed partners to support individual and coordinated communication of water quality information in the basin and support partners in following through with the communication efforts identified in the plan." In addition, the following language was added to the plan to provide some background context for this strategy: "Public comment indicated the need for targeted programming for property owners to increase buy in to clean water efforts, paying farmers to host open houses and participate in workshops and programs, and overall increasing community engagement by hosting community get togethers, and conducting outreach and volunteer events in the basin. In response to these comments a strategy was added to develop a communications plan for watershed partners."

Comment received via Email: Suggested edit to the draft plan to change the following "Holland Pond does not have a lake association but has two active road associations and mailing lists to these associations will be used for outreach on Lake Wise assessments and opportunities to address road runoff and *restore flow across a historical road will be evaluated*." to say "*restore John Judd Brook to its natural bed from the present man-made diversion will be evaluated*."

Response: Thank you for providing this feedback and your support for efforts to protect and restore water quality conditions in Holland Pond. During a site visit conducted during the public comment process there didn't appear to be any cost-effective way to restore the natural drainage of John Judd Brook. However, on this site visit there was an opportunity identified to improve the management of an existing beaver baffle and to harden a VFWD parking lot where gravel washes out when high flows from rain events are directed in this direction by beaver dams in this system.

Efforts to harden the parking lot and redirect flows from the driveway into a natural drainage are being explored and the reference to restoring flows across the historical road in relation to John Judd Brook will be removed from the plan.

Appendix C. Municipal Protectiveness Table

Table C1. Municipal protectiveness matrix for towns with significant area in Basin 17

	National Flood Insurance Program (NFIP)	Road and Bridge Standards	Emergency Operations Plan (LEOP)	Hazard Mitigation Plan (LHMP)	River Corridor Protection	ERAF	Flood Resilience in Town Plan	Road Erosion Inventory		Storm-water Master Plan	Illicit Discharge Detection and Elimination		Storm-water Mapping	Municipal By-law or Zoning District for Water Resource Setback Y = Yes S = Some		
	Enrolled?	Adopted?	Completed?	Adopted?	Adopted?	Percent	Completed	Completed	Year	Completed?	Completed?	Year	Completed?	Rivers	Wetlands	Lakes
Albany	No	No	Yes	Yes[1]	No	7.5%	No	Yes	2018	No	No		No	No	No	No
Albany Village	No	Yes	Yes	Yes[1]	No	7.5%	No	No		No	No		No	No	No	No
Averill UTG	Yes	Yes	Yes	Yes	Yes	17.5%	Yes	No		No	No		No	Y	Y	Y
Barton	Yes	Yes	No	Yes	No	7.5%	No	No		No	No		No	No	No	S
Barton Village	Yes	Yes	Yes	Yes	No	12.5%	No	No		Yes	Yes	2015	Yes	No	No	S
Brighton	Yes	Yes	Yes	No	No	7.5%	No	Yes	2015	Yes	Yes	2015	Yes	No	No	S
Brownington	No	Yes	Yes	Yes	No	7.5%	Yes	Yes	2017	No	No		No	No	No	No
Charleston	No	Yes	Yes	Yes	No	7.5%	No	Yes	2014	No	No		No	No	No	No
Coventry	Yes	Yes	Yes	Yes	No	12.5%	No	Yes	2017	No	No		No	No	No	No
Craftsbury	Yes	Yes	No	Yes	No	12.5%	Yes	Yes	2018	No	No		Yes	No	No	No
Derby	Yes	Yes	Yes	Yes	No	12.5%	No	Yes	2017	Yes	Yes	2015	Yes	No	No	Y
Derby Line Village	Yes	Yes	Yes	Yes	No	12.5% 12.5%	No	No		Yes	Yes	2015	Yes	No	No	No
Glover	Yes	Yes	No	Yes	No	7.5%	No	No		Yes	No	2015	Yes	No	No	No
Greensboro	Yes	Yes	Yes	No	No	7.5%	Yes	No		No	No		No	Y	No	Y
Holland	No	Yes	Yes	No	No	7.5%	Yes	Yes	2018	Yes	No		Yes	No	No	No
Irasburg	No	Yes	Yes	No	No	7.5%	No	Yes	2015	No	No		No	No	No	No

Lowell	Yes	Yes	Yes/no	Yes	No	12.5% /7.5%	No	Yes	2018	No	No		No	No	No	No
Morgan	No	Yes	Yes	No	No	7.5%	No	Yes	2015	No	No		No	No	No	S
Newport City	Yes	Yes	Yes	Yes	No	12.5%	Yes	Yes	2018	Yes	Yes	2015	Yes	No	No	S
Newport Town	Yes	Yes	Yes	No	No	7.5%	Yes	No		No	No		No	No	No	No
Norton	Yes	Yes	Yes	No	Yes	7.5%	Yes	Yes	2018	No	No		No	Y	No	Y
Orleans Village	Yes	Yes	Yes	Yes	No	12.5%	No	No		Yes	Yes	2015	Yes	No	No	S
Troy	Yes	Yes	Yes	Yes	Yes	17.5%	No	Yes	2017	No	No		No	No	No	No
UTG	Yes	Yes	Yes	Yes	Yes	17.5%	Yes	No		No	No		No	Y	Y	Y
Westmore	No	Yes	No	No	No	7.5%	No	Yes	2015	No	No		No	Y	No	Y

Appendix D. Watersheds lacking biological assessment data.

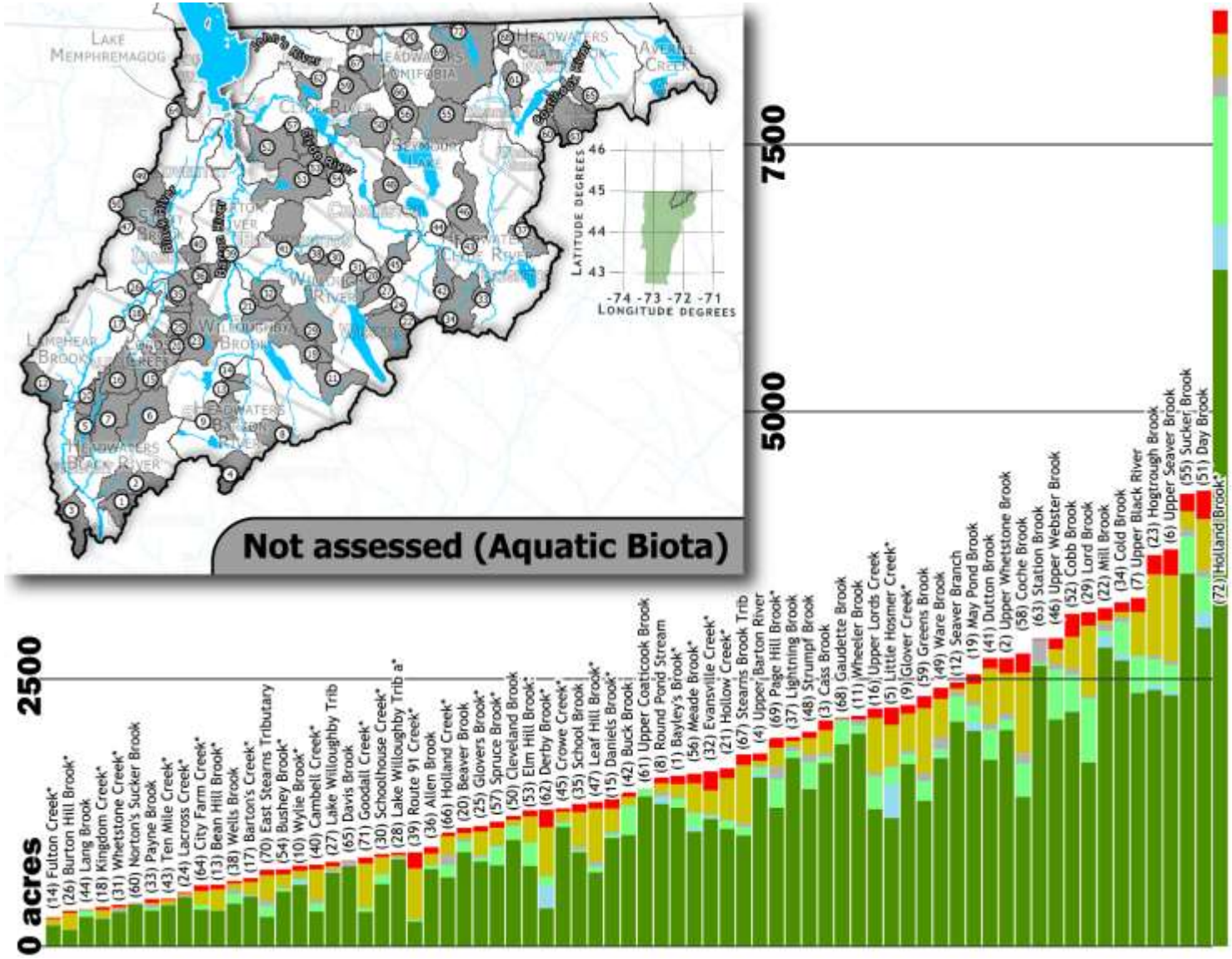

Table D1. Table of watersheds lacking biological data and the associated size and landuse. Bold indicates priority for monitirng.

Map ID	Latitude	Longitude	Watershed (km^2)	Location name	Developed	Agriculture	Other	Wetland	Water	Forest
1	44.6192	-72.3565	6.5	Bayley's Brook*	4.8%	7.3%	1.5%	5.3%	0.0%	81.2%
2	44.6235	-72.3604	10.7	Upper Whetstone Brook	5.1%	14.0%	2.2%	3.6%	0.0%	75.1%
3	44.6294	-72.3853	8.4	Cass Brook	4.3%	10.2%	1.6%	2.8%	0.0%	81.2%
4	44.6571	-72.1987	6.9	Upper Barton River	3.8%	2.5%	1.0%	3.4%	1.8%	87.6%
5	44.6619	-72.3695	8.7	Little Hosmer Creek*	7.1%	17.1%	0.6%	7.2%	14.2%	53.8%
6	**44.6685**	**-72.3280**	**15.0**	**Upper Seaver Brook**	**6.5%**	**21.6%**	**1.1%**	**6.7%**	**0.9%**	**63.3%**
7	44.6687	-72.3584	13.4	Upper Black River	4.0%	12.4%	0.4%	10.3%	0.3%	72.7%
8	44.6786	-72.1814	6.4	Round Pond Stream	3.4%	5.7%	2.5%	0.7%	3.6%	84.3%
9	44.6956	-72.1965	8.9	Glover Creek*	3.5%	15.1%	1.8%	4.2%	0.0%	75.5%
10	44.6990	-72.3831	3.0	Wylie Brook*	6.1%	8.1%	2.4%	3.6%	3.8%	76.0%
11	**44.7019**	**-72.0987**	**8.5**	**Wheeler Brook**	**1.6%**	**0.0%**	**2.6%**	**2.8%**	**0.7%**	**92.3%**
12	**44.7037**	**-72.3938**	**9.8**	**Seaver Branch**	**2.3%**	**1.4%**	**1.8%**	**9.4%**	**0.1%**	**85.1%**
13	44.7139	-72.1929	2.5	Bean Hill Brook*	7.3%	33.5%	0.0%	1.5%	0.0%	57.7%
14	44.7198	-72.1988	1.2	Fulton Creek*	4.5%	20.3%	2.6%	0.5%	0.0%	72.2%
15	44.7351	-72.3202	5.7	Daniels Brook*	6.6%	15.4%	1.9%	2.7%	0.1%	73.3%
16	44.7367	-72.3241	9.1	Upper Lords Creek	3.9%	23.2%	1.6%	13.7%	0.0%	57.7%
17	44.7394	-72.3031	2.7	Barton's Creek*	5.3%	17.3%	2.8%	1.5%	0.0%	73.0%
18	44.7460	-72.2915	1.5	Kingdom Creek*	7.4%	20.4%	1.8%	0.2%	0.0%	70.2%
19	44.7499	-72.1629	10.4	May Pond Brook	3.4%	6.7%	1.5%	6.3%	2.9%	79.2%
20	44.7558	-72.2911	4.6	Beaver Brook	4.4%	4.8%	2.5%	8.8%	0.0%	79.6%
21	44.7579	-72.1900	6.9	Hollow Creek*	5.6%	23.0%	0.8%	4.6%	0.0%	65.9%
22	**44.7658**	**-72.0527**	**12.6**	**Mill Brook**	**3.7%**	**1.0%**	**2.0%**	**1.9%**	**3.2%**	**88.3%**
23	44.7683	-72.2174	14.7	Hogtrough Brook	4.9%	20.8%	0.9%	6.6%	1.3%	65.5%
24	44.7714	-72.0525	2.5	Lacross Creek*	2.2%	3.4%	3.5%	0.0%	0.0%	90.9%
25	44.7742	-72.2783	4.4	Glovers Brook*	4.6%	19.4%	1.9%	3.6%	0.0%	70.5%
26	44.7762	-72.2670	1.2	Burton Hill Brook*	5.9%	47.6%	0.0%	0.8%	0.0%	45.7%
27	44.7795	-72.0598	3.2	Lake Willoughby Trib	5.0%	3.5%	3.9%	0.4%	0.0%	87.2%
28	44.7846	-72.0594	3.8	Lake Willoughby Trib a*	2.4%	2.1%	2.6%	0.1%	0.0%	92.8%

29	44.7885	-72.1208	12.9	Lord Brook	4.0%	21.1%	0.8%	19.1%	0.0%	55.0%
30	44.7949	-72.1050	3.6	Schoolhouse Creek*	3.0%	19.0%	0.0%	10.5%	0.0%	67.4%
31	44.7954	-72.0763	2.4	Whetstone Creek*	4.7%	4.6%	8.6%	0.2%	0.0%	81.9%
32	44.7993	-72.1753	6.6	Evansville Creek*	10.9%	13.0%	1.2%	1.1%	1.1%	72.7%
33	44.7994	-71.9123	1.8	Payne Brook	7.8%	3.4%	6.5%	6.6%	0.0%	75.8%
34	**44.7995**	**-71.9310**	**13.1**	**Cold Brook**	**2.8%**	**1.5%**	**1.3%**	**9.7%**	**1.6%**	**83.1%**
35	44.8004	-72.2714	5.5	School Brook	5.8%	24.2%	2.4%	1.6%	0.1%	65.9%
36	44.8044	-72.2615	3.6	Allen Brook	6.5%	10.9%	0.9%	3.9%	0.0%	77.8%
37	**44.8176**	**-71.8692**	**6.6**	**Lightning Brook**	**1.9%**	**2.6%**	**2.2%**	**3.3%**	**0.0%**	**90.1%**
38	44.8200	-72.1237	2.7	Wells Brook	3.6%	9.0%	7.7%	14.3%	0.0%	65.4%
39	**44.8216**	**-72.2070**	**4.2**	**Route 91 Creek***	**17.1%**	**53.7%**	**1.0%**	**1.9%**	**0.0%**	**26.3%**
40	44.8237	-72.2652	3.3	Cambell Creek*	5.6%	38.1%	3.8%	10.1%	0.0%	42.4%
41	44.8253	-72.1461	11.0	Dutton Brook	3.4%	19.2%	2.0%	10.5%	0.0%	64.8%
42	44.8259	-71.9648	6.1	Buck Brook	2.7%	5.4%	0.5%	18.9%	0.2%	72.3%
43	44.8263	-71.9395	2.2	Ten Mile Creek*	3.1%	10.0%	0.7%	0.2%	0.0%	86.1%
44	44.8304	-71.9515	1.8	Lang Brook	2.1%	0.3%	0.0%	17.9%	0.0%	79.8%
45	44.8338	-72.0063	5.1	Crowe Creek*	2.3%	6.9%	1.0%	3.1%	0.0%	86.6%
46	44.8364	-71.9245	11.8	Upper Webster Brook	3.5%	4.6%	1.9%	16.3%	0.0%	73.7%
47	**44.8443**	**-72.2787**	**5.4**	**Leaf Hill Brook***	**4.6%**	**36.5%**	**3.6%**	**4.1%**	**0.0%**	**51.2%**
48	44.8615	-72.0399	8.7	Strumpf Brook	2.9%	7.6%	3.7%	12.3%	0.2%	73.4%
49	44.8638	-72.2752	9.7	Ware Brook	4.2%	14.8%	4.6%	2.8%	0.8%	72.8%
50	44.8648	-72.2822	4.8	Cleveland Brook	2.9%	4.0%	0.9%	10.5%	0.0%	81.8%
51	**44.8732**	**-72.1749**	**16.7**	**Day Brook**	**6.2%**	**11.2%**	**1.5%**	**8.0%**	**3.2%**	**69.9%**
52	44.8990	-72.1835	12.8	Cobb Brook	6.9%	9.6%	1.8%	10.8%	0.4%	70.6%
53	44.9057	-72.1013	6.3	Elm Hill Brook*	4.4%	19.1%	0.3%	17.0%	0.0%	59.2%
54	44.9102	-72.0906	2.8	Bushey Brook*	6.2%	17.2%	2.0%	3.6%	0.0%	71.0%
55	**44.9117**	**-71.9809**	**17.6**	**Sucker Brook**	**3.8%**	**3.8%**	**1.7%**	**8.2%**	**0.1%**	**82.4%**
56	44.9135	-72.0123	6.5	Meade Brook*	5.5%	16.8%	0.5%	8.4%	2.2%	66.5%
57	44.9180	-72.1145	4.9	Spruce Brook*	4.8%	13.7%	1.2%	14.9%	0.4%	65.0%
58	**44.9217**	**-72.0795**	**12.0**	**Coche Brook**	**6.5%**	**27.6%**	**3.5%**	**11.4%**	**0.0%**	**51.0%**
59	44.9369	-72.0978	9.6	Greens Brook	4.8%	26.2%	3.0%	7.8%	0.1%	58.2%

60	44.9379	-71.8551	1.7	Norton's Sucker Brook	0.2%	0.0%	4.6%	0.0%	0.0%	95.3%
61	**44.9423**	**-71.8840**	**6.1**	**Upper Coaticook Brook**	**0.1%**	**0.0%**	**0.4%**	**4.3%**	**0.0%**	**95.2%**
62	44.9445	-72.1216	5.0	Derby Brook*	12.9%	35.4%	0.5%	6.9%	16.4%	27.9%
63	**44.9523**	**-71.8465**	**11.5**	**Station Brook**	**0.3%**	**0.0%**	**7.8%**	**0.8%**	**0.0%**	**91.1%**
64	44.9529	-72.2355	3.3	City Farm Creek*	9.3%	23.8%	0.1%	6.5%	0.1%	60.2%
65	44.9619	-71.8244	3.3	Davis Brook	0.6%	0.0%	6.0%	0.0%	0.0%	93.3%
66	44.9661	-72.0228	4.2	Holland Creek*	3.2%	16.7%	9.1%	10.5%	0.0%	60.6%
67	**44.9786**	**-72.0356**	**7.4**	**Stearns Brook Trib**	**5.4%**	**30.4%**	**2.0%**	**4.4%**	**0.0%**	**57.8%**
68	**44.9811**	**-71.8282**	**8.5**	**Gaudette Brook**	**0.4%**	**0.1%**	**0.9%**	**10.3%**	**0.0%**	**88.4%**
69	44.9846	-71.9641	8.0	Page Hill Brook*	4.6%	9.3%	5.6%	13.9%	0.0%	66.5%
70	44.9948	-72.0201	3.2	East Stearns Tributary	7.0%	33.2%	7.0%	14.6%	0.0%	38.3%
71	**44.9974**	**-72.0392**	**3.7**	**Goodall Creek***	**6.8%**	**50.2%**	**0.6%**	**3.6%**	**0.0%**	**38.8%**
72	**45.0045**	**-71.9722**	**39.0**	**Holland Brook***	**2.5%**	**4.6%**	**2.2%**	**13.7%**	**4.8%**	**72.3%**