Ottauquechee, Black Rivers & Connecticut River Direct Tributaries

Basin 10 Tactical Basin Plan

Ascutney Mountain from the Connecticut River

DRAFT - May 2023

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:

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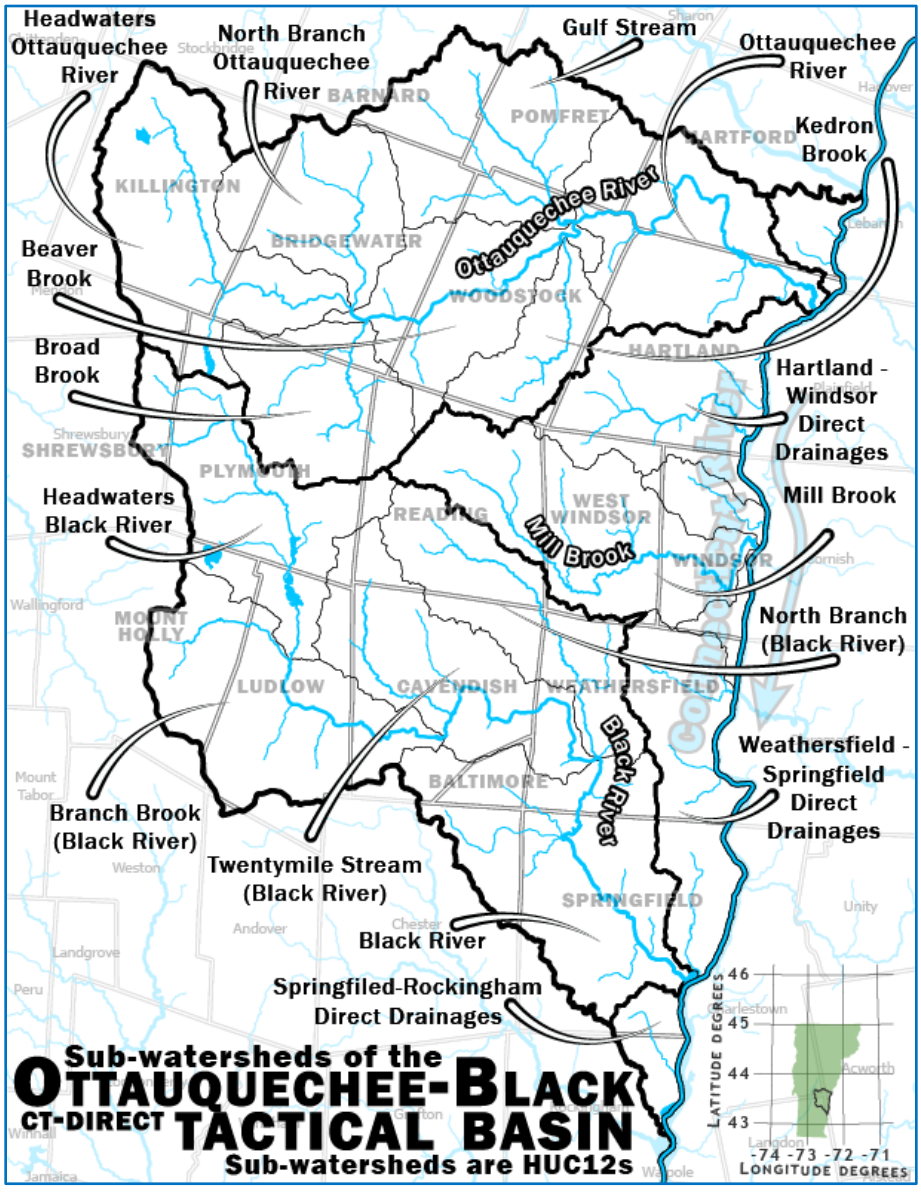
Basin Towns

Andover*	Hartford	Plymouth	Stockbridge
Baltimore	Hartland	Pomfret	Weathersfield
Barnard	Killington	Reading	West Windsor
Bridgewater	Ludlow	Rockingham*	Windsor
Cavendish	Mendon*	Shrewsbury	Woodstock
Chester	Mt. Holly	Springfield	* *Towns with small area within the Basin*

Basin 10 Watershed Boundary and Towns



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Executive Summary

The Ottauquechee-Black-Connecticut River Direct Basin, Basin 10, covers 223 square miles of southeastern Vermont from White River Junction to just north of Bellows Falls. The Basin hosts a number of recreational resorts and their associated development along with Springfield, Woodstock and White River Junction.

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.

In overview, the Basin water quality conditions are assessed at *Very Good* or better with a few exceptions in some of the population centers listed above. Three streams are candidates for reclassification from B(2) to A(1) for aquatic biota; one lake is a reclassification candidate from B(2) to A(1) for aesthetics; and 14 streams from B(2) to B(1) for fishing. Three wetlands are recommended for Class I designation.

Surface waters in both Killington and Ludlow/Okemo show impacts from land development and stormwater runoff. The only listed impaired waters in Basin 10 are two streams impacted by pollutants in urban stormwater near Killington Resort; and three small streams, one each in Bridgewater, Hartford, and Rockingham, which have impairments related to legacy landfills. Altered flows created by the large dams in the Basin impact the entire reach of the Connecticut River through the Basin as well as the lower Ottauquechee River.

The most prevalent water quality issues are flow alteration, land erosion and invasive species. These are being addressed through the sector-based strategies proposed to meet overall protection and restoration goals. These strategies focus on voluntary participation and project implementation by watershed partners in the Basin. 57 detailed strategies are recommended for the next five years.

Target areas and overarching strategies for restoration and protection are summarized in Table 1. Of the 42 strategies identified in the 2018 Basin Plan 86% have been completed or are on-going projects. Others have been carried forward for future implementation.

Monitoring priorities have been identified and 64 locations are identified to fill data gaps, track changes in water quality condition, and identify waters for reclassification and Class I wetland designation. Due to the Long Island Sound TMDL, nitrogen is a key pollutant of concern in the Connecticut River watershed. Total Nitrogen (TN) levels, in the Connecticut River watershed, are being monitored but significant data gaps exist. Nitrogen monitoring will help inform the EPA's development of load allocations therefore targeted monitoring is needed to identify nitrogen discharge loads of the Basin's tributaries.

Adapting how we manage and use our surface waters in the face of climate change is one of the overarching challenges for basin planning. Key findings of the Vermont Climate Assessment are incorporated into this Plan to help address climate adaptation, flood hazard mitigation and

resiliency, and address social equity issues that climate change is exacerbating in Vermont. Strategies addressing climate change issues can be found relating to all the sector categories.

Table 1. Focus Areas and Priority Strategies for Restoration and Protection

See Acronyms List p. 106

Focus Areas	Priority Strategies
AGRICULTURE	
Hartford, Hartland, Windsor, Weathersfield, Springfield, Rockingham	Work on agricultural lands along the Connecticut River to establish and enhance riparian buffers following the stabilization of water level fluctuations from hydropower production
Basin wide	Increase outreach and education to producers in the basin, implement field practices to study N-reduction potential of BMPs and track results of practices implemented
DEVELOPED LANDS - STORMWATER	
Hartford, Hartland, Killington, West Windsor	Continue supporting the development of SWMPs
Ludlow, Springfield, Windsor, Woodstock	Prioritize projects, develop final designs and implement stormwater treatment projects identified in the Stormwater Master Plans and Stormwater Mapping Reports
Plymouth, Ludlow, Windsor	Work with lake communities to mitigate stormwater runoff from development and private roads reaching the lakes
DEVELOPED LANDS - ROADS	
Basin wide	Conduct gully erosion inventory and identify, prioritize and address gully erosion from roads and failed Class 4 roads
Basin wide	Provide technical support to towns to implement MRGP projects identified through REIs, LWAP's, and gully erosion inventories that are having significant water quality impacts
WASTEWATER	
Hartland, Killington, Plymouth, Reading, Weathersfield	Provide outreach on the Village Wastewater Solutions to communities without wastewater treatment, and seek funding for planning and implementation of priority projects that have community support
All towns	Encourage and support upgrades to public wastewater treatment facilities to help remove nitrogen from discharges
NATURAL RESOURCES	
Basin-wide	Support and enhance the riparian buffer and floodplain plantings throughout the landscape
Basin –wide	Support reclassification and designation of rivers, streams, lakes, ponds and wetlands throughout the Basin
Basin –wide	Identify priority areas for conservation easements including forestland, agricultural and riparian land and conduct outreach to landowners to develop opportunities
Basin-wide	Work toward stream equilibrium in all restoration efforts

Focus Areas	Priority Strategies
RIVERS	
Basin-wide	Secure stable funding for the USGS monitoring gauge at Northfield, MA
Windsor, Hartland	Develop an RCP for Hubbard Brook and Lulls Brook
Basin-wide	Support river and stream restoration projects to improve stream geomorphic compatibility, aquatic organism passage, and flood resilience as identified in statewide and local assessments. Prioritize dam removals, and bridge and culvert replacements when possible
Basin-wide	Buy-out properties that are highly vulnerable to flooding from inundation and erosion hazards from willing sellers
LAKES	
Lakes Amherst, Echo, Rescue, Pauline	Establish AIS Greeter Programs
Amherst, Echo, Rescue, Pauline, Ninevah, Runnemede	Develop Lake Watershed Action Plans (LWAP) and provide outreach to the lake communities on the plan and proposed actions, including installation of riparian buffers on lake tributaries
Pinneo, Runnemede, Dewey's Mill	Conduct Lake Wise Assessments and implement lakeshore restoration projects to improve "poor" shoreland score from VT Lake Scorecard
WETLANDS	
No. Branch Black, Twentymile Stream, Mill Brook-N	Restore degraded wetlands for habitat and water quality improvement
Lake Ninevah wetlands, Killington Flats wetlands	Support local efforts to designate wetlands identified as Class I wetlands
FORESTS	
Basin-wide	Continue and expand Portable Skidder Bridge Programs
All state lands	Implement forestry AMPs on high priority state lands through ANR road inventory, prioritization, and implementation
CLIMATE CHANGE ADAPTATION	
Basin-wide	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of Species of Greatest Conservation Need (SGCN) populations & targeted abundance levels
Connecticut River - Rockingham, Weathersfield	Work to maintain connectivity with wildlife populations across the Connecticut River to New Hampshire
SOCIAL EQUITY	
Black River lakes, Basin-wide	Seek opportunities to increase public access to lakes, rivers and wetlands for diverse populations

Focus Areas	Priority Strategies
Basin-wide	Identify communities where water quality concerns prevent use of waters or present unhealthy conditions and address these conditions
Basin-wide	Locate implementation projects where they will offer dual advantages of open space and cleaner environment to underserved populations

The 2018 Basin Plan identified 42 strategies to address protection and restoration of surface waters. Of the 42 strategies identified, 6 are complete, 30 are ongoing, 6 are being carried forward into this plan (Figure 1). The Basin Report Card is included as Appendix A.

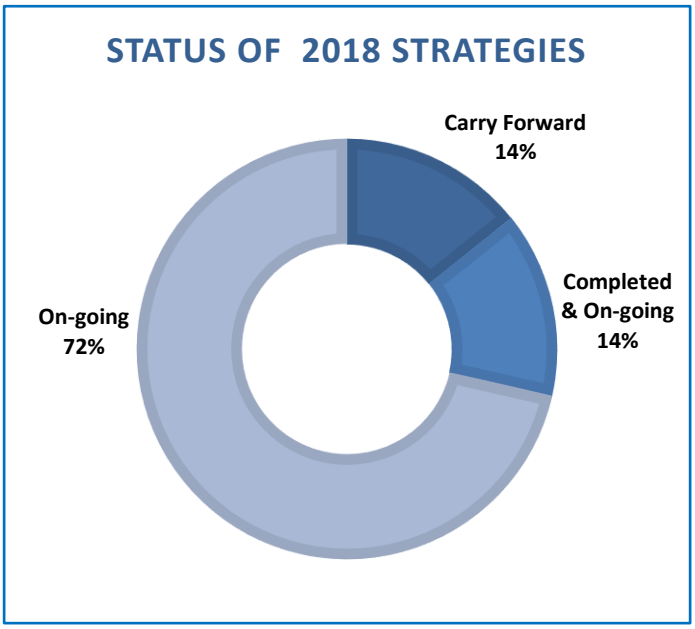


Figure 1. Status of 2018 Strategies

The 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 concerns about the continued need to address flood mitigation and climate change in the Plan, stormwater runoff in high development ski areas, increased protection and conservation of wetlands and rare, threatened and endangered species, in particular, freshwater mussels and riparian species.

What is a Tactical Basin Plan?

A Tactical Basin Plan 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 Environmental Protection Agency's (EPA) 9-element framework for watershed plans (Environmental Protection Agency, 2013) 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 2. The five major policy requirements that inform tactical basin planning

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 (SWMS) 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.

Chapters 1 through 4 in the TBP describe water quality in the basin, protection and restoration priorities, and efforts to protect and restore

Figure 3. 5-year Basin Planning Cycle

water quality for each sector. This information supports the targeted strategies listed in the implementation table in Chapter 5 (Figure 4).

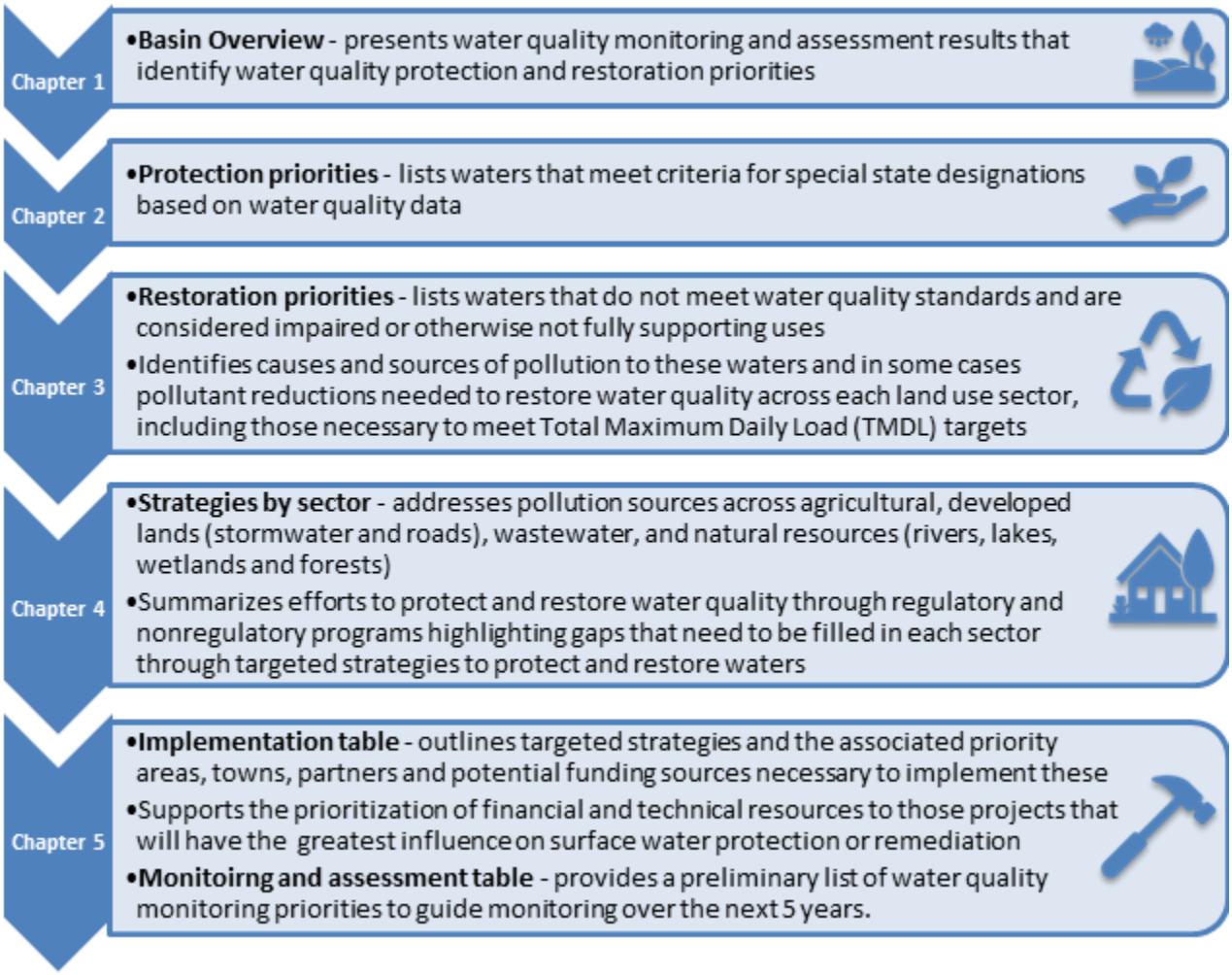


Figure 4. Chapters of Tactical Basin Plans

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

Basin 10 consists of two major watersheds in southeastern Vermont - the Ottauquechee River watershed and the Black River watershed. Both rivers flow from the central Green Mountain range with Killington Peak in the northwest, Ludlow or Okemo Mountain in the southwest boundary, and Mount Ascutney to the east along the Connecticut River.

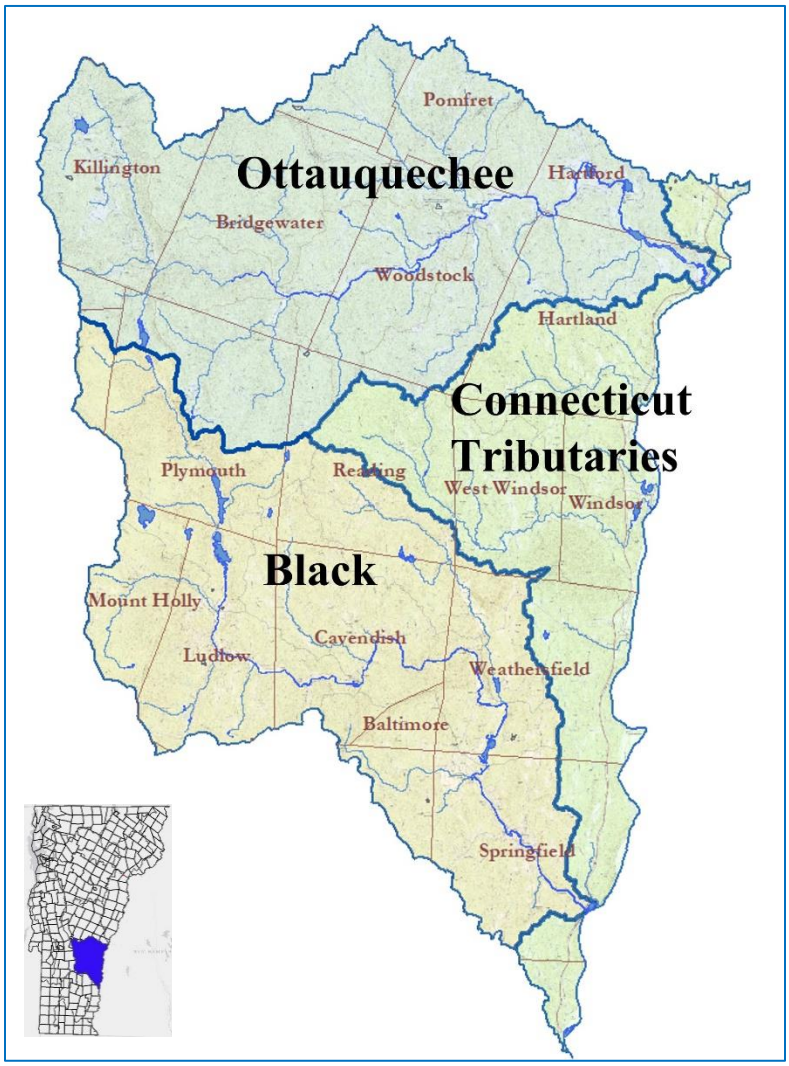


Figure 5. Basin Watershed Map

Basin 10 also includes approximately 37 miles of the mainstem of the Connecticut River and the streams that flow directly into it from White River Junction down to the mouth of the Williams River in Rockingham. Among these are the two Mill Brooks that run on the north and south sides of Ascutney Mountain and Spencer, Blood and Lulls Brooks.

The Ottauquechee River has a mainstem length of 38 miles and drains an area of 223 square miles. With its' headwaters near Killington Peak, the river drops almost 3900 feet in elevation down to the Connecticut River in Hartland.

The Black River has a mainstem length of 40 miles and drains an area of 202 square miles. It originates from the outlet of Black Pond in the town of Plymouth and drops 3040 feet in elevation from the top of Ludlow Mountian (Okemo) to Hoyts Landing in Springfield.

There are 28 lakes and ponds in the Basin that are 10 acres or larger covering approximately 1,612 acres. Lake Rescue, Lake Ninevah, North Hartland Reservoir, Woodward Reservoir, Kent Pond, and Echo Lake are the largest bodies of water in Basin 10, each being over 100 acres in size.

Land Use and Land Cover

The Basin is a predominantly forested landscape, with forests covering about 78% of the basin. Wetlands and open water cover about 3%. Developed and agricultural land cover about 7% and 8% of the basin, respectively (Figure 6 & 7).

The forested and agricultural landscapes correspond with elevation. The western half of the Basin is higher in elevation and mostly forested while the eastern half is lower in elevation and hosts most of the agriculture land on the flatter terrain. The most concentrated agricultural lands are along the Connecticut River valley.

Large areas of properly managed forests, riparian buffers, and wetlands are principally responsible for the good water quality found in most of the Basin. Where good management practices and quality local stewardship exist on agricultural and developed lands, good water quality will too. The areas in the Basin that are experiencing degraded water quality trends are adjacent to:

- concentrated development in Killington along Roaring and East Roaring Brooks
- concentrated development in Ludlow along Branch and Coleman Brooks
- concentrated development in Springfield along Mile Brook
- capped landfill drainage in Hartford along Neal Brook

A large portion of road networks are located along the rivers and tributaries, often connecting the larger impervious areas of the Basin. Large wetland complexes are found adjacent to some of these road/river corridors such as Route 4 through Killington, Route 5 through Windsor and Route 100 through Plymouth. Important large wetlands are also found along the Connecticut River at Upper Meadows in Rockingham, Hoyts Landing in Springfield, and Paradise Park in Windsor.

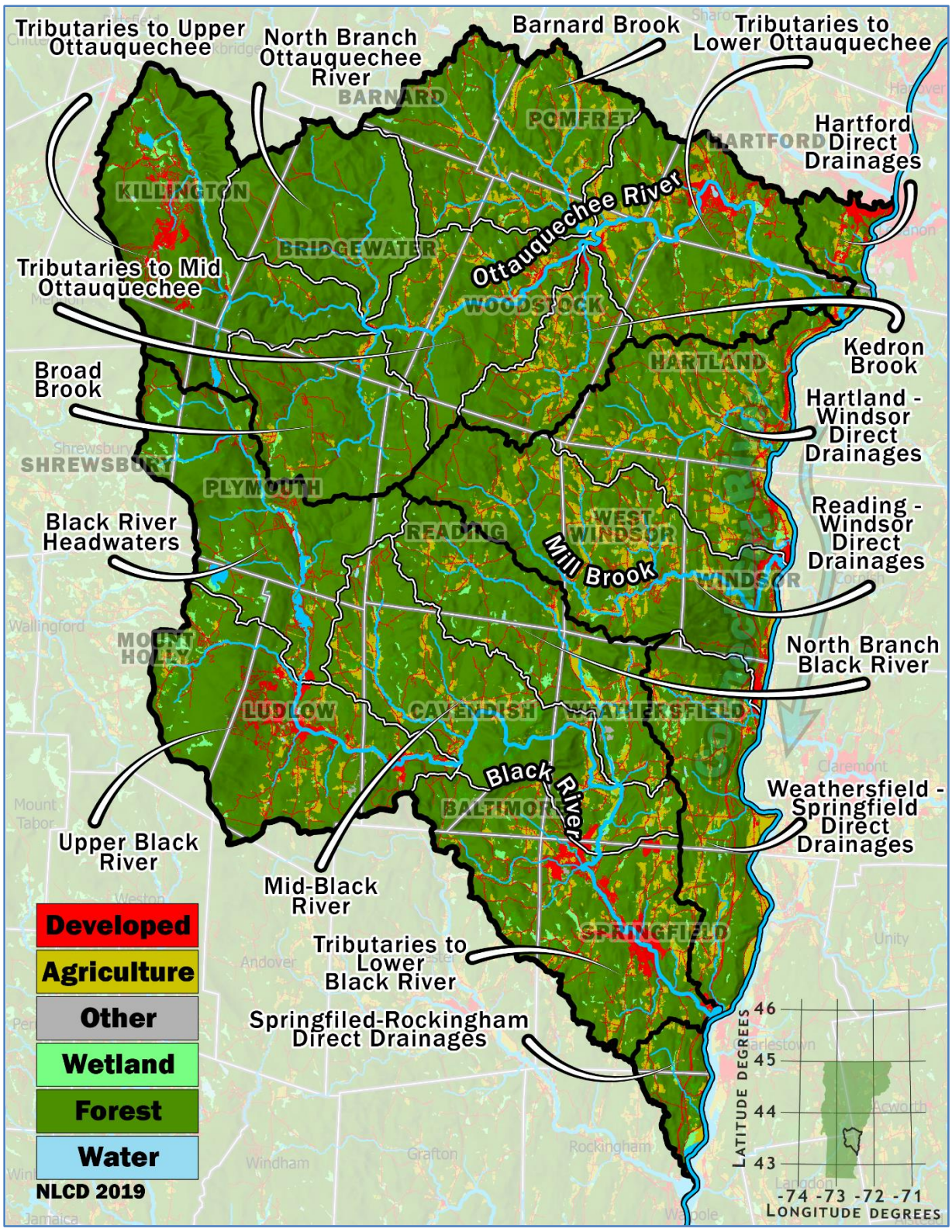


Figure 6. Land Cover Map

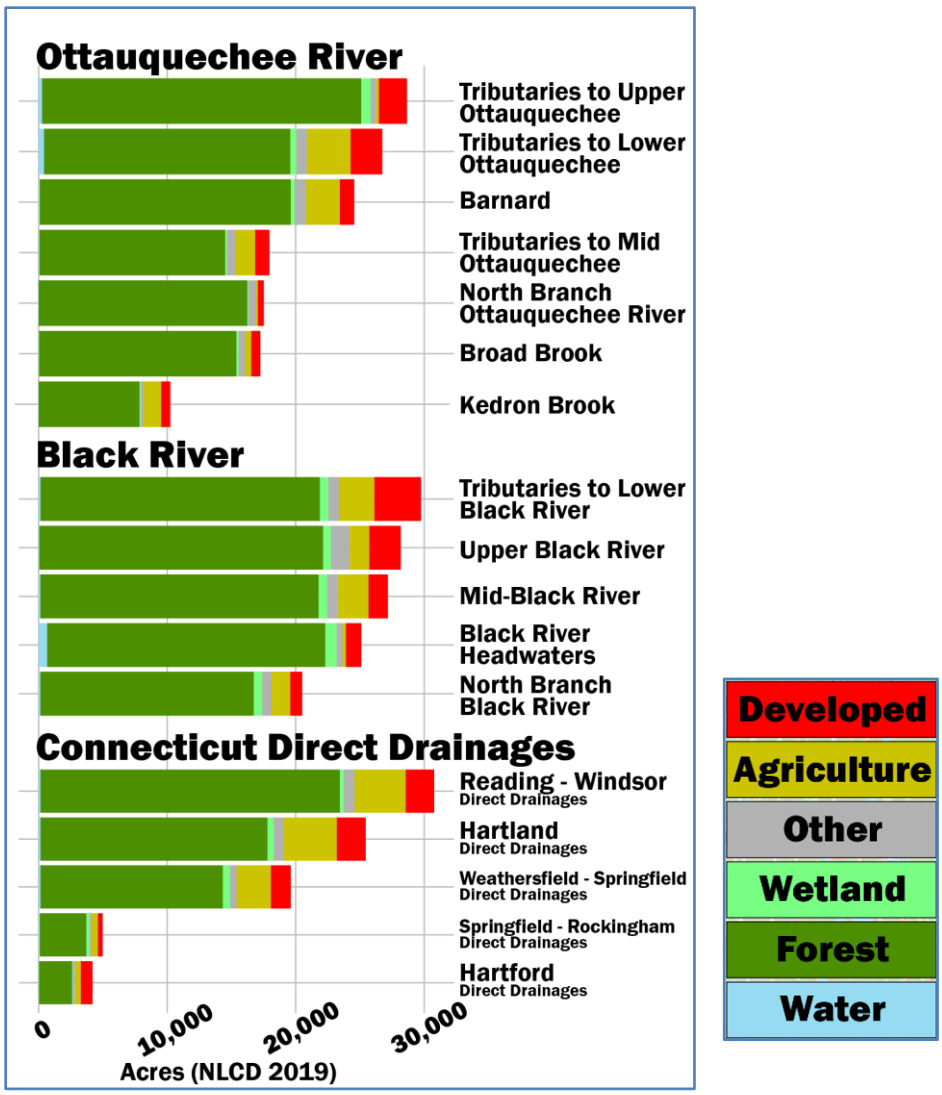


Figure 7. Land Cover by Acreage of Sub-watershed

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 overarching challenges for basin planning. Climate is defined by long-term weather patterns, which in turn influence human and natural systems.

The 2021 Vermont Climate Assessment documents that Vermont's average annual temperature has increased by almost 2°F (1.11°C) since 1900 with warming occurring twice as fast in winter. Precipitation has increased 21% since 1900. Key findings of the Assessment report that the average annual precipitation has increased by 7.5 inches since the early 1900s and has been increasing at a rate of 1.4 inches per decade in the same period. The 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. Extreme precipitation events can have dramatic impacts on water quality through increased erosion and runoff from adjacent land uses such as development and agricultural.

Average annual stream flows are increasing, and this is expected to continue. More frequent high flows lead to increased inundation flooding and fluvial erosion (stream-related erosion) all of which can be exacerbated or alleviated by land-use management decisions. These events also increase the discharge of pollutants into waters.

Rising stream temperatures threaten the health of rivers and affect their biodiversity and their fisheries. 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). 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. Infrastructure such as roads and dams have severely hampered the mobility of aquatic species and form a barrier for migrating fish and for fish seeking cold refuge during warmer weather.

In Vermont, *E. coli* bacteria presence in recreational water is a common cause of beach closures which often occur after rainstorms flush sediment, bacteria, and pollutants into nearby waterbodies. *E. coli* is ubiquitous in the environment and recent research at the University of Guelph, Ontario, Canada concluded that climate change may trigger changes in bacteria to enable certain strains of *E. coli* to survive better in warmer soil and water conditions (van Elsas, 2011).

Vermont's natural resources, like its floodplains and wetlands, will play a large role in the future under altered climate conditions. Wetlands and riparian forests can attenuate water flows by holding water during times of extreme precipitation and mitigate polluted runoff by infiltration and uptake of nutrients, but they need to be protected to maintain these functions.

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 damages to many roads and crossing structures. Risk reduction requires addressing outdated and poorly sized 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, Best Management Practices (BMP) that increase water infiltration 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, K.B., T.H. Ricketts, G. Galford, S. Polasky, J. O'Niel-Dunne 2016) (Weiskel, Peter K. 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(RCE), 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 at the Climate Change in Vermont website.

B. Water Quality Conditions

The federal Clean Water Act requires all states to develop and submit to the US EPA a report that describes the quality of the State's surface waters and contains an analysis of the extent to which its waters provide for the protection and propagation of a balanced population of fish, shellfish and wildlife. This biennial Vermont Water Quality Assessment Report is commonly known as the 305(b) Report.

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 (BASS) 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 Black River Action Team (BRAT), Connecticut River Conservancy, Connecticut River Joint Commissions and the Ottauquechee Natural Resources Conservation District (ONRCD) participate in LPP by sampling streams throughout this Basin and conducting targeted monitoring for pollutant tracking.
- The Rivers Program (RP) supports stream geomorphic assessments that evaluate geomorphic and physical habitat conditions of rivers.
- The Lakes and Ponds Program (LPP) 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 (VFWD) Fisheries Divisions 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 is funded and operated in partnership among DEC, Vermont Agency of Transportation (VAOT), Vermont Department of Public Safety (VDPS) and US Geological Society (USGS).
- 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 – rivers and streams, lakes and ponds, wetlands, and 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.

Aquatic biomonitoring can be used for detecting aquatic biota impairments and providing information to help determine the extent and severity of potential stressor(s). This monitoring can also identify 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 Water Quality Standards - to *Excellent*. If a stream fails to meet minimum water quality criteria, it is a candidate for the impaired waters list.

Biological Monitoring Results

Seventeen sites have been assessed for macroinvertebrates and five for fish communities between 2014 and 2021. Communities are assessed individually for macroinvertebrates and fish and are ranked from Excellent to Poor.

Macroinvertebrate and fish community 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). Of all the sites monitored for both communities, one site was unable to be assessed for fish condition because Brook trout (BKT) was the only species present. Fish assessments require that at least two native species be present.

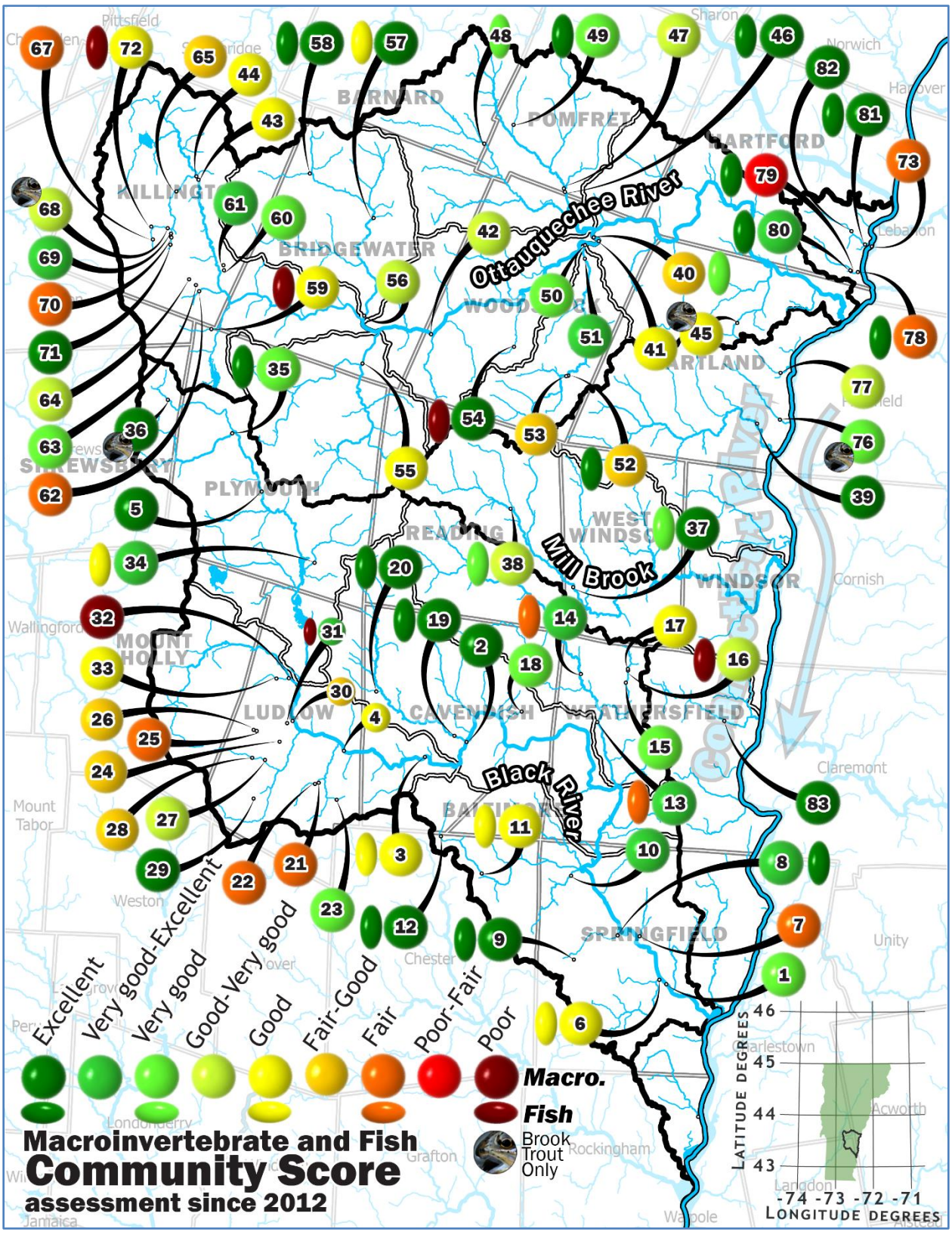


Figure 8. Biological Condition of Macroinvertebrate and Fish Communities

More information about the biological and chemical results of these sampling sites and events can be found online through the Vermont Integrated Watershed Information System (IWIS).

Table 2. Biological Condition of Macroinvertebrate and Fish Communities

		Macroinvertebrates		Fish	
Map ID	Location	Year	Assessment	Year	Assessment
1	Broad Brook, 3.1	2019	Good		
2	Madden Brook, 5.2	2014	Good	2014	Poor
3	Harlow Brook, 0.2	2014	Good	2014	BKT
4	Kedron Brook, 0.2	2019	Fair/Good		
5	Kedron Brook, 0.4	2014	Very Good/Excellent		
6	Kedron Brook, 0.5	2019	Fair/Good	2015	Excellent
7	Kedron Brook, 22.3	2014	Very Good		
8	Falls Brook, 0.2	2018	Fair		
9	Carpenter Brook, 0.2	2021	Very Good		
10	Ottauquechee River Trib 57, 0.3	2021	Very Good/ Excellent-		
11	Ottauquechee River Trib 57, 3.1	2021	Very Good		
12	North Branch Ottauquechee River, 0.1	2019	Good/Very Good		
13	North Branch Ottauquechee River, 0.6	2021	Excellent	2021	Good
14	Barnard Brook, 0.1	2014	Good/Very Good		
15	Barnard Brook, 0.2	2019	Excellent	2019	Excellent
16	North Branch Ottauquechee Trib #15, 0.3	2020	Excellent	2020	Excellent
17	Barnard Brook Trib #6, 0.4	2014	Very Good	2014	Excellent

BKT – Brook trout only present

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

There is limited coverage of Phase I or Phase II Stream Geomorphic Assessments (SGAs) in the Basin (Figure 9). Both the Ottauquechee and Black rivers are altered by the large flood control dams limiting assessment only to areas outside of the impounded reaches.

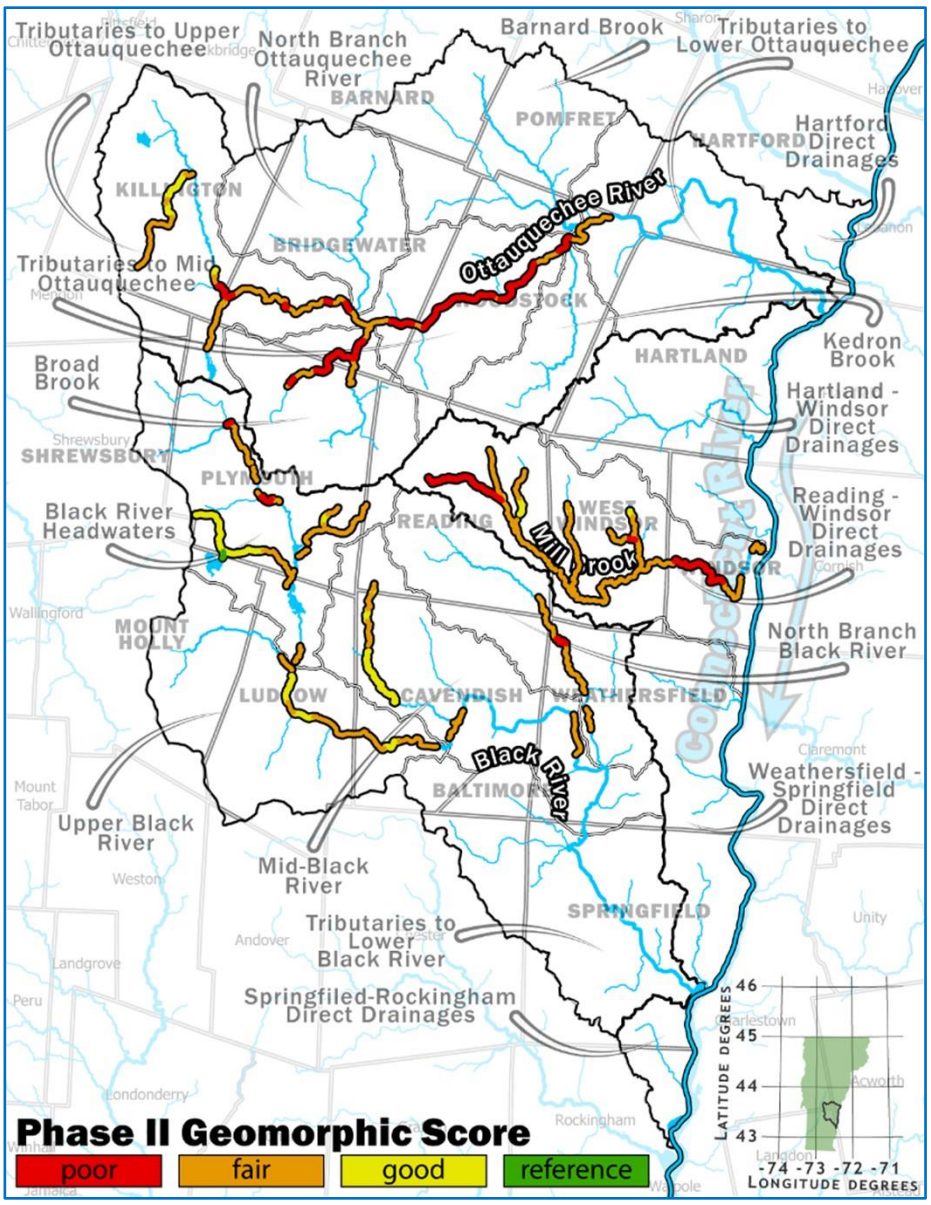


Figure 9. Geomorphic Scores of Assessed Rivers

The reaches that have been assessed show the majority are in Fair to Poor geomorphic condition. The River Corridor Plans from these assessments provide numerous restoration and protection opportunities which are recommended for implementation. This plan also recommends that additional assessments be conducted for Lulls and Hubbard Brooks and portions of the Barnard Brook watershed. Final SGAs can be accessed at: Stream Geomorphic Assessment - Final Reports.[1]

Lakes and Ponds

There are 28 lakes and ponds in the Basin that are ten acres or greater. Lake Rescue, Lake Ninevah, the North Hartland and Woodward Reservoirs, Kent Pond and Echo Lake are all over 100 acres. Of the 65 lakes and ponds with data, 36 have dams that raise the water level of the impoundment. All

[1] https://anrweb.vt.gov/DEC/SGA/finalReports.aspx

of the lakes over 50 acres, with the exception of Echo Lake are dammed. Lakes impounded by dams should be managed in accordance with the Vermont Hydrology Policy and meet the Hydrology Criteria (§29A-304) in the Vermont Water Quality Standards to ensure full support of designated uses. More information on dam location, status, purpose, and ownership can be found in Appendix B.

Lake Scorecard Assessment

The Vermont Lakes and Ponds Management and Protection Program (LPP) share lake assessments using the VT Inland Lakes Scorecard (Figure 10, Table 3). The scorecard provides a comprehensive summary of overall lake health by rating the waterbody's nutrient trend, water quality, shoreland, habitat, atmospheric pollution, aquatic invasive species conditions and compliance with VWQS. Lake-specific water quality and chemistry data can be accessed online through the VT Lay Monitoring Program webpage.

Of the 32 lakes evaluated for shoreland condition in the Basin, four have *Poor* ratings, 17 scored as *Fair* and 9 are rated as *Good*. Of the 37 lakes monitored for water quality trends, three lakes have a *Poor* rating, 9 are rated as *Fair* and 23 are rated as *Good*. Lake Runnemede (aka Evarts Pond) rated *Poor* for Water Quality Trend (i.e., nutrient trend). Phosphorus levels in this shallow lake have been increasing, as have levels of Chlorophyll-a. The Paradise Park Commission manages the lake and wetlands and has created a lake management plan to guide monitoring and is actively working to determine the causes of these increases. Lake Rescue Spring Phosphorus levels are also significantly increasing.

North Hartland Reservoir, Stoughton Pond, North Springfield Reservoir are all listed as *Altered* due to water level fluctuations that impact aquatic habitat.

Eight of the Basin's lakes are impacted by aquatic invasive species, mostly by Eurasian Watermilfoil (*Myriophyllum spicatum*). Mill, Kent, Woodward, Deweys Ponds also have populations of Common Reed (*Phragmites australis*). The North Springfield Reservoir is the only lake I the basin with invasive Water chestnut (*Trapa natans*).

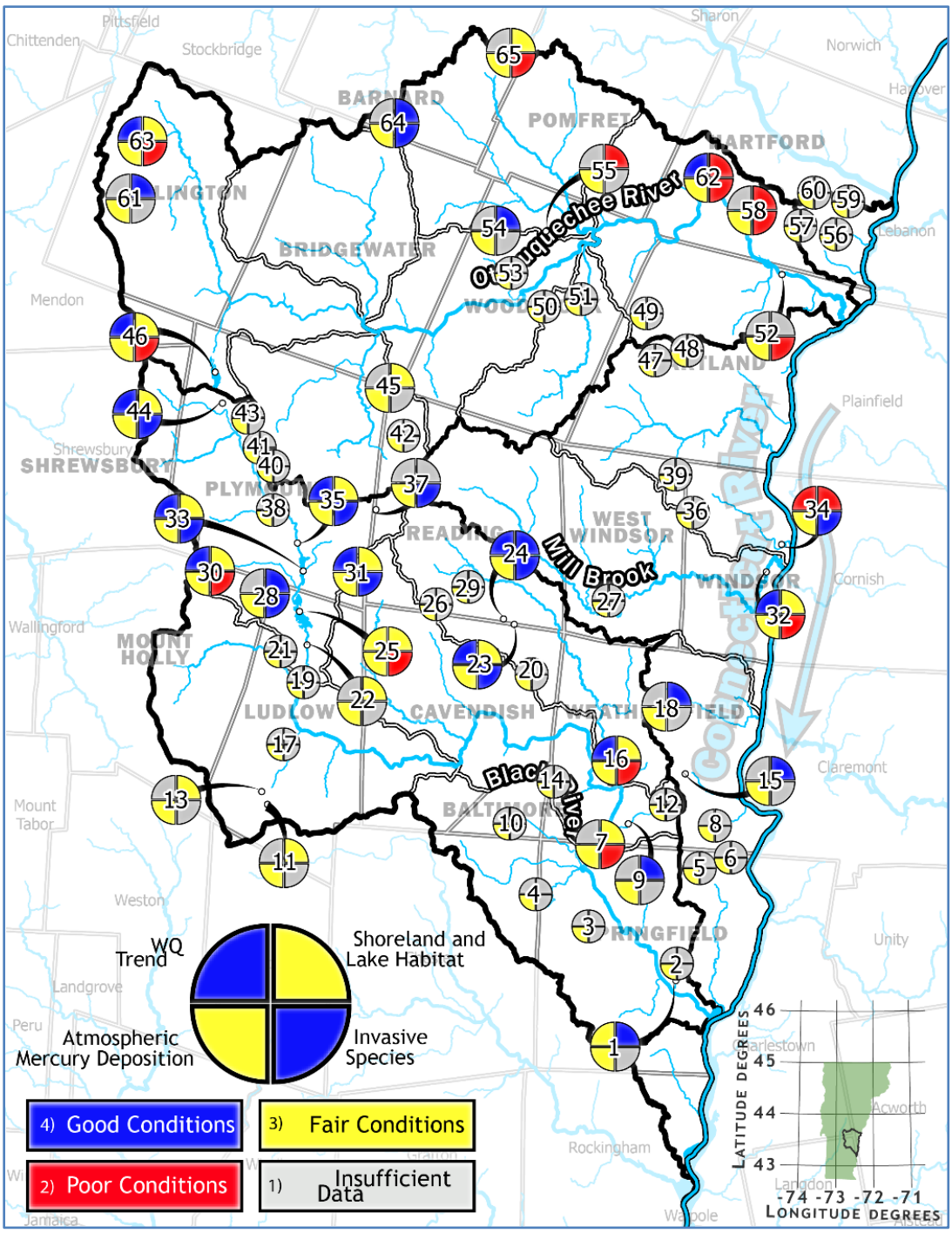


Figure 10. Condition of Lakes and Ponds

Table 3. Lake Scorecard Ratings

Lake Score Card

Map ID corresponds to the map above

Map ID	Lake ID	Area (ac)	Max Depth (ft)	Nutrient Trend	Shoreland	AIS	Mercury	WQ Status
1	GOULDS POND	5.9	10	Fair	Good	Insufficient Data	Fair	Insufficient Data
2	CHESTNUT POND	4.1		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
3	FRENCH POND	3		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
4	SPOONERVILLE POND	6		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
5	RATTLESNAKE POND	2.8		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
6	BLOODSUCKER POND	5.3		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
7	NORTH SPRINGFIELD RESERVOIR	96.4	3	Insufficient Data	Fair	Poor	Fair	Poor
8	BARKMILL POND	20.9		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
9	SPRINGFIELD RESERVOIR	8.6	28	Insufficient Data	Good	Insufficient Data	Fair	Insufficient Data
10	BEAVER MEADOW POND	1		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
11	JEWELL BK #1 RESERVOIR	4.5	5	Insufficient Data	Fair	Insufficient Data	Fair	Fair
12	WEATHERSFIELD POND	4.1		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
13	JEWELL BK #2 RESERVOIR	2.5	7	Insufficient Data	Fair	Insufficient Data	Fair	Good
14	QUARRY POND	0.7		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
15	COOKS POND	17.6	10	Insufficient Data	Good	Insufficient Data	Fair	Insufficient Data
16	STOUGHTON POND	50.1	20	Good	Fair	Poor	Fair	Poor
17	JEWELL BK #3 RESERVOIR	10.7		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
18	BEAVER POND (WEATHERSFIELD)	19.9	4	Insufficient Data	Good	Insufficient Data	Fair	Good
19	GRAHAMVILLE POND	4.4		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data

Map ID	Lake ID	Area (ac)	Max Depth (ft)	Nutrient Trend	Shoreland	AIS	Mercury	WQ Status
20	ALBERT LORD POND	7.2		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
21	COOK	2.9		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
22	RESERVOIR POND (Lake Pauline)	34.8	47	Insufficient Data	Fair	Insufficient Data	Fair	Good
23	KNAPP BROOK POND #1	27.2	12	Good	Fair	Good	Fair	Fair
24	KNAPP BROOK POND #2	32	20	Good	Good	Good	Fair	Fair
25	RESCUE LAKE	189.2	95	Fair	Fair	Poor	Fair	Good
26	TRACER POND	2.7		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
27	ROWE POND	6.3		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
28	TINY POND	34.7	17	Insufficient Data	Good	Good	Fair	Good
29	SOUTH READING POND	8.9		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
30	LAKE NINEVAH	175.6	12	Good	Fair	Poor	Fair	Fair
31	COLBY POND	21	16	Good	Fair	Good	Fair	Fair
32	MILL POND	56.3	26	Good	Fair	Poor	Fair	Good
33	ECHO LAKE	100.1	91	Good	Fair	Good	Fair	Good
34	LAKE RUNNEMEDE	62.8	13	Poor	Poor	Good	Fair	Good
35	AMHERST LAKE	82.4	90	Good	Fair	Good	Fair	Good
36	PRISON POND	0.9		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
37	READING POND	24.1	10	Insufficient Data	Insufficient Data	Good	Fair	Fair
38	BM1145 (Plymouth)	7.7		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
39	HOLBROOK POND	4.2		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
40	LOWER MOORE POND	4.3		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Good
41	UPPER MOORE POND	2.9		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Good
42	SOUTH MECAWEE POND	0.2		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Good
43	GRSS POND	2.3		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
44	BLACK POND	20.3	7	Good	Fair	Good	Fair	Good

Map ID	Lake ID	Area (ac)	Max Depth (ft)	Nutrient Trend	Shoreland	AIS	Mercury	WQ Status
45	MECAWEE POND	13	10	Insufficient Data	Fair	Insufficient Data	Fair	Fair
46	WOODWARD RESERVOIR	109.8	48	Good	Fair	Poor	Fair	Good
47	BEAVER POND (Hartland)	0.2		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
48	BREEZE POND	4.4		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
49	CRYSTAL POND	2.4		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
50	CARLTON RESERVOIR	2.1		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
51	VIEW POND	2.3		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
52	NORTH HARTLAND RESERVOIR	167.6	11	Insufficient Data	Insufficient Data	Poor	Fair	Poor
53	COX RESERVOIR	1.4		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Insufficient Data
54	VONDELL RESERVOIR	8.2	17	Insufficient Data	Good	Insufficient Data	Fair	Good
55	THE POGUE	14.3	5	Insufficient Data	Poor	Insufficient Data	Fair	Good
56	SIMONDS POND	0.3		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Good
57	UPPER HURRICANE RESERVOIR	2.5		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Good
58	DEWEYS MILL POND	54.3	7	Insufficient Data	Poor	Poor	Fair	Good
59	WRIGHT RESERVOIR	2.9		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Good
60	LOWER HURRICANE RESERVOIR	4.7		Insufficient Data	Insufficient Data	Insufficient Data	Fair	Good
61	PICO POND	11.4	4	Insufficient Data	Good	Poor	Fair	Fair
62	LAKE PINNEO	45.8	11	Good	Poor	Poor	Fair	Good
63	KENT POND	101.9	15	Good	Fair	Poor	Fair	Good
64	LAKOTA LAKE	18.4	11	Insufficient Data	Good	Good	Fair	Fair
65	LINE POND	9.2	4	Insufficient Data	Fair	Poor	Fair	Insufficient Data

Acid Status

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. While this basin lacks lakes or ponds impaired for pH, nine are pH stressed. Due to implementation of the Clean Air Act and its amendments, acid deposition has declined dramatically in Vermont and most acid impaired lakes are steadily improving.

Due to atmospheric deposition of mercury, fish consumption advisories are active in nearly every lake in Vermont. Dramatic shifts in water level, due to the way reservoirs are managed for hydroelectrical generation, 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. As a result, all lakes in the Basin get a *Fair* condition score for mercury. The Vermont Department of Health posts a Health Alert for fish consumption for all Vermont waters recommending limits to fish consumption statewide.

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. These wetlands often exhibit habitat loss.

Wetland Bioassessment and Vermont Rapid Assessment Method

The Vermont State Wetlands Inventory includes around 10.6 sq. mi. of wetland within the Basin. This is approximately 1.9 % of the total area within this Basin. However, many wetlands in the Basin may not be mapped.

A total of 81 Basin wetlands have been assessed using the Vermont Rapid Assessment Method (VRAM). Of these, 73 were assessed during the most recent rotational basin field season in this basin, which was 2017 – 2021. Ten of these are Level 3 assessments, which are detailed in-field assessments.

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 wetlands scored a 91, one of which is in Hartland under private ownership and the other is in Killington at the headwaters of the Ottauquechee watershed. Ten other wetlands scored 80 or above, indicating excellent condition and/or very high levels of function and value. Eleven wetlands scored below 50. The average score was 63.

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.

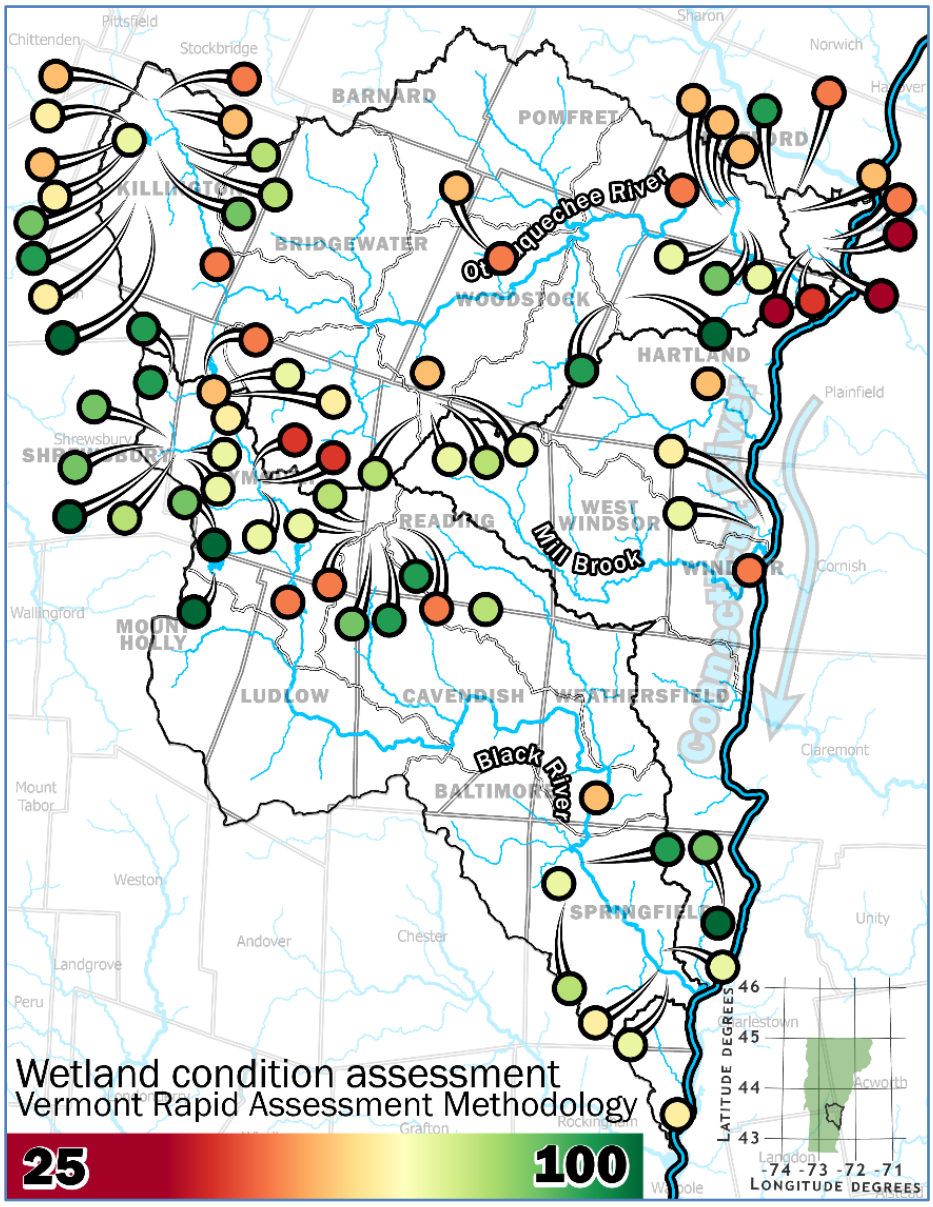


Figure 11. Wetland Condition Assessment

Recreational Fisheries

The Vermont Fish & Wildlife Department (VFWD) assesses fishery populations and important nursery areas to document biological and habitat conditions to manage for high-quality recreational fisheries.

VFWD completed 12 monitoring events in the Ottauquechee watershed in its most recent sampling in 2021. A variety of fish species exist within the Ottauquechee River basin, many of which support a popular recreational fishery. Naturally reproducing (wild) native Brook trout remain common in colder, higher elevation tributaries and within the mainstem above West Bridgewater. Wild populations of naturalized Brown trout and Rainbow trout are less common but are present within individual tributaries and mainstem reaches. Wild trout populations within the mainstem below West Bridgewater are limited, likely due to high summer water temperatures and poor overall habitat quality. Hatchery-reared Rainbow trout are stocked annually by VFWD within the Ottauquechee River from Bridgewater Corners (Junction of Rt.4 & 100) to the Taftsville Dam and provide additional angling opportunities in areas with high water temperatures and low wild trout productivity. Tributary streams are not stocked and are managed as wild trout waters. Results from 2021 monitoring identified two additional streams (Kent Pond Brook and Cloudland Brook) as "very good," candidates for class B(1) waters for recreational fishing.

Water temperature monitoring conducted by VFWD in 2005, 2016 and 2021 showed mainstem water temperatures exceeding 80°F at most locations between Bridgewater and North Hartland. In 2021, water temperatures were monitored in the mainstem from Killington to Hartford in addition to the lower reaches of five tributaries. While elevated water temperatures in Broad Brook and the North Branch likely limit wild trout populations, temperatures within Pinney Hollow Brook, Barnard Brook, and Kedron Brook remain suitable for trout.

The Black River basin supports a wide variety of both warm and cold-water fisheries. The mouth of the Black River and its lower reach contains many warm-water fish species as are commonly seen in the Connecticut River. The lower portion of the Black River and its lower tributaries also serve as spawning areas for wild Rainbow trout populations residing in the Connecticut River and native anadromous Sea Lamprey, a species of greatest conservation need (SGCN) which migrate up the Connecticut River from the Atlantic Ocean. Other SGCN including Redbreast Sunfish, and anadromous American Shad also utilize the lower Black River downstream of the Lovejoy Dam. The number of American Shad that have passed above the Bellows Falls fish ladder has only begun to increase in recent years. Improved fish passage may increase successful passage of SGCN species American Eel, Sea Lamprey, and American Shad to the Black River.

Upper reaches of the Black River mainstem and its tributaries, especially above the Cavendish Dam, are managed for wild Brook trout (a SGCN), and Brown trout populations. The Black River mainstem downstream of the Cavendish Dam is wide, shallow, and thermally impaired. Water temperatures throughout the summer months are too high to support wild trout populations. However, fishing pressure, spring flows, and abundant access provide good conditions for a

successful and very popular "put and take" trophy trout fishery. Long-term survival of the stocked trout is low due to summer water temperatures which is validated by a decrease in catch rates over the season.

The mainstem of the Black River is highly impounded by thirteen dams, including the North Springfield Reservoir (96 acres), Rescue Lake (224 acres), Echo Lake (100 acres), Lake Amherst (83 acres), and Black Pond (20 acres). Dams and their impoundments heavily impact the physical, chemical, and biological processes in the river. Dams alter the natural hydrology and sediment transport of the river system. In the Black River, there are five hydroelectric facilities currently operating, with the majority located in downtown Springfield. These facilities have the potential to entrain and impinge fish, which can cause mortality of riverine species. At least one of these facilities (Slack Dam) regularly interrupts flows which can draw down water levels and impact aquatic biota. The North Springfield Reservoir is a flood control facility operated by the Army Corps of Engineers that regulates water flow in the Black River mainstem. Flow alterations from both controlled release and "run-of-river" facilities impact natural stream processes including channel morphology and substrate composition. Large amounts of sediment accumulated in impoundments degrades channel equilibrium by depriving downstream reaches of the sediment that would naturally replenish from upstream. When the sediment from the downstream reach naturally erodes and is not replenished from upstream, considerable erosion and channel destabilization occurs. Lack of diverse sediments can degrade instream habitat for aquatic organisms.

Elevated water temperatures have been shown to be a main factor limiting trout production in the Black River given their maximum temperature thresholds. Brook trout are the most sensitive trout species regarding water temperature. Temperature monitoring has been conducted with stationary loggers at multiple locations since 1995 on the Black River and temperatures exceeding 80°F are regularly recorded suggesting temperature likely limits wild trout production in the river (Simard 2019). Water temperatures in the Black River upstream of the Plymouth lakes generally remained relatively cool with a majority of daily max water temperatures below 68°F, though temperatures still exceeded 72°F on several days in early July. However, all locations on the Black River mainstem between or below the Plymouth Lakes exceed 80°F.

Management opportunities for fisheries restoration are recommended:

- Work to improve riparian corridors and thermal conditions;
- Work to improve aquatic habitat connectivity;
- Work to improve instream habitat complexity and diversity;
- Work to improve flows;
- Work to stop the spread of exotic species and pathogens;
- Work to identify and designate B1 High Quality Fishing – Wild Salmonid Streams;
- Consider Outstanding Water Resources designation for the following streams due to their high-quality habitat, cold-water refugia, and very good and/or exceptional wild trout populations.

Recommendations for reclassification of waters to Class B(1) for fisheries are included in Chapter 2, Table 6.

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 data. 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. Three streams in this Basin meet or exceed standards for very high-quality condition and are prioritized for reclassification (Table 6, Figure 12).

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.

Classifications of surface waters and their uses are published in the VWQS. The VWQS state that recommendations for use reclassification shall be made during the tactical basin planning process or by DEC 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

All Vermont surface waters are protected by the Antidegradation Policy required by the federal Clean Water Act and Vermont State Statute. Antidegradation limits incremental lowering of water quality in lakes, rivers, and wetlands when applied during a permit review process. Any lowering of

water quality must be found to be necessary to avoid substantial economic and social impacts. The surface water's uses and values established in State law, swimming, boating, and fishing, must always be maintained and protected, including their use by fish, wildlife, and other living things, and the physical habitat that supports aquatic life.

Surface waters may be further protected 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 would 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.

A(2) Public Water Sources

Six waters in the Basin are designated as A(2) public water sources (Table 7). All or portions of each are no longer used as a public water sources. These abandoned water supplies are candidates for reclassification to A(1) or B(1) to reflect their current condition for the designated uses and to provide better long term management.

Table 5. Class A(2) Public Water Sources

Waters	Aq. Biota	Aq. Hab.	Aesthetics	Boating	Fishing	Swim	Pub. WS	Irrigate	Date	Approx. Miles/Acres
Ottauquechee River										
Spring and unnamed tributary to the Ottauquechee River. **Abandoned** - Village of North Hartland water source.	A2	A2	A2	A2	A2	A2	A2	B2	11/16/67	0.3 mile
Cox, Vondell, and Carlton Hill Reservoirs. Cox and Vondell – Emergency; **Carlton Hill – Abandoned** - Village of Woodstock (WSID 5342) water sources.	A2	A2	A2	A2	A2	A2	A2	B2	11/16/67	2.5 miles (Stream only)
Wright, Upper Hurricane, and Lower Hurricane Reservoirs. Wright – Emergency; **Hurricane – Abandoned** - Hartford Town (WSID 5319) water sources.	A2	A2	A2	A2	A2	A2	A2	B2	7/1/71	10.4 acres
Black River										
Springfield Reservoir Brook. **Abandoned** - Village of Springfield water source.	A2	A2	A2	A2	A2	A2	A2	B2	3/30/66	1.8 miles
Springfield Reservoir and tributaries. **Abandoned** - Village of Springfield water source.	A2	A2	A2	A2	A2	A2	A2	B2	3/30/66	9.8 acres
Unnamed tributary to Mill Brook. **Abandoned** - Village of Ascutney water source.	A2	A2	A2	A2	A2	A2	A2	B2	7/1/1971	1.7 miles

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

Biomonitoring assessments by the WSMD identify waters that consistently and demonstrably attain a higher level of quality than Class B(2), meeting Class A(1) or B(1) criteria for aquatic biota. For the designated use for aesthetic conditions, DEC has developed numeric nutrient criteria for lakes and ponds which are reflected in the VWQS.(Table 6 and Figure 12).

Four streams are candidates for reclassification for aquatic biota and one lake for aesthetics. Strategies for enhanced protection of waters are described in further detail in the following sections.

Three streams have been prioritized for reclassification to A(1) for Aquatic Biota.

- North Branch Ottauquechee Trib #15

- Chester Brook Trib #4
- Tinker Brook

One stream has been prioritized for reclassification to B(1) for Aquatic Biota.

- Great Roaring Brook

There is one lake that is a candidate for reclassification to A(1) for aesthetics.

- Lake Rescue

Based on limited data, Lake Ninevah may also meet the requirements for reclassification to A(1) for aesthetics uses; therefore, it is a priority for additional monitoring.

B(1) for Recreational Fishing Use

Rivers and streams can now be classified as B(1) recreational fishing waters support wild, self-sustaining salmonid populations characterized by the presence of multiple age classes and a minimum abundance of 1,000 individuals per mile (all species/ages/sizes); and/or 200 large (> 6 inches total length) individuals per mile; and/or 20 pounds/acre (all species/ages/sizes)[3]. Fourteen streams are candidates for reclassification from B(2) to B(1) for recreational fishing use are listed in Table 8 (based on the criteria in §29A-306 of the VWQS). These waters shall be managed to achieve and maintain the documented quality of fishing.

Table 6. Protection Priorities Candidates for A(1) and B(1)

Map ID	Location Name	Designated Use	Class
Ottauquechee River Watershed			
1	North Branch Ottauquechee Trib #15	Aquatic Biota	A(1)
3	Roaring Brook	Fishery	B(1)
5	Reservoir Brook	Fishery	B(1)
4	Madden Brook	Fishery	B(1)
13	Kedron Brook	Fishery	B(1)
14	Babcock Brook	Fishery	B(1)
12	Cloudland Brook	Fishery	B(1)
2	Kent Pond Brook	Fishery	B(1)
Black River Watershed			
10	Great Brook	Aquatic Biota	A(1)
11	Chester Brook Trib #4	Aquatic Biota	A(1)
6	Jewell Brook	Fishery	B(1)
8	Grant Brook	Fishery	B(1)

Map ID	Location Name	Designated Use	Class
7	Sanders Brook	Fishery	B(1)
9	Twenty Mile Stream	Fishery	B(1)
16	North Branch Black (Upstream of Ascutney Basin Road)	Fishery	B(1)
17	Sherman Brook	Fishery	B(1)
18	Lake Rescue	Lake Aesthetics	A(1)
Connecticut River Watershed			
15	Hubbard Brook	Fishery	B(1)

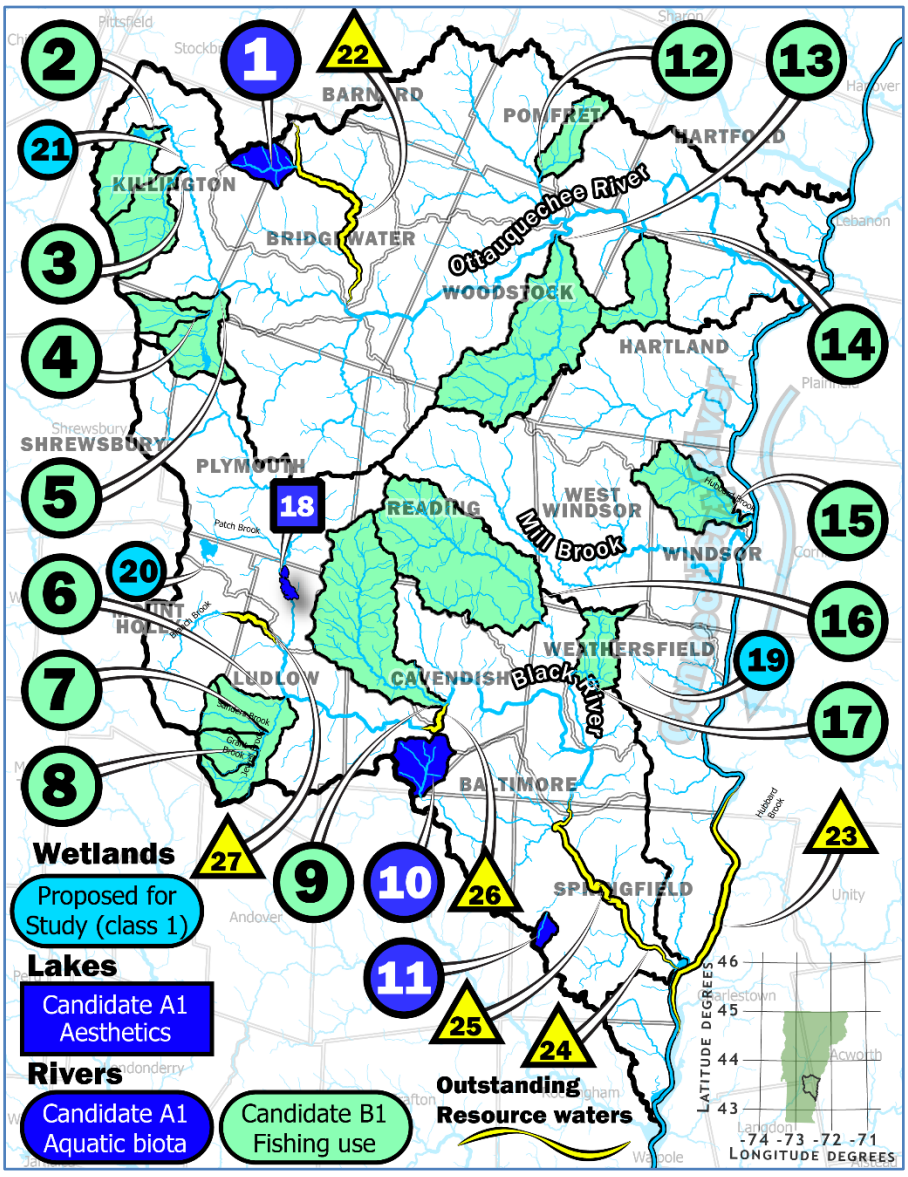


Figure 12. Protection Priorities

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 and Vermont's Class I Wetlands: An Interactive Journey highlight the designated Class I wetlands statewide and lists those recommended for Class I designation.

Eshqua Bog in Hartland was designated as a Class I wetland in early 2023 making it the first Class I wetland in the Basin. Four other wetlands have been identified for further study to determine their eligibility for Class I designation.

Table 7. Wetlands Proposed for Study for Class I

Map ID	Wetland	Status	Town
19	Beaver Pond Wetlands	Proposed for Study	Weathersfield
20	Lake Ninevah Wetlands	Proposed for Study	Mt Holly
21	Killington Flats	Proposed for Study	Killington Flats

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 through a petition or departmental rulemaking authority, consistent with the Vermont Wetland Rules.

C. Outstanding Resource Waters Designation

Rivers, streams, lakes, ponds and wetlands 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. In its evaluation of a proposed ORW designation, ANR may consider, but not be limited to considering, one or more of the following features:

1. existing water quality and current water quality classification;
2. the presence of aquifer protection areas;
3. the waters' value in providing temporary water storage for flood water and storm runoff;
4. the waters' value as fish habitat;
5. the waters' value in providing or maintaining habitat for threatened or endangered plants or animals;
6. the waters' value in providing habitat for wildlife, including stopover habitat for migratory birds;
7. the presence of gorges, rapids, waterfalls, or other significant geologic features;
8. the presence of scenic areas and sites;
9. the presence of rare and irreplaceable natural areas;
10. the presence of known archeological sites;
11. the presence of historic resources, including those designated as historic districts or structures;
12. existing usage and accessibility of the waters for recreational, educational, and research purposes and for other public uses;
13. studies, inventories and plans prepared by local, regional, statewide, national, or international groups or agencies, that indicate the waters in question merit protection as outstanding resource waters; and
14. existing alterations, diversions or impoundments by permit holders under state or federal law.

There are currently no waters with ORW designation in the Basin. Six waters are recommended for further study for ORW designation in the Basin. (Table 8.)

Table 8. Waters Recommended for Study for ORW Designation

	Location	Comments	ORW Feature
These waters display outstanding qualities based on one or more of 14 features			
North Branch Ottauquechee River	Bridgewater, Killington - All	Fish habitat and fishery, recreation	1,4,12
Buttermilk Falls, Branch Brook	Ludlow	Geologic features, recreation	7,8,12
Cavendish Gorge, Black River	Cavendish	Geologic features, recreation	7,8,12
Comtu Falls, Black River	Springfield	Geologic features, recreation	7, 8
Black River mainstem	Springfield	Native American travel route	10, 11
Connecticut River mainstem	Springfield	Native American sites & travel routes	10, 11

DEC welcomes recommendations for ORW designation through public petition.

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 can be found on the Basin 10 webpage.

The public is encouraged to recommend waters for the existing uses of swimming, boating, fishing, and public water source.

Waters In Need of Further Assessment

Nineteen rivers and streams are in need of supplemental monitoring to determine their potential for enhanced protection (Table 9. Figure 13). These waters are included in Chapter 5 in the Monitoring and Assessment Table. Additionally, further monitoring should be done on Lake Ninevah to determine if it is A(1) eligible and on Lakota and Amherst Lakes and Woodward Reservoir for B(1).

Surface waters in need of additional monitoring to determine if they may meet the criteria for a higher class are included in Chapter 5 in the Monitoring and Assessment Table.

Table 9. Monitoring Needed to Confirm Reclassification

Map ID	Name	Sample By:
1	Commissary Brook, 0.2	♦
2	Chester Brook, 0.3	2025

Map ID	Name	Sample By:
3	Spoonerville Brook, 0.5	♦
4	Soapstone Brook Trib 3, 0.4	2025
5	Grant Brook, 0.8	2025
6	Tarbell Hill Brook, 0.8	♦
7	Mill Brook (S), 1.7	2025
8	Whitney Brook, 0.3	2025
9	Twenty Mile Stream, 0.6	2025
10	Patch Brook, 1.1	♦
11	Mill Brook (N), 11.4	2023
12	Great Roaring Brook, 0.1	♦
13	Lulls Brook, 3.4	2025
14	McArthur Brook, 0.5	2023
15	Tinker Brook Trib, 0.8	♦
16	Neal Brook, 0.5	♦
17	Kilburn Brook, 0.2	♦
18	Barnard Brook, 2.5	2025
19	Barnard Brook Trib #6, 0.4	♦

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

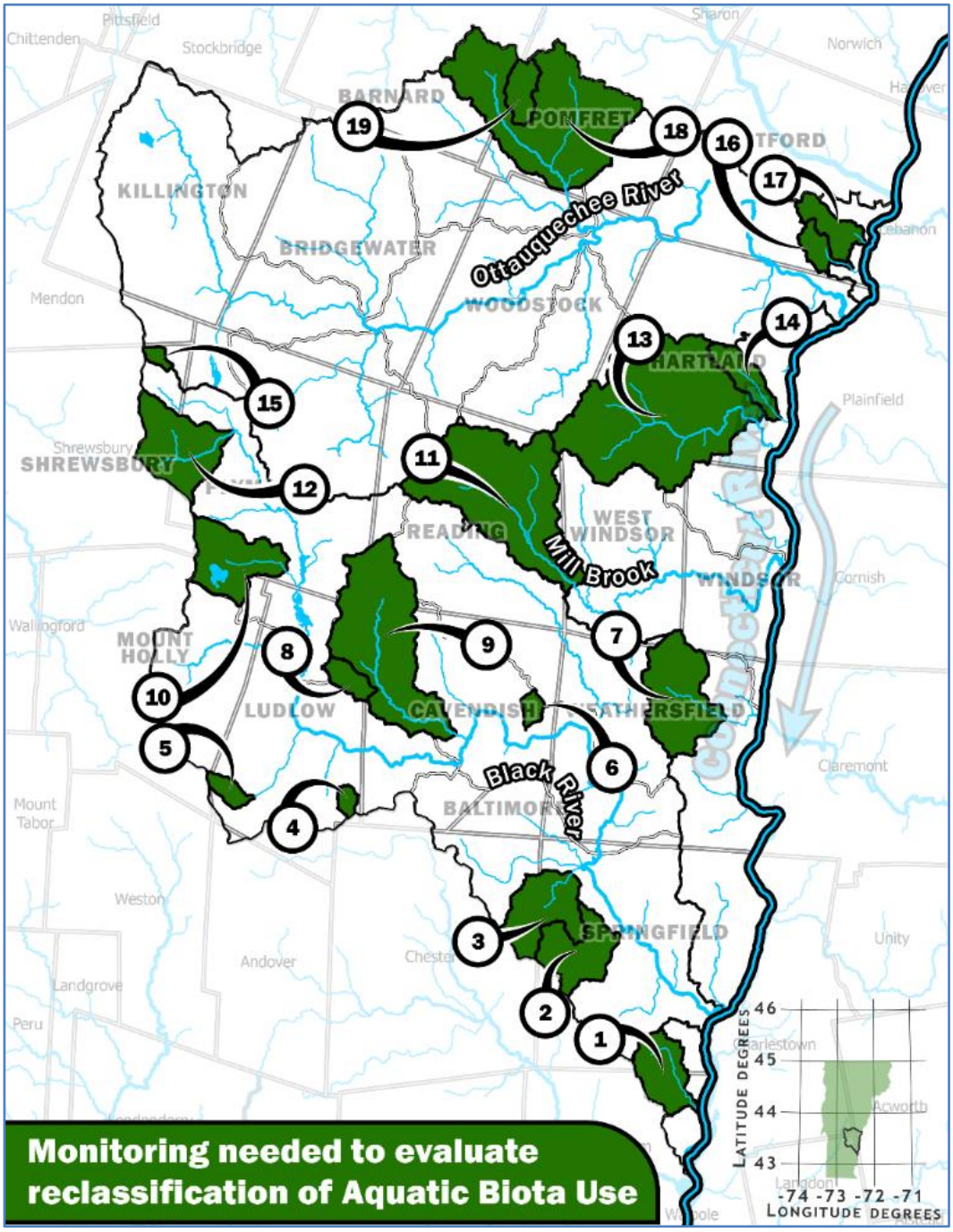


Figure 13. Monitoring Needed to Evaluate Reclassification

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 10 & 11). 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.

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

The restoration 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.

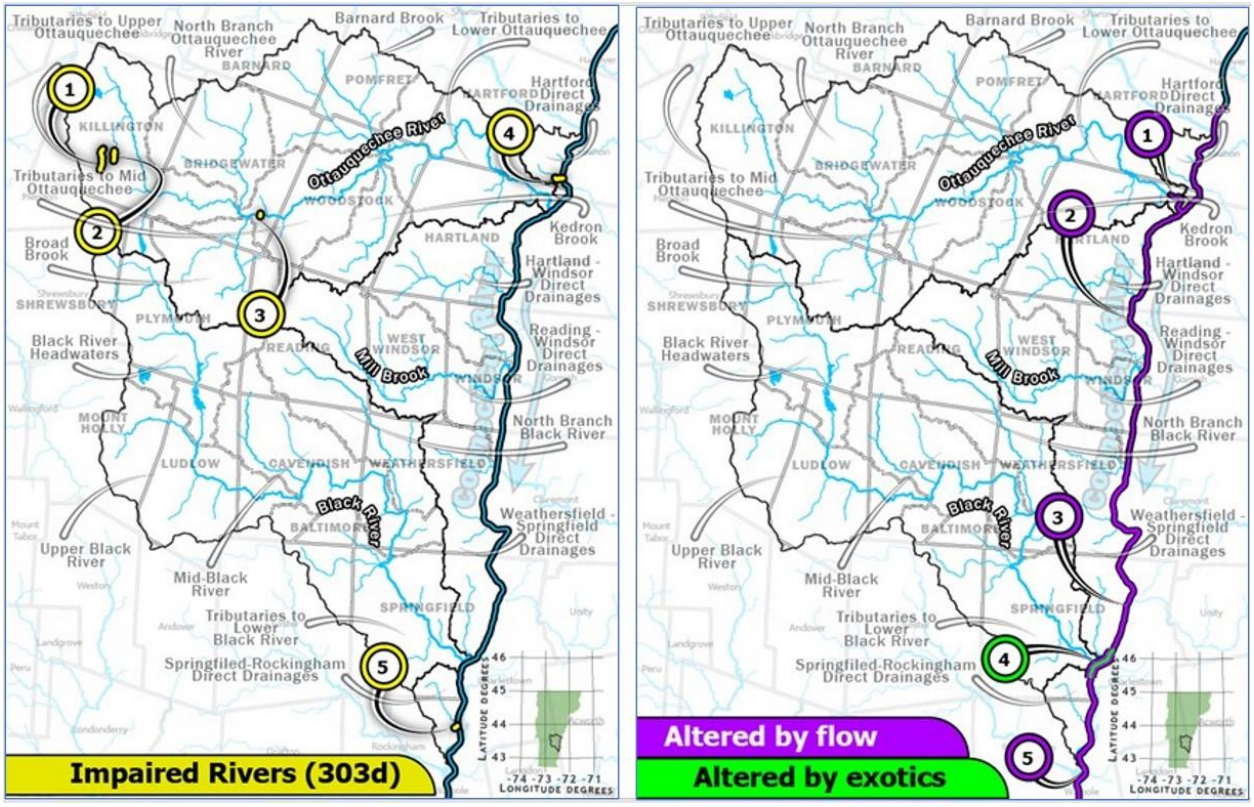


Figure 14. Priority Rivers for Restoration

Table 10. Priority Rivers for Restoration and Pollutants

Listing	Map ID	Name	Pollutant	Problem	Impaired Use
Impaired Rivers					
Impaired TMDL Needed	**1**	Roaring Brook, rm 3.5 to rm 4.2	Pollutants in urban stormwater	Stormwater runoff, land development, erosion	AES, ALS
Impaired TMDL Needed	**2**	E. Branch Roaring Brook, rm 0.1 to rm 0.6	Pollutants in urban stormwater, iron	Stormwater runoff, land development, erosion	AES, ALS
Impaired TMDL Needed	**3**	Small Stream to Ottauquechee River (Bridgewater)	Iron	Bridgewater landfill; leachate entering surface water	ALS, AES
Impaired TMDL Needed	**4**	Neal Brook, Mouth to rm 0.4	Metals	Landfill drainage impacts macroinvertebrates	ALS
Impaired TMDL Needed	**5**	Commissary Brook Trib, Mouth to rm 0.2	Sedimentation/ siltation	Bank failure and erosion due to past clay mining	AES, ALS
Altered Rivers					
Altered Flow	**1**	Lower Ottauquechee River, Below No. Hartland Dam (0.9 Mile)	Artificial flow regulation & condition	USACE dam; no conservation flow based on any biological/wq criteria; 401 WQC issued for operation of the hydroelectric project in Oct. 2021; FERC license still pending	AES, ALS, RB
Altered Flow	**2**	Connecticut River, Wilder Dam to Ascutney Village	Artificial flow condition, fluctuating flows associated with hydropower production	Agreement on operation of Wilder dam was reached in 2020 that is expected to meet VWQS; FERC license and 401 WQC still pending	ALS

Listing	Map ID	Name	Pollutant	Problem	Impaired Use
Altered Flow	**3**	Connecticut River Above Bellow Falls Dam in Springfield	Water level fluctuation at dam; dewatered shorelines/wetlands; unstable/eroding streambanks	Agreement on operation of Bellows Falls dam was reached in 2020 that is expected to meet VWQS; FERC license and 401 WQC still pending	AES, ALS
Altered Flow	**4**	Connecticut River, Hoyts Landing	Eurasian watermilfoil	No active management.	AES, ALS, CR, CRB
Altered Flow	**5**	Connecticut River Above Bellow Falls Dam, Rockingham	Water level fluctuation at dam; dewatered shorelines/wetlands	Agreement on operations of Bellows Falls dam was reached in 2020 that is expected to VWQS; FERC license and 401 WQC still pending	ALS

AES = Aesthetics ALS = Aquatic Biota

CR = Contact Recreation RB = Recreation Boating CRB = Contact Recreation Boating

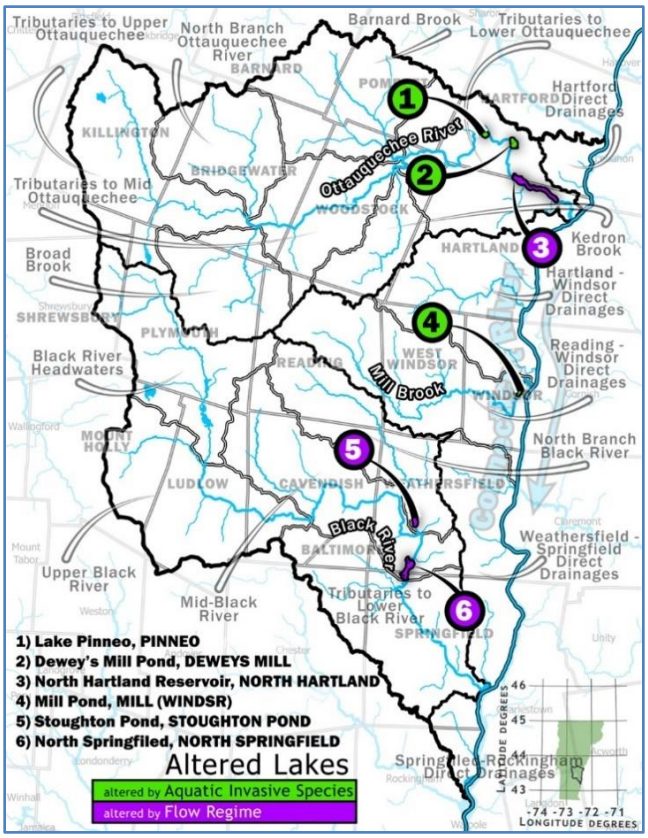


Figure 15. Priority Lakes for Restoration

Table 11. Priority Lakes and Pollutants

Listing	Map ID	Name	Pollutant	Problem
Altered Lakes				
Altered AIS	**1**	Lake Pinneo	Eurasian Watermilfoil	Management plan proposed that includes herbicides.
Altered AIS	**2**	Deweys Mills Pond	Eurasian Watermilfoil	Ongoing management plan that includes benthic barriers and hand-pulling.
Altered Flow	**3**	North Hartland Reservoir	Water level fluctuation	Dam now used for hydropower; operated under FERC license of 2023
Altered AIS	**4**	Mill Pond (Windsor)	Eurasian Watermilfoil	No active management.
Altered Flow	**5**	Stoughton Pond	Water level fluctuation	USACOE dam; no conservation flow based on any biological/wq criteria
Altered Flow	**6**	North Springfield Reservoir	Water level fluctuation	USACOE dam; no conservation flow based on any biological/wq criteria

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.

The ANR is required to develop clean-up plans to guide the restoration of impaired waters where other pollution control mechanisms are not sufficient to achieve water quality standards. In some cases, TBPs are also TMDL implementation plans guiding the execution of actions necessary to meet TMDL reduction targets specific to each planning basin.

TMDLs for Basins 10 include:

- Total Phosphorus – Black River at Ludlow
- Vermont Statewide Total Maximum Daily Load (TMDL) for Bacteria-Impaired Waters
    - Appendix 19 – CSO & WWTF Related (Springfield)

- Dissolved Oxygen TMDL – Long Island Sound (LIS), developed by Connecticut and New York States
    - Vermont Enhanced Implementation Plan for the Long Island Sound TMDL
- Northeast Regional Mercury Total Maximum Daily Load

Long Island Sound TMDL

The Long Island Sound watershed encompasses 16,820 square miles in five states. It is the second largest estuary on the East Coast and receives water from 16,000 miles of rivers and streams. The 410 mile long Connecticut River is its largest tributary. 42% or 3932 square miles of Vermont, drains to the Connecticut River. 427 square miles of those are in Basin 10.

The Long Island Sound Dissolved Oxygen TMDL released in 2000 is designed to address low dissolved oxygen or hypoxia in Long Island Sound bottom waters. It is often referred to as the Connecticut River Nitrogen TMDL because it is linked to an overabundance of nitrogen discharging into the Sound from the Connecticut River and other tributaries. While nitrogen is essential to a productive ecosystem, too much nitrogen fuels the excessive growth of algae. When the algae die, they sink to the bottom, where they are consumed by bacteria. The microbial decay of algae and the respiration of these organisms uses up the available oxygen in the lower water column and in the bottom sediments, gradually reducing the dissolved oxygen concentration to unhealthy levels.[2] (New York State Department of Environmental Conservation, 2000).

Due to the Long Island Sound TMDL, nitrogen is a key pollutant of concern in the Connecticut River watershed. Total Nitrogen (TN) levels show correlation with development and impervious surface increases. Wastewater discharges and stormwater and agricultural runoff are common contributors of nitrogen.

Vermont's nitrogen export to LIS is estimated to be about 12% of the total load to the Sound based on the recently published SPARROW model[3] (Astor, 2019). Basin 10 is responsible for approximately 12.5% of Vermont's load. This delivered loading is 5% from municipal wastewater treatment, 14% from developed land runoff, 10% septic system effluent, and 7% from agriculture through nitrogen fixing crops, farm fertilizer and manure (Figure 16).[4] Approximately 64% of nitrogen from the Basin comes from atmospheric deposition.[5] Figure 16 shows the delivered loading in percent contribution. Efforts to reduce atmospheric deposition have been occurring at the

[2] A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound
[3] Spatially Referenced Models of Streamflow and Nitrogen, Phosphorus, and Suspended-Sediment Loads in Streams of the Northeastern United States
[4] Ibid.
[5] Ibid.

national level through the 1990 Clean Air Act and its amendments. Total nitrogen deposition has declined since 1985.

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

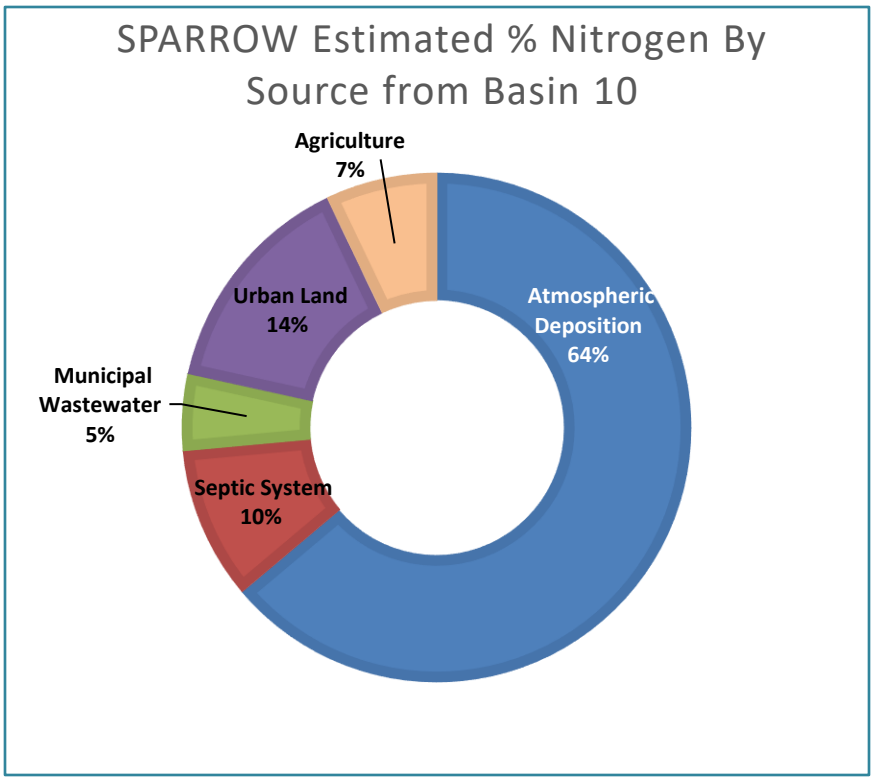


Figure 16. Estimated % Nitrogen by Source

The sources of nitrogen to be addressed in Vermont include wastewater and septic discharges, agricultural lands, developed lands, and forest practices. The adoption of Vermont's Act 64, the Vermont Clean Water Act, helps implement overarching strategies and steps required to meet loading reductions for the Long Island Sound's TMDL. Each of the five watershed states completed a section of the LIS TMDL Enhanced Implementation Plan Report in 2013. The Vermont State Section, prepared by DEC, tasks TBPs with identifying actions and priority projects for the remediation of impaired, altered and stressed waters. Action items include both data collection and assessment efforts and specific implementation activities (DEC, 2013). The Implementation Table in Chapter 5 offers strategies and actions to address nitrogen reduction in the Basin. The Implementation Table points to specific projects or actions that are necessary to achieve compliance with a TMDL for a specific impaired water.

The Vermont Enhanced Implementation Plan for the Long Island Sound TMDL (DEC, 2013) was added to the LIS-TMDL to address four goals:

1. To identify the Vermont sources of nitrogen as they are currently understood, across broad land use sectors, such as developed, agricultural and forested;
2. To identify the status and trends of important drivers of nitrogen export such as the intensity of agricultural and development activities and investigate how these might have changed since the TMDL baseline period of 1990;

3. To identify the management programs, operating at that time, that address these drivers of nitrogen loading that have a significant effect on reducing or preventing nitrogen export. A part of this is to identify a timeline as to when programs were initiated or enhanced; and
4. Using a weight-of-evidence approach, to assess the combined management programs/projects to develop a qualitative evaluation as to whether management efforts are sufficient to meet the original 2000 TMDL of a 10% non-point source nitrogen reduction and if these strategies are sufficient to maintain that control into the future (DEC, 2013).

In 2023 the Windham County Natural Resources Conservation District received funding from the Long Island Sound Futures Fund of the National Fish and Wildlife Foundation to address nitrogen inputs to the upper Connecticut River watershed of Vermont and New Hampshire.

The project, titled *Working with Agricultural Producers and Partners to Restore and Protect Water Quality in the Upper Connecticut River Basin,* will identify and gather a bi-state team of key stakeholders and partners working in agriculture in the upper Connecticut River Valley to select best management practices for reducing Nitrogen pollution to Long Island Sound. And will design and plan implementation trials and monitoring and assessment studies to identify practices with the greatest impact on reducing Connecticut River nitrogen inputs.

Progress toward the reduction of nitrogen to the Sound is being made particularly through efforts in the lower watershed in Connecticut and New York through investments in wastewater treatment and agriculture. These efforts have resulted in the total area of the hypoxic waters being reduced from 205 to 89 square miles between 2014 and 2018.[6]

[6] Clean Water Solutions to Reduce Nitrogen Pollution, © 2022 Long Island Sound Study,

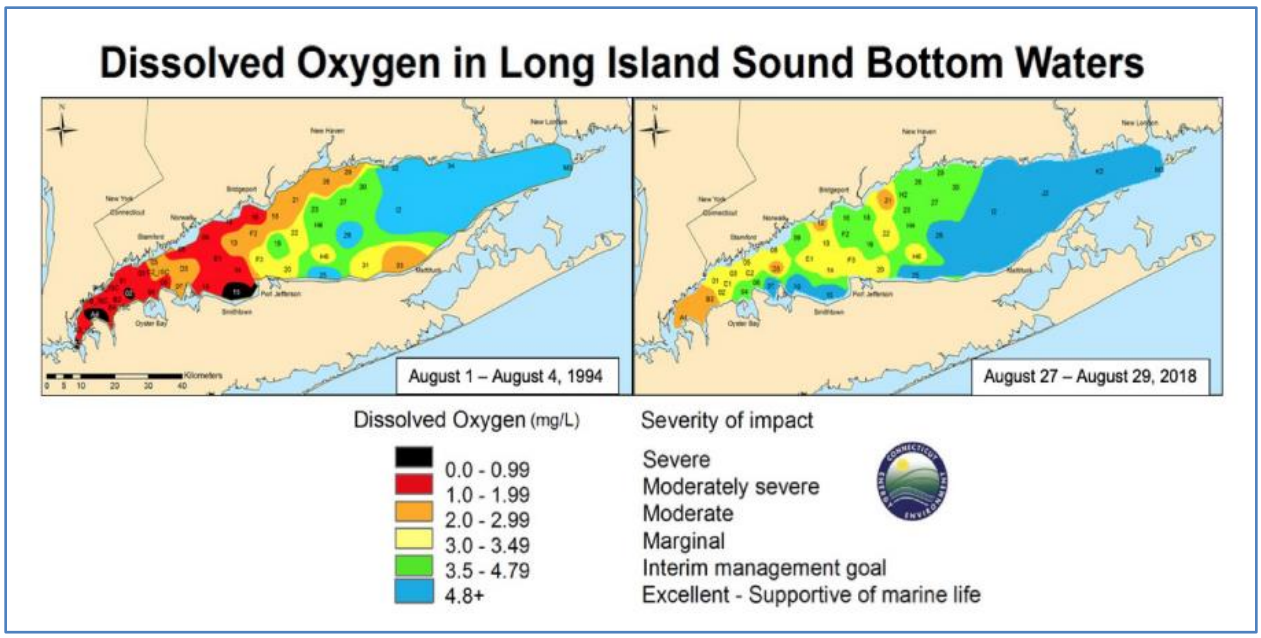


Figure 17. Decreases in the Frequency of Hypoxia in Long Island Sound 1994 - 2018

Significant reductions in the nitrogen load are still needed to meet water quality goals. This plan puts forward strategies to help better understand and reduce Vermont's contribution.

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 18). Ongoing protection and restoration efforts and recommendations to meet water quality objectives are developed for each sector. These recommendations support the development of the strategies in the Chapter 5 Implementation Table.

Figure 18. Land Use Sector Framework
with practices used to enhance, maintain, protect, and restore water quality

A. Agriculture

Agricultural land use makes up approximately 8.4 percent of the land cover in the Basin. A large majority of this land is in hay or pasture with only a small amount in cultivated crops. The highest concentrations of agricultural land are found along the Connecticut River and the lower Ottauquechee River and its tributaries, Barnard Brook and Kedron Brook. The majority of agricultural land is in hay production. Pastureland is heaviest in the Mill Brook-N[7] and Lulls Brook watersheds. Cropland is minimal in the Basin with the largest fields located on the banks of the Connecticut River and its direct tributaries.

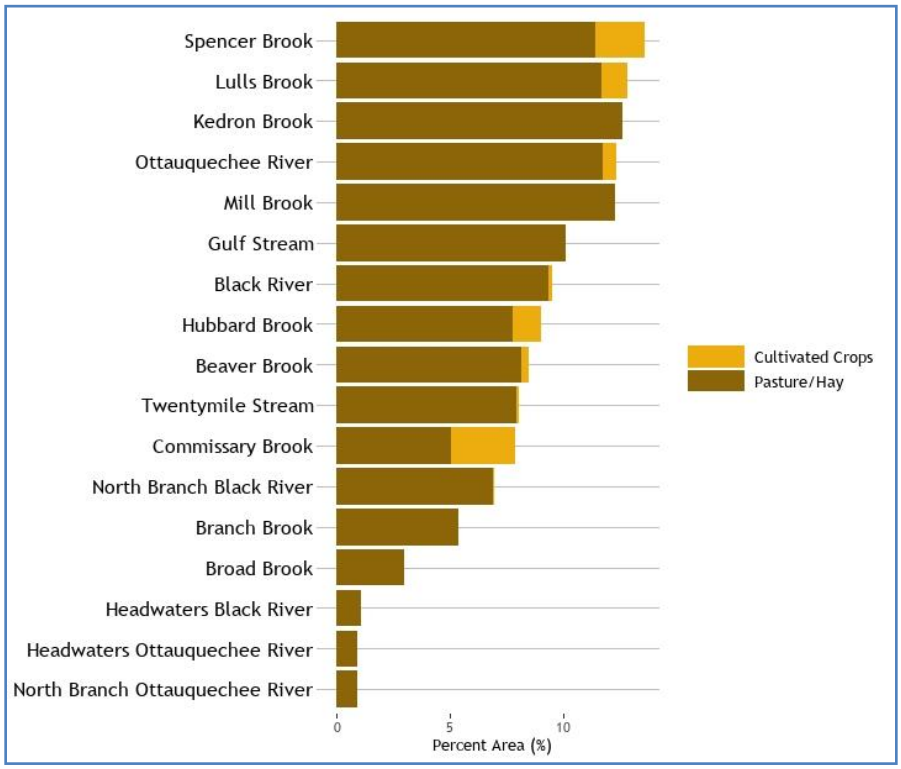


Figure 19. Percent Land Coverage by Agricultural Land Use

Implementation of agricultural conservation practices is increasing steadily in the Basin. Since 2018 approximately $1.9 million has been invested in agricultural clean water projects by federal, state, local, and farmer/in-kind sources. These investments have resulted in the implementation of conservation practices such as cover cropping, reduced tillage, no till pasture and hayland renovation, fencing, animal trails and walkways, nutrient management planning, and riparian buffer installation. Investments in agricultural conservation practices and outcomes can be explored further in the Clean Water Interactive Dashboard.

[7] There are two Mill Brooks in the Basin, one on each side of Ascutney Mountain. These are designated as Mill Brook-N which runs through Reading, West Windsor and Windsor and Mill Brook-S which runs through Weathersfield

In addition to financial investments made for agricultural conservation practice adoption, AAFM and partners provide educational opportunities and technical assistance to farmers to promote and assist with conservation practice adoption. Between 2018-2022, 12 education events were hosted in Basin 10, with 157 attendees. In Windsor country, which expands beyond Basin 10, approximately 105 on-farm technical assistance visits were conducted by UVM Extension, Conservation Districts, and AAFM.

AAFM and DEC regulatory programs work to protect surface waters by requiring baseline farm management practices that ensure environmental stewardship. The Required Agricultural Practices (RAPs) 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. Vermont farms are also regulated by additional rules promulgated by the AAFM based on farm animal numbers defining farm size classifications of small, medium and large operations.

There are currently no permitted Concentrated Animal Feeding Operations (CAFO)s, Large Farm Operations (LFOs) or permitted Medium Farm Operations (MFOs) in the Basin. There are 15 Certified Small Farm Operations (CSFOs) in the Basin that are required to comply with the RAPs, certify annually with AAFM and will be inspected at least once every seven years. The AAFM estimates there are 28 Small Farm Operations (SFOs) in the Basin that do not meet the thresholds of a CSFO and are not required to receive routine inspections by AAFM, but still need to comply with the RAPs. Since 2019, approximately 20 farm facilities have been inspected encompassing 160 acres of production areas in Windsor County, which expands beyond Basin 10.

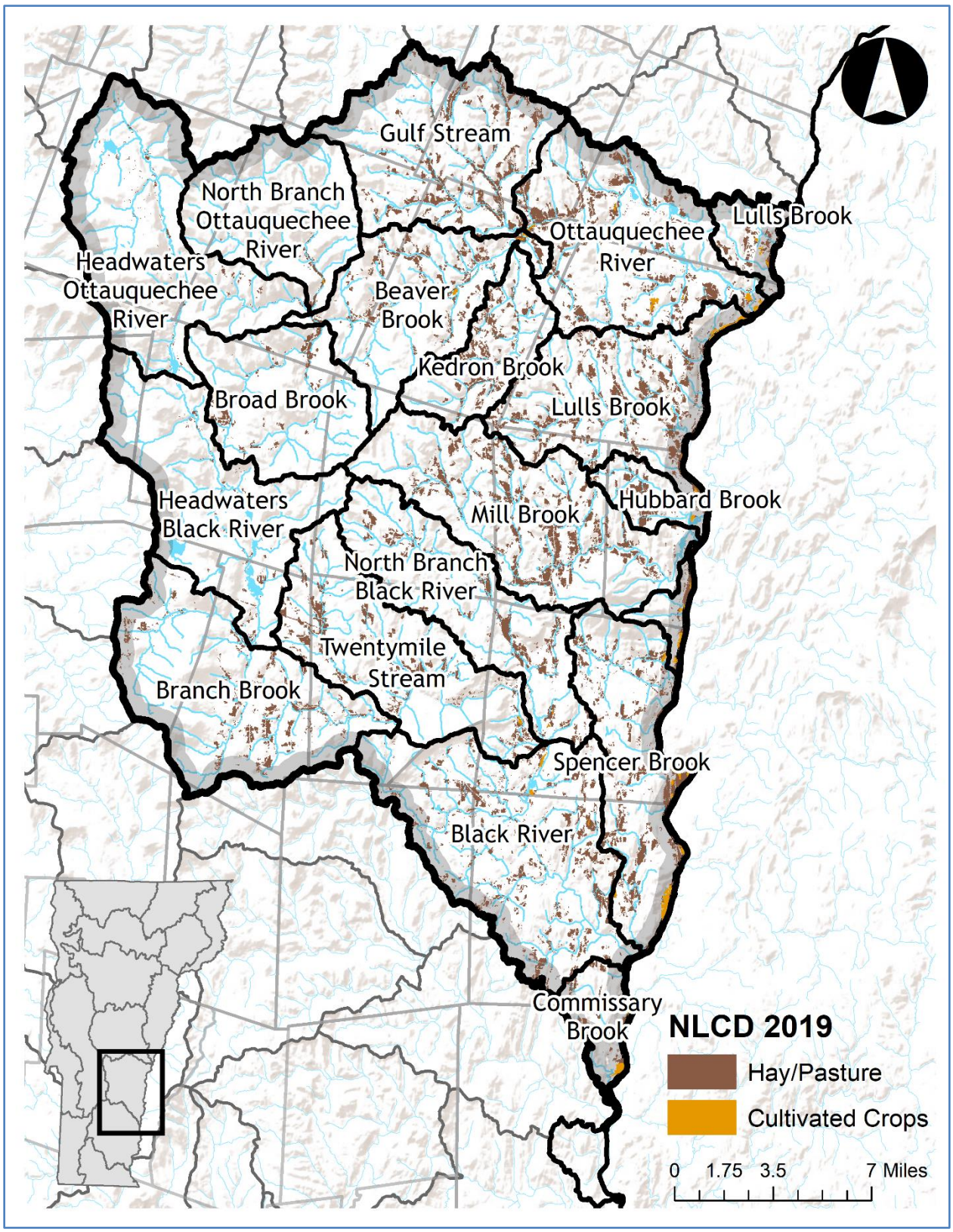


Figure 20. Agricultural Land Use

Outreach will continue to help landowners understand where they fall within the RAP farm categories and the RAP requirements. Priority watersheds for this work have been identified in Chapter 5 using current monitoring data and environmental modeling.

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 targeted cropland management assessments in accordance with RAPs and permit rules as applicable.

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

There are no agriculturally impaired waters in the Basin. There are, however, waters of concern in areas where agriculture is the predominant land use.

Barnard Brook and Gulf Stream north of Woodstock and Kedron Brook to its south as well as the mainstem Ottauquechee River through to Bridgewater village all show impacts from sediment and nutrients. Similarly, Mill Brook-N and Lulls Brook and the North Branch of the Black River have these same agriculture-related impacts. Further monitoring of these waters is recommended to help determine the source of the pollutants.

Strategies informed by agricultural community partners include focus on outreach, education and technical assistance for increased implementation of farm and field practices and supporting adoption of conservation practices through innovative equipment.

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 with it 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.

Strategies to address stormwater in Tactical Basin Plan are often stem from Stormwater Master Plans (SWMP). SWMPs are developed with municipal and public involvement to create a comprehensive listing of all known problems. Plans result in a prioritized list of projects offering a strategic approach to address stormwater runoff. Additionally, TBPs use recommendations from the Vermont Nonpoint Source (NPS) Management Program Plan which summarizes the causes and sources of NPS pollution and identifies strategies to protect and restore waters impacted by NPS pollution.

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 include:

- Operational Stormwater Permits
- Construction Stormwater Discharge Permits
- Municipal Separate Storm Sewer System (MS4) General Permits
- Multi-Sector General Permit (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. This permit is active in Basin 10 for new development, redevelopment, and permit renewal. Full implementation of the Three-Acre General Permit does not begin until 2033 for the majority of the Basin. However, for the sub-watersheds of Roaring Brook and the East Branch of Roaring Brook in Killington the Three-Acre General Permit conditions are required due to their current stormwater impairments.

Beginning July 1, 2022, projects statewide 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.

Stormwater Mapping and Master Planning

Stormwater infrastructure mapping projects are completed for municipalities by the CleanWater Initiative Program to supplement any existing drainage data collected by towns. The intent of this work is to provide a tool for planning, maintenance, and inspection of the stormwater infrastructure.

All towns in the Basin except Andover, Baltimore, Pomfret and Stockbridge have completed stormwater mapping. Stormwater Master Plans are completed for Ludlow and Springfield, and are being developed for Chester, Londonderry, Windsor and Woodstock. Stormwater mapping and existing stormwater master plans are posted and are filed by Town in which they are located.

Since the 2018 TBP was completed, nine stormwater projects have been completed. Three projects have received funding and are in-progress and numerous projects are in the planning stage.

Assessment reports and maps from each town provide an overall picture and understanding of the connectivity of the storm drainage systems on both public and private properties. 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 are entered into the Watershed Projects database and may be implemented by towns with the aid of watershed

partners. All towns in the Basin with significant development adjacent to surface waters where priority projects have been identified should pursue project implementation. For those towns with less development, an individual project identified by a stormwater mapping report can be developed.

Table 12. Towns with Completed Assessments
(Click town to link to report.)

Town Name	Mapping Report Status	# Priority Projects ID'd	Master Plan Status	# Priority Projects ID'd
Andover	Not Planned	-	Not Planned	
Baltimore	Not Planned	-	Not Planned	
Barnard	Completed	3	TBD	
Bridgewater	Completed	1	TBD	
Cavendish	Completed	3	TBD	
Chester	Completed	7	In-Progress	
Hartford	Completed	22	Planned	
Hartland	Completed	4	Planned	
Killington	Completed	12	Planned	
Ludlow	Completed	16	Completed	24
Mendon	Completed	32	In-Progress	
Mount Holly	Completed	0	Not Planned	
Plymouth	Completed	0	Not Planned	
Pomfret	Not Planned	-	Not Planned	
Reading	Completed	1	TBD	
Springfield	Completed	45	Completed	53
Stockbridge	Not Planned	-	Not Planned	
Weathersfield	Completed	1	TBD	
West Windsor	Completed	6	Planned	
Windsor	Completed	8	In-Progress	
Woodstock	Completed	17	In-Progress	

Illicit Discharge Detection & Elimination Studies (IDDE)

Illicit discharges are discharges of wastewater or industrial process water into a stormwater-only drainage system. All towns in the Basin, except Baltimore and Pomfret, have completed IDDE reports.

Of the 356 outfalls assessed only four were confirmed to have illicit discharges. Two of these have been eliminated, one is being monitored and one was misidentified due to excessive de-icing salt concentrations in the outfall.

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. Outreach is recommended to support bylaw development for stormwater management of road segments receiving stormwater runoff in priority catchments in Hartford, Killington, Ludlow, Springfield, Windsor and Woodstock. Additionally, outreach by the Regional Planning Commissions is encouraged in towns that have contemplated stormwater management, where population growth is likely, and impervious surface is moderate to high.

Roads

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. Roads can also impinge on stream floodplains and be a barrier to aquatic organism passage (AOP) due to undersized culverts. Road runoff results in sediment, phosphorus, and chloride loading to adjacent waterbodies.

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).

The implementation of the priorities identified in REI's will reduce sediment, nutrients, 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," which are 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 Stormwater - Road Segment Priority layer onthe ANR Natural Resource Atlas and REI results by town can be view in the MRGP Implementation Table.

Table 13. MRGP Compliance Status

Permit Information	Requirements for Full Compliance		
Town	MRGP Fully Compliant	REI Data Submitted and Technically Complete	# Connected Segments
Springfield	YES	YES	1120
Hartford	YES	YES	1102
Rockingham	YES	YES	987
Mount Holly	YES	YES	967
Chester	YES	YES	966
Woodstock	YES	YES	792
Barnard	YES	YES	750
Ludlow	YES	YES	672
Weathersfield	YES	YES	659
Pomfret	YES	YES	605
Plymouth	YES	YES	575
Bridgewater	YES	YES	574
Hartland	YES	YES	550
Cavendish	NO	NO	545
Reading	YES	YES	514
Killington	NO	NO	507
West Windsor	YES	YES	488
Stockbridge	YES	YES	465
Shrewsbury	YES	YES	463

Town	MRGP Fully Compliant	REI Data Submitted and Technically Complete	# Connected Segments
Windsor	YES	YES	418
Mendon	YES	YES	361
Andover	YES	YES	332
Ludlow Village	YES	YES	161
Woodstock Village	YES	YES	111
Baltimore	YES	YES	81

Based on protocols developed by DEC with the assistance of the Regional Planning Commissions, all the towns in the Basin have completed REIs. 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. Two Basin towns have yet to meet this requirement. *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.

The MRGP was reissued 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 will require 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. The reissued permit now requires that culvert size meets the Active Channel Width for non-compliant intermittent stream crossings.

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. Projects on *Very High* and *High* priority roads are water quality priorities (Figure 21 & 22).

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.

Springfield, Weathersfield, and Ludlow are priority towns for funding due to the high number of *Very High – Moderate* roads to be improved.

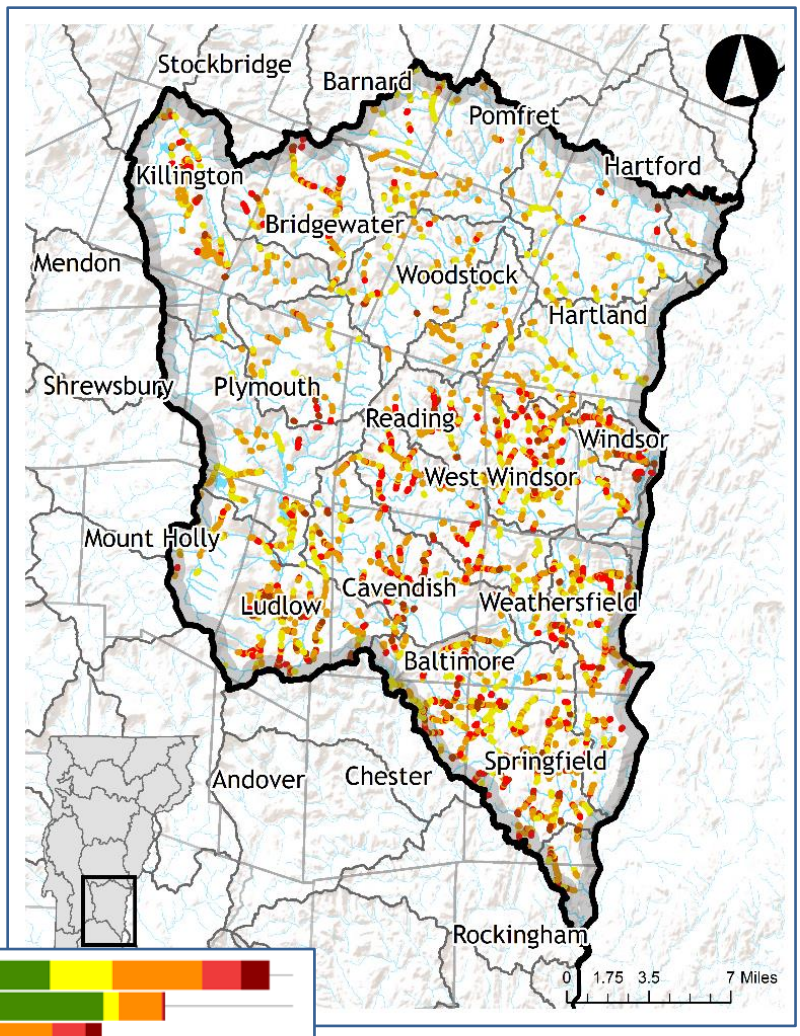


Figure 21. REI Project Priorities

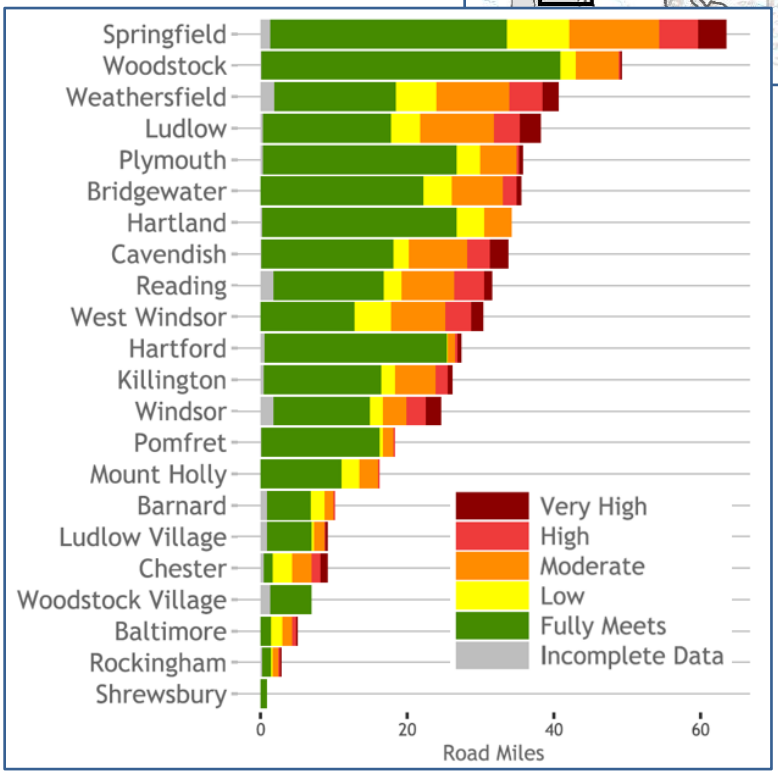


Figure 22. Priority Road Miles by Town

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 provides training, technical assistance, communication tools and opportunities for information exchange to assists municipalities improve their road networks. These programs help implement the strategies described here and listed in Chapter 5.

Transportation Separate Storm Sewer System General Permit – TS4

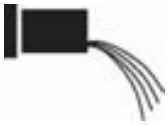
The Transportation Separate Storm Sewer System General Permit (TS4) covers stormwater discharges from all Vermont Agency of Transportation (VTrans) owned or controlled impervious surfaces. The TS4 general permit combines the stormwater requirements for VTrans associated with its designated regulated 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.

Projects on VTrans roads, rights-of-way, and facilities are being prioritized to include highly hydrologically connected road segments, existing road drainage deficiency, or localized erosion. The VTrans factsheet provides additional information. VTrans also uses the Transportation Resilience Planning Tool (TRPT) is 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 (VRBS). These standards 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 impacted 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 conveyed to centralized wastewater treatment facilities (WWTF), and treated to established standards identified in permits before being discharged into a receiving water. There are 11 municipal, three industrial and one community wastewater treatment facilities that are subject to National Pollutant Discharge Elimination System (NPDES) permits in the Basin (Table 15).

An overarching consideration for the issuance of permits in the Basin is the Long Island Sound TMDL for nitrogen. All wastewater facilities discharging to the Long Island Sound (LIS) are required to have Nitrogen Optimization Plans (NOPs) included in their permit. All facilities are required to maintain a mass discharge of total nitrogen (TN) lower than the existing mass loading of TN. Each is assigned a baseline annual average daily TN load discharge for the facility estimated in lbs/day.

To meet statutory requirements, the WSMD, with assistance from municipalities, documents the current loading conditions to determine the "reasonable potential" that WWTFs have, to cause or contribute to downstream water quality impairment. Each of the public facilities received a reasonable potential determination (RPD).

Limitations must control all pollutants or pollutant parameters (either conventional, nonconventional, or toxic pollutants) which the Director determines are or may be discharged at a level that will cause, have the reasonable potential to cause, or contribute to a deviation above any state water quality standard, including state narrative criteria for water quality." At each renewal, permit writers 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 14. Wastewater Treatment Facilities

PERMIT #	FACILITY NAME	CITY	TREATMENT TYPE	PERMITTED FLOW (MGD)	RECEIVING WATER	PERMIT ISSUE DATE	PERMIT EXPIRATION DATE
3-1156	Bridgewater WWTF	Bridgewater	RBC	0.043	Ottauquechee River	9/6/2016	9/30/2021*†
3-1474	VT Quarries Corp	Cavendish	Sump pit and settling pond (operations currently inactive)	0.12	Unnamed Trib of Black River	12/15/2015	9/30/2020*
3-1205	Cavendish WWTF	Cavendish	Lagoon	0.15	Black River	11/12/2014	9/20/2019*
3-1185	Hartford - Quechee WWTF	Hartford	SBR	0.475	Ottauquechee River	11/26/2019	9/30/2024
3-1243	Sherburne FD 1 WWTF	Killington	RBC	0.3	Ottauquechee River	2/27/2015	3/31/2020*
3-1208	Ludlow WWTF	Ludlow	Extended Aeration and Oxidation Ditch	1.05	Black River	1/21/2015	12/31/2019*
3-1506	Imerys Talc - Rainbow Mine	Ludlow	Drainage swales and stone filter berm	0.432	Black River	12/24/2013	3/31/2019
3-0348	Magris Talc USA, Inc - Argonaut Mine	Ludlow	Settling ponds	As necessary based on precipitation	Unnamed Trib of Soapstone Brook	2/1/2021	12/31/2023
3-1551	Ottauquechee Hydro	North Hartland	No treatment (discharge of non-contact cooling water)	0.0096	Ottauquechee River	12/3/2019	12/31/2024
3-1178	Woodstock - South WWTF	South Woodstock	SBR	0.05	Kedron Brook	9/6/2016	9/30/2021*†
3-1154	Springfield WWTF	Springfield	Activated sludge	2.2	Black River	10/27/2015	9/30/2020*
3-1179	Woodstock - Taftsville WWTF	Taftsville	Extended aeration	0.01	Ottauquechee River	1/23/2020	12/31/2024
3-1222	Imerys Talc - West Windsor Mill	West Windsor	Settling ponds	0.7	Mill Brook-N	12/15/2015	9/30/2020

PERMIT #	FACILITY NAME	CITY	TREATMENT TYPE	PERMITTED FLOW (MGD)	RECEIVING WATER	PERMIT ISSUE DATE	PERMIT EXPIRATION DATE
3-1225	Hartford WWTF - WRJ	White River Junction	SBR	1.45	Connecticut River	3/21/2018	3/31/2023
3-1168	Windsor Weston Heights WWTF	Windsor	Extended aeration	0.015	Connecticut River	1/3/2017	12/31/2021*
3-1253	Windsor Main WWTF	Windsor	RBC	1.13	Connecticut River	9/26/2016	9/30/2021*
3-1228	Woodstock WWTF	Woodstock	Extended aeration	0.45	Ottauquechee River	9/6/2019	3/31/2020* †

* - permit extension authorized

† - facility undergoing upgrade at time of writing

RBC - Rotating Biological Contactor

† - facility upgrade planning process

SBR - Sequencing Batch Reactor

South Woodstock WWTF is currently under construction. They are replacing the package plant with an SBR facility.

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 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 an on-site septic system) or water supply; repair and/or replacement of a failed[8] 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[8] often discharge untreated sewage that

[8] Wastewater systems that have wastewater surfacing, backing up into the building or discharging to the waters of the State are considered failed systems

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 through the On-site Loan Program and the Healthy Homes Initiative to qualifying homeowners that need to upgrade their systems if the costs are prohibitive.

Many historic villages 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*, and nutrients to surface waters. Additionally, failed systems can cause cross-contamination of nearby drinking water wells.

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 through both the Clean Water State Revolving Fund and the Vermont Engineering Planning Advance Program. 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 and the Clean Water State Revolving Fund are both loan programs available to municipalities without existing municipal water or sewer systems. The Planning Advance Program provides funding for conducting a feasibility study for community based 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, (Stone Environmental, 2005) 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 wastewater pollution sources, however significant federal funding has become available through the American Rescue Plan Act (ARPA) and is available through ANR to help address this issue.

Wastewater Workshops (AKA Septic Socials)

Concerns around failing septic systems are 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 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 using the host homeowner's system as the demonstration model. 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 developed communities that do not have municipal wastewater – Sunrise Village, East Mountain and Bear Mountain in Killington, Hawk Mountain and in Plymouth and the lake communities around Amherst, Echo, Rescue and Pauline Lakes. Small village communities like Cavendish, Reading, Weathersfield and Hartland are also 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 ecosystem services such as flood control, wildlife habitat, filtration of pollutants that these natural resources provide.

While Agency regulatory programs aim to maintain and protect natural resources, the Agency 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 all forms of connectivity, upstream-to-downstream and river-to-floodplain, 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 tools used to increase river connectivity.

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: Stream Geomorphic Assessment - Final Reports. Waters with SGAs and/or RCPs are listed in Table 15. Where funding, local support, and interest exists, priority projects and objectives identified in these plans should be pursued.

Table 15. Stream Geomorphic Assessments Completed

Watershed	Date	Coverage
Black River Corridor Plan	2009	Phase 1, 2 & Corridor Plan
Patch & Buffalo Brooks Corridor Plan	2010	Phase 1, 2 & Corridor Plan
Ottauquechee River Corridor Plan	2013	Phase 1, 2 & Corridor Plan
Roaring Brook Phase 1 and 2 SGA	2006	Phase 1, 2 Only
Mill Brook River Corridor Plan	2015	Phase 1, 2 & Corridor Plan
Mile Brook - Valley St	2017	Phase 2
Hubbard Brook Phase 1 SGA	2008	Phase 1 Only

While overall water quality in the Basin is good, degraded geomorphic condition (Figure 9) of the rivers and streams may impact:

- wildlife and fish habitat (e.g., riparian buffer removal increases water temperature, reduces shading and habitat for insects that feed fish, channel alteration destroys aquatic habitat);
- public safety (e.g., loss of floodplains that store floodwaters, accelerated streambank erosion which results in infrastructure damage, 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, moving toward equilibrium will help to mitigate impacts of increased runoff and streamflow from climate change.

River Restoration and Conservation

Active river restoration can include, but is not limited to, the reconnection of floodplains through berm removal, woody buffer plantings (trees and shrubs), and stabilization techniques when a channel has the dimensions and meander planform that supports dynamic equilibrium.

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 polluted 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.

Since the last Basin Plan, numerous river planting, floodplain restoration and dam removal projects have been completed or have designs ready to construct. Twenty-six miles of rivers and streams have been reconnected for equilibrium and wildlife passage, 37 agricultural practice structures have been installed, 954 acres of agricultural land have been treated with conservation practices, 27 stormwater projects have been identified through SWMPs, 475 hydrologically connected road miles have been inventoried and 359 acres of land have been conserved with natural resource protections.

Restoration and Strategic Wood Additions

Wood plays a vital role in stabilization of river channels. In geomorphically stable streams, wood helps to create diverse channel conditions through the processes of sediment deposition and scour (Baillie et al 2008, Brooks et al (2004)). Wood's ability to trap sediment within the channel helps provide bed stability and withstand degradational processes, thereby promoting floodplain connection (Jeffries et al 2003, Sear et al 2010, Gurnell et al 2002, Cordova et al 2007). Wood also creates important instream habitat for fish and other aquatic species.

Many reaches of stream in Vermont are lacking in large wood due to a legacy of deforestation and direct removal of wood from stream ecosystems (Wohl, 2014). The process of forest maturation that will eventually lead to wood recruitment in stream channels is a slow one, so wood addition is a restoration strategy to jumpstart this process. Wood addition can enhance dynamic channel stability and help restore the processes that support a dynamically stable channel, rather than maintaining a static channel form and location. Wood addition projects are being planned for the Basin with a focus on state lands to provide demonstration sites to develop more knowledge around these project types and support improvements on state lands for water quality and habitat improvements.

Training and workshops on assessment and implementation of this work are needed to grow the knowledge base needed to increase implementation.

Dams and Dam Safety

There are currently 108 known dams of different types, sizes, and condition in the Basin. There are likely many more that have not been documented. Each known dam is categorized by the status of its use or condition. See Appendix B for a full list.

While some dams are used to generate electricity and provide recreational opportunities such as boating, fishing, and swimming, all dams impede a river's ability to transport water 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.

The Dam Safety Statute and 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 rules apply to all dams that do not generate electricity and all non-federally owned dams. 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.

Table 16. Dam Hazard Class

Hazard Class	# of Dams
High	10
Significant	27
Low	33
Minimal	14
Removed	3
Breached	12
Unknown	9
TOTAL	108

Dams are rated for their hazard potential. The hazard potential classification of the dam is based on the potential loss of human life, property damage, and economic loss that would occur in the event of a dam failure. These ratings are High, Significant, Low and Minimal. A number of dams have already been breached or removed. Table 17 shows the hazard class of the Basin's dams.

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.

Dam removal is a priority for the Basin. Three dams have been removed since the 2018 plan, three removals have been designed and are ready for removal and three others are being studied for possible removal.

Table 17. Status of Dam Removal Projects

Dam	Waterbody	Status
West Windsor Firehouse	Mill Brook-N	Removed
Harrington	Mill Brook-N	Removed
South Mountain Rd	trib to Mill Brook-S	Removed
Springfield Reservoir	trib to Black River	Removal Design
Valley Street	Mile Brook	Removal Design
Rockefeller	trib to Woodward Reservoir	Removal Design
Billings Pond	Barnard Brook	Being Studied
Golf Course	Kedron Brook	Being Studied
Prison Pond	trib to Hubbard Brook	Being Studied

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 to achieve the 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. Windsor County received official "digital" FIRMs in 2007, but these were based on the old map data. The new update will cover the

entire state in stages and may become effective in some counties as soon as 2024 as part of FEMA's Risk Mapping, Assessment, and Planning (Risk MAP) program. Towns will receive a notice from FEMA of an initial discovery meeting. During the meeting, stakeholders, including FEMA, state, and community officials, will discuss areas of flooding concern and project goals, milestones, and products. For more information on the FEMA mapping process, visit the Rivers Flood Training site "Get Ready for New FEMA Flood Insurance Rate Maps".

Updated FIRM maps will identify the high-risk flood hazard areas in the Basin that are the focus of municipal flood regulations. Most of the area will have much improved computer-model based Zone A hazard information using updated flood discharge data and one-foot contours. Some reaches will have older studies aligned with current topography. A few areas may be prioritized for updated field-based studies incorporating data from bridges and other obstructions.

Flood Control & Hydro Power Dams

Flood control dams are operated by the US Army Corps of Engineers to reduce flood damages downstream of the dams and to reduce damages collectively along the entirety of Connecticut River. Local flood control dams protect municipalities in the same way. This service has prevented many millions of dollars in flood damage from occurring from Vermont to Connecticut.

Eight flood control dams and reservoirs are located in the Basin. Four of these are USACE dams:

North Springfield Reservoir
Stoughton Pond
North Hartland Reservoir
    This dam also produces hydroelectricity.

Five are municipal flood control dams operated by the Town of Ludlow:

Jewell Brook Site No. 1
Jewell Brook Site No. 2
Jewell Brook Site No. 3
Jewell Brook Site No. 3 Dike
Jewell Brook Site No. 5

Flood protection benefits come with some environmental costs. These include blocking fish passage, disrupting the continuity of stream flow and sediment, warming the water temperature, and causing unnatural fluctuations in flow levels and stream velocity.

The hydroelectric power dams on the Connecticut River at Hartford and Bellows Falls have similar environmental impacts as do flood control dams. The dams create impoundments that are 45 and 26 miles long respectively, creating reservoir conditions from Bellows Falls reaching up to Newbury with a short stretch of free-flowing river in Windsor. Fish passage is provided by fish ladders, but these are not well used, each has a viewing station. The dams continue to impact the migration of

anadromous Sea lamprey, American shad and catadromous American eel, and can kill fish as they move downstream through the generating turbines. Additionally, other aquatic species such as freshwater mussels, dragonflies, and aquatic insects are impacted by unnatural fluctuating surface water levels. Managing for safe fish passage upstream and downstream, and stabilizing flow rates to protect endangered and threatened aquatic species are being addressed in the hydro-relicensing process the southern Connecticut River dams are currently undergoing.

On the Black River the Cavendish dam owned by Green Mountain Power (GMP) and on the Ottauquechee River, the Deweys Mills (USACE) and Quechee Mills (Simon Pierce Inc.) dams in Hartford and the Taftsville (GMP) dam in Woodstock also produce hydro power and are run-of-river operations.

Flood Hazard Mitigation and Climate Resiliency

Since 2014, Vermont has required municipal and regional plans to incorporate a "flood resilience" component into all future plans. Working towards resiliency means both proactively reducing vulnerabilities to flooding and flood damage and improving response and recovery efforts when flood events do occur to minimize long term economic, social, and natural resource impacts. ANR provides resources and assistance to make flood resiliency an integral part of town planning by offering river corridor maps and model language for town and regional plans and local zoning ordinances.

Financial incentives for municipalities have been established in accordance with the requirements of 10 V.S.A. §§ 1427 and 1428 for the adoption and implementation of municipal zoning bylaws that protect and preserve river corridors, shorelands and buffers. Communities become eligible for financial incentives based on adoption of a suite of mitigation activities. The Emergency Relief and Assistance Fund (ERAF) provides State funding to match Federal Public Assistance after federally-declared disasters. Eligible public costs are reimbursed by federal taxpayers at 75%. For disasters after October 23, 2014, the State of Vermont will contribute an additional 7.5% toward the costs. For communities that take specific steps to reduce flood damage the State will contribute 12.5% or 17.5% of the total cost.

The four mitigation measures towns must have in place to receive 12.5%:

1. National Flood Insurance Program (participate or have applied);
2. Town Road and Bridge Standards (adopt standards that meet or exceed the 2013 template in the current: VTrans Orange Book: Handbook for Local Officials);
3. Local Emergency Management Plan (adopt annually after town meeting and before May 1);
4. Local Hazard Mitigation Plan (adopt a FEMA-approved local plan (valid for five years) or, submit a draft plan to FEMA Region 1 for review).

To receive 17.5% - eligible communities also must:

5. Protect River Corridors from new encroachment; or, protect their flood hazard areas from new encroachments and participate in the FEMA Community Rating System.

Figure 23. Emergency Relief and Assistance Fund Cost Share per $1 Million

From: https://floodready.vermont.gov/find_funding/emergency_relief_assistance

Figure 23 demonstrates, in the event of $1,000,000 in damages to infrastructure, the municipal share of recovery costs will decrease by up to $100,000 when full ERAF protections are in place.

Two towns in the Basin, Baltimore and Reading, have adopted the full requirements and will receive the maximum 17.5% State match for future damages. Eight towns have reached the 12.5% match rate and seven towns remain at the 7.5% rate. Detailed information municipal protections in place can be found in Appendix D, and the most updated list can be found at Flood Ready Vermont.

Climate Change Resiliency

Beyond flood resiliency, the anticipated effects of a warming climate have particular implications for this Basin. A number of species occur only in the southern Connecticut River valley. Some reach the northern limit of their range here making the Connecticut River an important corridor for the northern migration of species responding to climate change pressures such as increasing temperatures, increasing drought, food web disturbances, habitat degradation and others. Habitat protection for these species will be critical to their long-term survival. Forested riparian buffers provide corridors for wildlife to access otherwise fragmented habitats as they adjust to climate pressures.

Of particular concern for this Basin and identified in the Vermont Wildlife Action Plan as priorities for conservation:

American Eel (*Anguilla rostrata*) – Connecticut River population – S2[9], SGCN, STATUS – Declining Eel management in the Connecticut River is currently focused on construction of eelpasses (to enable upstream juvenile eel movement around dams) and enumeration of immigrating eels.

American Shad (*Alosa sapidissima*) – S4, G5, SGCN, STATUS – Increasing
Restricted to the Connecticut River from the Massachusetts line upstream to at least Bellows Falls dam. In 2020 over 362,000 shad migrated past the Holyoke Dam in Massachusetts but only 1,745 were counted passing the Vernon Dam into Vermont with none reaching Bellows Falls. Providing upstream passage for this species is a priority.

Cobblestone Tiger Beetle (*Cicindela marginipennis*) – State Threatened – G3, RSGCN*, STATUS – Declining
Found on the shores of the Connecticut River.

Dwarf Wedgemussel (*Alasmidonta heterodon*) – RSGCN, STATUS – Declining
Found throughout the Connecticut River and near tributaries.

Wood Turtle (*Glyptemys insculpta*) – S3, SGCN, STATUS – Declining
National Fish and Wildlife Foundation (NFWF) is funding a special Wood Turtle conservation program partnering with the Connecticut River Conservancy focused on restoration of important riparian buffer habitat.

Barbed-bristle Bulrush (*Scirpus ancistrochaetus*) – State Endangered – G3, SGCN, STATUS – High Priority
Beaver wetland-dependent species found only in the Connecticut River valley in southeastern Vermont.

Habitat conservation, restoration and connectivity are priorities for the Basin.

* RSGCN - Regional Species of Greatest Conservation Need

Connecticut River Aquatic Invasives

There is growing concern about spreading populations of riverine aquatic invasive plants throughout the Connecticut River particularly associated with boat launches. Eurasian watermilfoil, water chestnut, hydrilla, curly leaf pondweed, European Naiad/European water nymph, Japanese knotweed, phragmites/common reed, purple loosestrife, yellow flag iris, and flowering rush are all documented along the river. Gaining a full understanding of the extent of these invasives, tracking and working to prevent further spread and undertaking control where necessary is recommended.

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[9] Vermont Fish & Wildlife Department Explanation of Legal Status and Information Ranks

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 what it carries with it into lakes 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.

Protecting and Improving Lakeshore Condition

The Shoreland Protection Act (VSA 49 §1441) regulates shoreland development within 250 feet of a lake's mean water level for all lakes greater than 10 acres in size. The practices required by this rule 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. 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. A Lake Wise Award certifies a property is well managed, using shoreland Best Management Practices, and is maintained to protect the lake.

Five lakes in the Basin are identified as a priority for LakeWise based on their shoreland habitat conditions. These are Amherst, Echo, Rescue, Runnemede, and Pinneo lakes. If communities on any lake 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.

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, as a first step to moving toward a healthier lake or pond.

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 results 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.

LWAPs are recommended for Lakes Amherst, Echo, Rescue, and Pauline (Reservoir) due to the level of development along their shorelines and the importance of their recreation uses.

Preventing Aquatic Invasive Species

Aquatic invasive species (AIS) have been confirmed in eight lakes. Additional aquatic invasive species populations are likely to exist but have not been confirmed.

Table 18. Lakes Impaired by Aquatic Invasives

Impaired and Altered Lakes	
Deweys Mill Pond	EWM / PH
Kent Pond	EWM / PH
Lake Ninevah	EWM
Lake Pinneo	EWM
Lake Rescue	EWM
Mill Pond	EWM / PH
North Hartland Reservoir	EWM
North Springfield Reservoir	EWM / WC
Woodward Reservoir	PH

EWM - Eurasian Watermilfoil
WC - Water chestnut
PH - Phragmites

New AIS introductions occur mainly in waterbodies with boat launch sites as the incoming boat traffic may be brought in from AIS infested waters. The VT Public Access Greeter Program and the Vermont Invasive Patrollers (VIP), an AIS identification training program, are supported by DEC's 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. Lake Ninevah and Woodward Reservoir have active programs and Lake Rescue's program is dependent on funding each year. Greeter Program are recommended for Amherst, Echo, Rescue and Pauline.

The Aquatic Nuisance Control (ANC) Grant-in-aid Program provides financial assistance to municipalities and agencies of the state for aquatic invasive and nuisance species management

programs. All infested lakes are a priority for continued AIS management and capacity building. To continue their work, these lake protection volunteers need a continuity plan for long-term success.

Wetlands

Wetlands cover at least 1.9 percent of the Basin, less than other parts of Vermont, and are important for safeguarding many of its high quality surface waters and reducing flooding. As recently as the 1980s, 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 remaining wetland resources is an important strategy in the Basin. Additionally, restoring degraded wetlands is essential to improving water quality.

Identifying wetland sites with the greatest potential for improving water quality through conservation and restoration 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.

Over 80 wetlands in the Basin have been assessed using the Vermont Rapid Assessment Method (VRAM). VRAM scores range from 0 to 100. Low-scoring wetlands may be prioritized for habitat restoration efforts, and high-scoring wetlands can be expected to remain in excellent shape if conserved and left alone. A low score does not indicate that the wetland does not provide important functions and values.

Six of the assessed wetlands scored above 85 and are considered to be in reference condition:

- Hartland Hill Road Wetland (43.599, -72.482)
- Pico Pond Softwood Swamp (43.644, -72.81)
- Skitchewaug Black Gum Swamp (43.295, -72.421)
- Lake Ninevah Wetland 1 (43.469, -72.761)
- Lake Ninevah Wetland 2 (43.479, -72.757)
- Old Plymouth Spruce Swamp (43.528, -72.79)

Thirty-three are rated as Moderate and 42 as being in Poor condition.

Protection, in the form of a Class I wetland designation, 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. Two wetlands are proposed for study for Class I consideration.

Surface Water – Town:

- Killington Flats – Killington
- Lake Ninevah contiguous – Mount Holly

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.

Wetland Mapping and Restoration

The Vermont Significant Wetlands Inventory mapping is used to preliminarily identify the locations of regulated wetlands (Class II and Class I). However, it is important to note that because previous mapping often missed forested and sloped wetland types common in this basin, it is especially likely that many Class II wetlands are missing in the existing wetland mapping. Enhanced wetland mapping is being developed for the entire Connecticut River valley with an anticipated completion date of 2024. Current maps can be found at Wetland Inventory Map.[10]

Wetland restoration is the process of returning a degraded, or drained 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 habitat loss is evident, and where wetlands can contribute to flood protection.

Recommendations for wetland restoration can be found in Stream Geomorphic Assessments and River Corridor Plans. Seven restoration sites have been identified in the Black River watershed, four in the Ottauquechee River watershed and one along the Connecticut River. All these projects should be pursued for landowner interest.

[10] https://anrmaps.vermont.gov/websites/WetlandProjects/default.html

Forests

Forest lands cover over 78% of the Basin. As the dominant land cover, forests are important for safeguarding many high-quality surface waters. Yet, nutrient runoff can and does originate from forestlands. Reducing runoff and erosion from forests is important to meeting the state's clean water goals. Forest management activities offer many benefits including maintaining healthy forest communities, improving wildlife habitat, addressing non-native invasive species, contributing to the working landscape economy, and remediating poor legacy road infrastructure. Significant portions of the Basin are protected by state and federal agencies and are overseen by agency land managers (Figure 26).

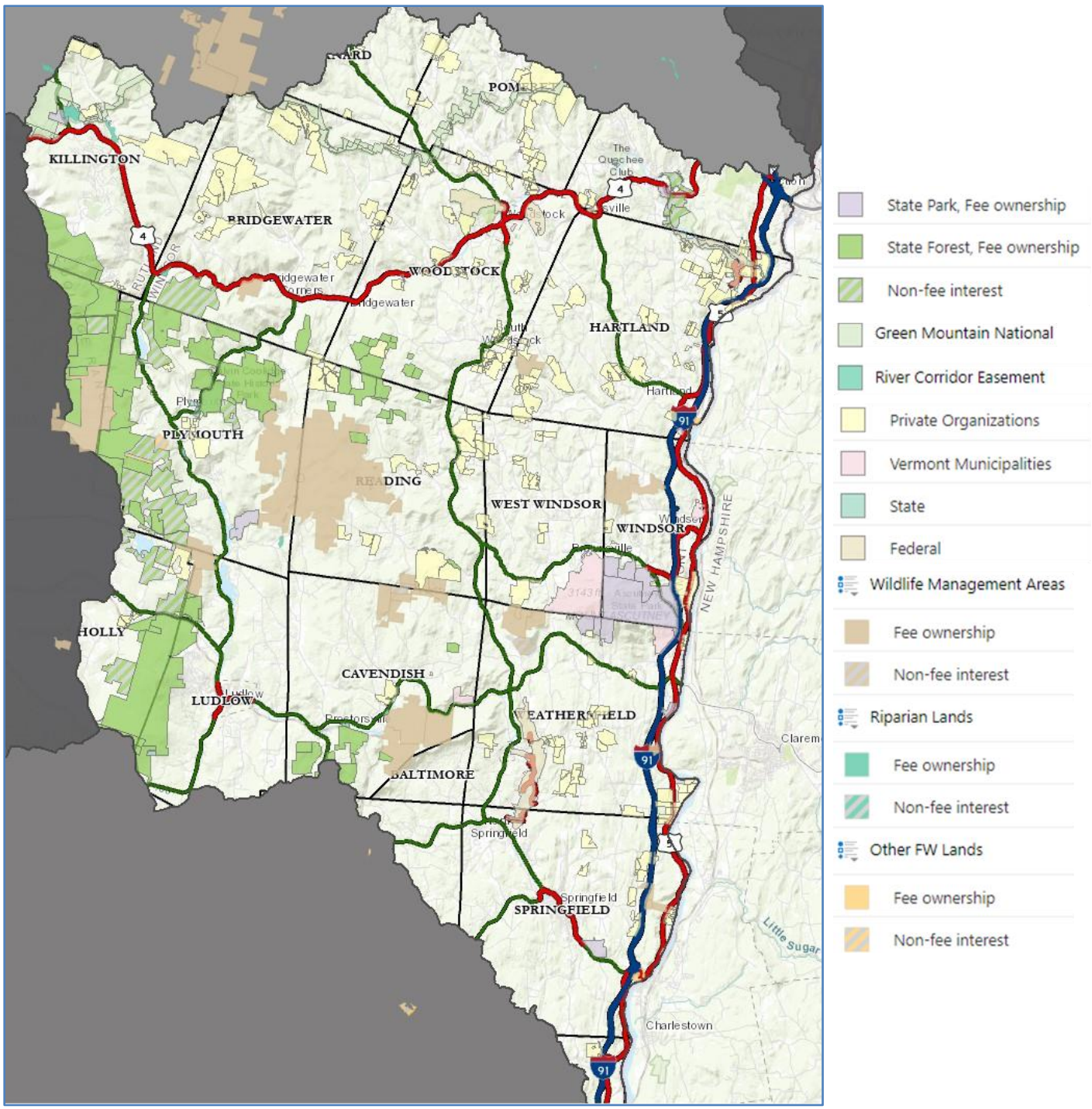

Figure 24. Protected Lands
(Federal, State and Privately Conserved)

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.

Forestry Acceptable Management Practices (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.[11] The Department of Forests, Parks and Recreation (DFPR) and watershed partners provide portable temporary bridge rental opportunities for use during timber harvests. These "Skidder" bridges reduce 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: Temporary Wooden Skidder Bridges. Information on the bridge rental program is found at: 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 DFPR in the Vermont Voluntary Harvesting Guidelines to Protect Forest Health and Sustainability, and through 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 for tax purposes based on the property's value for the production of forest or agricultural products 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 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.

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[11] Acceptable Management Practices for Logging Jobs

Almost 41% of the forestland in the Basin is enrolled in the UVA program (Figure 25). Enrollment requires landowners apply the AMPs on all logging work. This does not mean that the other forestland areas are not employing the AMPs, but landowners may be less likely to require AMPs on their property. Five subwatersheds are over 50% forested:

- North Branch Ottauquechee River
- Gulf Stream
- Kedron Brook
- Beaver Brook
- Lulls Brook.

This Basin also includes large areas under state ownership and management. The most significant of which are the Arthur Davis WMA, Coolidge State Forest, Okemo State Forest and Ascutney State Park. 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.

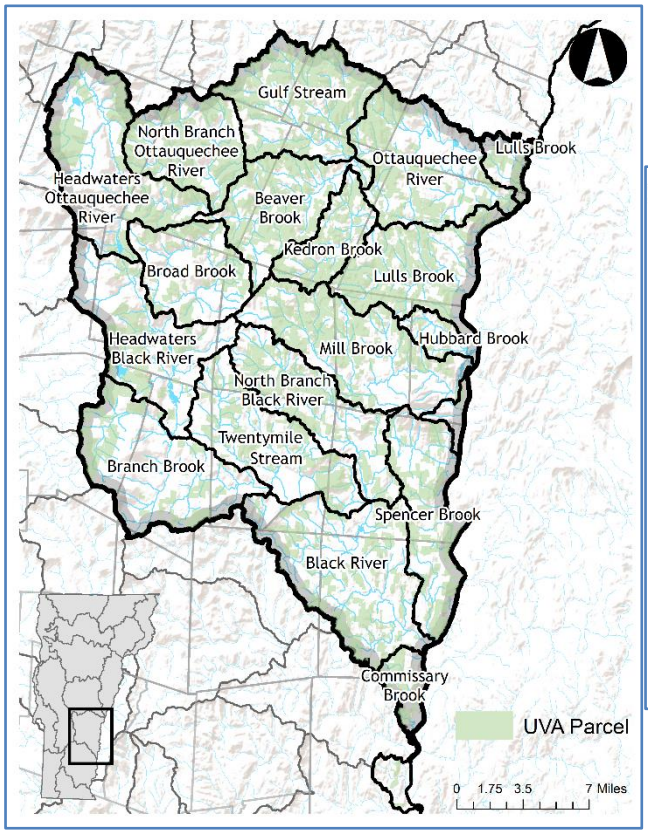

Figure 26. Land in UVA

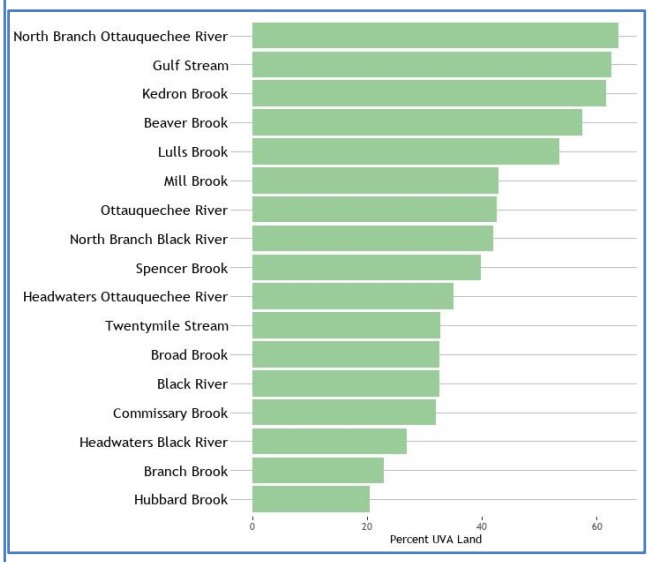

Figure 25. Percent of land in UVA by Subwatershed

Forest Road Assessments and Management

The ANR is in the process of assessing and prioritizing erosion issues along hydrologically connected forest roads on ANR-owned lands. State lands include state forests, parks, wildlife management areas, natural areas, riparian lands and others. Not all state lands have roads, but there are over 55,000 acres in the Basin under state ownership that could potentially be assessed.

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 it to prioritize their own efforts as well as for supporting funding requests. Target areas have been identified in the Basin for forest land road erosion inventories in the Implementation Table in Chapter 5.

Fisheries

Cold-water and warm-water fisheries in the Basin are managed by the Vermont Department of Fish and Wildlife (VDFW) who work to implement management actions to improve and enhance aquatic communities. Vermont's fisheries biologists participate in environmental impact review of projects that could negatively impact fish habitat and fish populations, as well as implement management actions to improve and enhance aquatic communities. Fisheries, as used here, are those activities related to recreational fishing and fish habitat. Fish community assessments as they relate to aquatic biota and wildlife are included in the river biological assessments.

Basin rivers and streams host a mix of wild Brook trout, naturalized trout such as Rainbow and Brown trout. Lakes and ponds provide habitat for trout, bass, Yellow perch, pickerel, Northern pike, Rainbow smelt, Brown bullhead, White sucker, pumpkinseed, and bluegill.

The condition of the Basin's fishery is dependent on the water quality and on the condition of the in-stream and riparian habitat for rivers and streams, and the littoral habitat of lakes and ponds.

Maintaining clear, cold, and well-oxygenated water is an important habitat requirement for trout. Water temperature increases due to the lack of riparian vegetation, sedimentation from road runoff, development and channel erosion, and barriers to aquatic organism passage are all impacting the Basin's fishery.

Improving fishery conditions through riparian and shoreline planting, mitigation of erosion and sediment, removal or replacement of undersized culverts and bridges, and strategic wood additions are priority projects. The Aquatic Habitat Conservation website provides further information on these topics.

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 10 Implementation Table

A. Progress in the Basin

The previous Basin Plan was completed in 2018. A total of 42 strategies were identified in the plan. Eighty-five percent of these projects have either been completed or are currently on-going. Six projects are being carried forward into this Plan.

This TBP addresses 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 19) and the Monitoring and Assessment Table (Table 21) 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, and natural communities and biological diversity mapping.

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 (DFW and DFPR), and federal partners including the Natural Resources Conservation Service Regional Conservation Partnership Program and the US Fish and Wildlife Services Partners for Fish and Wildlife Program.

The Division's reporting on financial investments made and nutrient loads addressed occurs annually. Progress toward the strategies from the 2018 plan can be found in Appendix A.

B. 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 Ottauquechee Natural Resources Conservation District (ONRCD), Mount Ascutney Regional Commission(MARC), Two-River Ottauquechee Regional Commission (TRORC), USDA Natural Resource Conservation Service (NRCS), UVM Extension Service, US Fish and Wildlife Service (USFWS), AAFM, Vermont Agency of Transportation (VTrans), Connecticut River

Conservancy (CRC), Connecticut River Joint Commissions (CRJC), Connecticut River Watershed Farmers Alliance (CRWFA), Vermont River Conservancy (VRC), Trout Unlimited (TU), Black River Action Team (BRAT), The Nature Conservancy of Vermont (TNC), lake associations, and municipal groups are active in:

- providing outreach and education to local stakeholders, private landowners, and municipalities.
- developing stream and floodplain protection and restoration projects (e.g., river corridor easements, tree plantings, culvert and bridge upgrades, dam removals, stream channel habitat restoration).
- developing stormwater projects (e.g., SWMPs, road erosion inventories, implementation of town road BMPs).
- working with farms in the basin developing and implementing BMPs for water quality,
- 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.

Public Participation

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

A series of nine public meetings were held to gather community input. These meetings were co-hosted with several of the partners listed above and brought over 90 participants into the basin discussions.

Additionally, an on-line survey was conducted to provide stakeholders with the opportunity to provide information to the planning process. The survey was widely distributed through state and partner distribution systems. Sixteen respondents from five in-basin and two outside-basin towns offered their input.

All of this information helps inform the strategies and projects proposed in this plan.

The top concerns were identified as road-related runoff causing sediment discharge, barriers to flow and wildlife passage by dams and undersized culverts, on-going issues with the Lake Amherst dam, climate change impacts on water resources and wetland conservation. Additionally invasive species, stormwater runoff, over-use due to recreation and climate change are identified as threats.

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 and education efforts to municipal road crews for better road management. including PFAS information in the plan.

C. Implementation Table

The Implementation Table (IT) (Table 19) provides a list of 57 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 is expected to be implemented and reported upon in future TBPs.

As projects are developed, priority for Clean Water 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 19. Implementation Strategies

(See List of Acronyms on page 106) * carried forward from 2018 TBP

	STRATEGY	PRIORITY SUBBASIN	FOCUS AREA	PARTNERS	FUNDING
	AGRICULTURE				
1	Identify areas in need of farm assessments and additional BMP practices*	Kedron Brook, No. Branch Black, Twentymile Stream	Woodstock, Weathersfield, Reading, Cavendish	NRCD, CRWFA, AAFM	ACWGP, RCPP
2	Pursue RCE on farmland located on alluvial fans and prior converted wetlands to help address climate change impacts	Kedron Brook/Ottauquechee confluence, Hubbard Brook, No. Branch Black, Twentymile Stream, Mill Brook, Connecticut River	Woodstock, Reading, Windsor, Cavendish, Springfield	NRCD, CRWFA, AAFM, NRCS, VHCB	CWF, LISFF, VHCB
3	Work on agricultural lands along the Connecticut River to establish and enhance riparian buffers following the stabilization of water level fluctuations from hydropower production	Connecticut River	Hartford, Hartland, Windsor, Weathersfield, Springfield, Rockingham, Cavendish, Reading, Weathersfield	NRCD, CRC, CRWFA, AAFM, NRCS	ACWGP, RCPP, TFS, CWF
4	Support monitoring efforts to identify water quality issues related to agricultural land use	Lower Ottauquechee, Barnard Brook, Kedron Brook, Mill Brook-N, No. Branch Black, Spencer Brook	Barnard, Hartland, Pomfret, Reading, Weathersfield, West Windsor, Windsor, Woodstock, Springfield	NRCD, CRWFA, CRC, CRJC, AAFM	LISFF
5	Implement field practices to study N-reduction potential of BMPs and track results of practices implemented	Basin wide	All towns	NRCD, NRCS, AAFM	LISFF

	STRATEGY	PRIORITY SUBBASIN	FOCUS AREA	PARTNERS	FUNDING
6	Provide information and technical assistance to farmers to improve soil health through Soil Health Assessments	Basin wide	All towns	NRCD, CRWFA, AAFM, NRCS	ACWGP, RCPP
7	Provide technical and financial support for the acquisition and management of shared equipment necessary for effective implementation of BMPs such as cover cropping and no-till planting	Basin wide	All towns	NRCD, NRCS, AAFM	CEAP, VHCB, ACWGP
DEVELOPED LANDS - STORMWATER					
8	Continue supporting the development of SWMPs	Basin-wide	Cavendish, Hartford, Hartland, Killington	RPC, NRCD, DEC	CWF, TBPSG, LISFF
9	Prioritize projects, develop final designs and implement stormwater treatment projects identified in the Stormwater Master Plans and Stormwater Mapping Reports	Black River, Mill Brook-N, Ottauquechee River	Ludlow, Springfield, Windsor, Woodstock	RPC, NRCD, Municipalities	ARPA, CWF, TBPSG, LISFF
10	Support evaluating and improving town salt and sand storage facilities to improve stormwater management on these sites	Basin wide	All towns	RPC, Municipalities	SWMG, GIA
11	Provide outreach to support bylaw development for stormwater runoff management in priority catchments	Basin wide	Hartford, Killington, Ludlow, Springfield, Windsor, Woodstock	DEC, NRCD, RPC, CRJC	TBPSG, MPG
12	Work with lake communities to mitigate stormwater runoff from development and private roads reaching the lakes	Upper Black River, Lake Runnemede	Plymouth, Ludlow, Windsor	DEC, Watershed Groups, NRCD	CWF, TBPSG, WG
13	Study, design and address the 303(d) listed water quality impairments where stormwater is impacting water quality	Basin wide	Bridgewater, Hartford, Killington, Rockingham	DEC, RPC, NRCD, Municipalities	CWF

	STRATEGY	PRIORITY SUBBASIN	FOCUS AREA	PARTNERS	FUNDING
DEVELOPED LANDS - ROADS					
14	Conduct gully erosion inventory and identify, prioritize and address gully erosion from roads, failed Class 4 roads and other stormwater discharges	Basin wide	All towns	NRCD, Watershed Groups, Con. Comm.	TBPSG, WG, CWF
15	Provide technical support to towns to implement MRGP projects identified through REIs, LWAP's, and gully erosion inventories that are having significant water quality impacts	Basin wide	All towns	NRCD, Watershed Groups, Con. Comm.	TBPSG, GIA, SWMG
16	Target financial support to towns with the greatest numbers of High and Very High priority road segments	Black River, No. Branch BR, Mill Brook-N, Mill Brook-S	Ludlow, Springfield, Weathersfield, West Windsor	Municipalities	GIA, BR, SWMG
17	Conduct gully erosion inventory and identify, prioritize and address gully erosion from roads, failed Class 4 roads and other stormwater discharges	Basin wide	All towns	NRCD, Watershed Groups, Con. Comm.	TBPSG, WG, CWF
WASTEWATER					
18	Provide outreach on the Village Wastewater Solutions to communities without wastewater treatment, and seek funding for planning and implementation of priority projects that have community support	Basin wide	Hartland, Killington, Plymouth, Reading, Weathersfield	DEC-WID, RPC, NRCD	TBPSG, CWF, WG
19	Encourage and support upgrades to public wastewater treatment facilities to reduce nitrogen from discharges	Basin wide	All towns	DEC-WID, RPC	TBPSG
20	Support in-fill development in villages with good wastewater solutions to lessen upland riparian impacts from dispersed development/roads and provide equitable affordable housing	Basin wide	All towns	DEC-WID, RPC	TBPSG, CWSRF

	STRATEGY	PRIORITY SUBBASIN	FOCUS AREA	PARTNERS	FUNDING
NATURAL RESOURCES					
21	Support and enhance the riparian buffer and floodplain plantings throughout the landscape	Basin-wide	All towns	DFW, DEC, DFPR, NRCD, Watershed Groups, Con. Comm., landowners	ACWGP, RCPP, TFS, CWG, NRCS, SWG, PFW, LISFF
22	Support reclassification and designation of rivers, streams, lakes, ponds and wetlands throughout the Basin	See Table 8	See Table 8	DEC, NRCD, Watershed Groups, DFW	TBPSG, WG
23	Work toward stream equilibrium in all restoration efforts	Basin-wide	All towns	All	CWF
24	Buy-out properties that are highly vulnerable to flooding from willing sellers	Basin-wide	All towns	RPC, municipalities	FEMA
25	Monitor swimming waters for bacteria and cyanobacteria to ensure health and safety	Basin-wide	All towns	DEC, Watershed Groups, Municipalities, Con. Comm.	SWG
RIVERS					
26	Secure stable funding for the USGS monitoring gauge at Northfield, MA	Basin wide	All towns	DEC-MAP, USGS, AAFM	LISS, LISFF
27	Implement Emergency Action Plans for High and Significant Hazard dams*	Basin-wide	Ludlow, Plymouth, Springfield, Woodstock	DEC-DS, RPC, Municipalities	VEM, MPG
28	Develop an RCP for Hubbard Brook and Lulls Brook	Hubbard Brook, Lulls Brook	Windsor, Hartland	DEC, NRCD, RPC	CWF

STRATEGY		PRIORITY SUBBASIN	FOCUS AREA	PARTNERS	FUNDING
29	Support municipal adoption of flood hazard by-laws and river corridor protections to meet ERAF standards	Basin-wide	Barnard, Bridgewater, Cavendish, Hartland, Hartford, Pomfret, Woodstock	DEC, NRCD, RPC, CRJC	TBPSG, MPG
30	Support the removal of the streamside berms to increase floodplain access	Basin wide	All towns	NRCD, DFW, DEC, Watershed Groups	CWF, SWG, PFW
31	Support dam removals and bridge and culvert replacements to improve stream geomorphic compatibility, aquatic organism passage, and flood resilience as identified in statewide and local assessments. Focus dam removals on tributaries that provide cold-water refuge from larger warm rivers	Basin-wide	All towns	RPC, NRCD, DFW, DEC, DFPR, Watershed Groups, Municipalities, Con. Comm., landowners	CWF, PFW, EBTJV, VEM, HMPG, FRCF
32	Support strategic wood additions for fish habitat improvement, sediment storage and floodplain connection where they are deemed appropriate	As identified by VDFW, Fisheries Div.		DFW, Watershed Groups	SWG, WG, EBTJV
33	Improve flow management at hydroelectric and flood control facilities to address WQ impairment, sediment transport and to benefit downstream species	Connecticut River, Ottauquechee River, Black River	Hartford, Hartland, Cavendish, Ludlow, Springfield	USACE, GRH, GMP	USACE, GRH, GMP
34	Expand outreach to owners of large tracts of private land to recruit participation in riparian protection and in-stream habitat work, including strategic wood addition projects. Focus on streams with wild native brook trout populations.	Basin-wide	All towns	DFW, NRCD, Watershed Groups, Con. Comm., landowners	TBPSG, CWI, RCPP, LISFF

	STRATEGY	PRIORITY SUBBASIN	FOCUS AREA	PARTNERS	FUNDING
35	Work with municipalities to complete and implement Hazard Mitigation Plans and Emergency Management Plans	Basin-wide	All towns	RPC	MPG, HMPG
36	Remove sewer lines from hazardous locations including streambeds*	Ottauquechee River, Mill Brook	Woodstock, Windsor	municipalities	HMGP
37	Enhance the VDFW access at the Lincoln Covered Bridge	Ottauquechee River	Woodstock	DFW, Watershed Groups, municipalities	DFW, NPS-RTCA
LAKES					
38	Recruit and promote participation in the LakeWise and VIP programs	Amherst, Echo, Rescue, Runnemede, Pinneo	Hartford, Ludlow, Plymouth, Windsor	Watershed Groups, NRCD, Con. Comm., DEC-LPP, Municipalities	CWF, WG
39	Establish AIS Greeter Programs and support and promote AIS control projects	Lakes Amherst, Echo, Rescue, Pauline	Ludlow, Plymouth	Watershed Groups, NRCD, Con. Comm., DEC-LPP, Municipalities	AIS, WG
40	Develop Lake Watershed Action Plans (LWAP) and provide outreach the lake community on the plan and proposed actions, including installation of riparian buffers on lake tributaries	Amherst, Echo, Rescue, Pauline, Ninevah, Runnemede	Ludlow, Mount Holly, Plymouth, Windsor	Watershed Groups, NRCD, Con. Comm., DEC-LPP, Municipalities	CWF, WG, TBPSG

	STRATEGY	PRIORITY SUBBASIN	FOCUS AREA	PARTNERS	FUNDING
WETLANDS					
41	Restore degraded wetlands for habitat, water quality improvement and carbon sequestration*	No. Branch Black, Twentymile Stream, Mill Brook, CTR - Upper Meadows	Cavendish, Windsor, Rockingham	DEC, NRCD, Watershed Groups, landowners	CWF, NRCS-WRE, CWG, RCPP, LISFF
42	Provide outreach and support publicizing and promoting wetland mapping updates to improve wetland protection	Basin-wide	All towns	DEC-WP, RPC, NRCD, Watershed Groups, Con. Comm.	TBPSG
43	Identify potential wetland restoration sites and support partner outreach to landowners to garner support for restoration projects	Basin-wide	All towns	DEC, NRCD, Watershed Groups	CWF, TBPSG, LISFF
44	Support continued vernal pool mapping	Basin-wide	All towns	DEC-WP, NRCD, Watershed Groups, Con. Comm.	CWG, SWG
45	Support local efforts to reclassify identified wetlands as Class I wetlands	Lake Ninevah wetlands, Killington Flats wetlands	Mount Holly, Killington	DEC-WP, RPC, NRCD, Watershed Groups, Con. Comm.	TBPSG
FORESTS					
46	Continue and expand Portable Skidder Bridge Programs*	Basin-wide	All towns	DFPR, NRCD	DFPR, TBPSG

	STRATEGY	PRIORITY SUBBASIN	FOCUS AREA	PARTNERS	FUNDING
47	Implement forestry AMPs on high priority state lands through ANR road inventory, prioritization, and implementation	All state lands	All towns	DFPR	CWF, LISFF
48	Encourage compact village settlement patterns and coordinated forest manage to prevent forest fragmentation and conversion	Basin-wide	Hartland, Killington, West Windsor, Woodstock	RPC, Watershed Groups, Con. Comm.	TBPSG
49	Protect headwater streams and sensitive upland surface waters	All state lands	All towns	DFPR	CWF, LISFF
50	Increase practices that sequester carbon for the long term	Basin-wide	All towns	DFPR, NRCD, Watershed Groups, Con. Comm., landowners	CWF, LISFF, RCPP
CLIMATE CHANGE ADAPTATION					
51	Monitor habitat conditions & effects of stressors on habitats; restore critical habitats or ameliorate threats when/where opportunities arise to secure/restore numbers of SGCN populations & targeted abundance levels	Basin-wide	All towns	DFW, USFWS	ANR
52	Work to maintain connectivity with wildlife populations across the Connecticut River to New Hampshire	Connecticut River	Rockingham, Weathersfield	DFW, CRC, CRJC, NRCD, USFWS	CWF, WISPr, VHCB
SOCIAL EQUITY					
53	Seek opportunities to increase public access to lakes, rivers and wetlands that are free and accessible to diverse populations (e.g., VRCs "A Swimming Hole in Every Town" program)	Black River lakes, Basin-wide	Ludlow, All towns	DFPR, DFW, Watershed Groups, municipalities	VHCB, SWG, USFWS

	STRATEGY	PRIORITY SUBBASIN	FOCUS AREA	PARTNERS	FUNDING
54	Identify communities where water quality concerns prevent use of waters or present unhealthy conditions and address these conditions	Basin-wide	All towns	DEC, Watershed Groups	ANR
55	Locate implementation projects where they will offer dual advantages of a cleaner environment and open space to underserved populations	Connecticut River	Hartford, Springfield, Windsor	DEC, RPC, NRCD, Watershed Groups, municipalities	CWF
56	Work to reduce contaminants that restrict fish consumption to protect those dependent on subsistence fishing for nutrition	Connecticut River	Hartford, Hartland, Windsor, Weathersfield, Springfield, Rockingham	EPA, USFWS, DFW, DEC	EPA
57	Implement projects to reduce flood hazards in resource-limited communities such as mobile home parks located in floodplains	Basin-wide	All towns	DEC, municipalities	ARPA

D. Monitoring and Assessment Table

The Monitoring and Assessment Table (Table 21) 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 20. Priorities For Monitoring and Assessment

WATERBODY	PROJECT DESCRIPTION	LOCATION	PARTNERS*	PURPOSE
Rivers & Streams				
Barnard Brook Trib #6, 0.4	Biological and chemical monitoring	Pomfret	BASS	Determine reclassification status for Aquatic Biota
Barnard Brook, 2.5	Biological and chemical monitoring	Pomfret	BASS	Determine reclassification status for Aquatic Biota
Bloodsucker Brook (from pond)	Biological and chemical monitoring	Weath/Sprfld	BASS	no data, high ag use
Broad Brook	Biological and chemical monitoring	Bridgewater	BASS, LPP	Document impacts from habitat alterations, sediment, streambank erosion
Broad Brook - upper	Biological and chemical monitoring	Plymouth	LPP	No data on upper watershed
Carpenter Brook	Biological and chemical monitoring	Killington	BASS	Document impacts from sediment, scour
Chester Brook, 0.3	Biological and chemical monitoring	Springfield	BASS	Determine reclassification status for Aquatic Biota
Coleman Brook	Biological and chemical monitoring	Ludlow	BASS	Document impacts from flow regime modification, pollutants in stormwater, ski area development
Commissary Brook, 0.2	Biological and chemical monitoring	Rockingham	BASS	Determine reclassification status for Aquatic Biota
East Trib Roaring Brook	Biological and chemical monitoring	Killington	BASS	Fair rating due to unknown cause

WATERBODY	PROJECT DESCRIPTION	LOCATION	PARTNERS*	PURPOSE
Falls Brook Trib 4	Biological and chemical monitoring	Killington	BASS	Last monitored 1999
Grant Brook, 0.8	Biological and chemical monitoring	Ludlow	BASS	Determine reclassification status for Aquatic Biota
Great Brook, 6.9	Biological and chemical monitoring	Ludlow	BASS	Determine reclassification status for Aquatic Biota
Great Roaring Brook, 0.1	Biological and chemical monitoring	Plymouth	BASS, LPP	Determine reclassification status for Aquatic Biota
Hubbard Brook	Biological, chemical, fisheries monitoring	Windsor	BASS / DFW	Determine reclassification status for Aquatic Biota & Fishery
Kedron Brook - Woodstock	Biological, chemical, fisheries monitoring	Woodstock	BASS, LPP	Document impacts to nutrients, sediment, from horse recreation activity, pasture, road runoff, loss of riparian vegetation, golf course
Kent Pond Outlet	Biological and chemical monitoring	Killington	BASS, LPP	Fair-Poor rating potentially due to impoundment
Kilburn Brook, 0.2	Biological and chemical monitoring	Hartford	BASS	Determine reclassification status for Aquatic Biota
Lulls Brook, 3.4	Biological and chemical monitoring	Hartland	BASS	Determine reclassification status for Aquatic Biota
McArthur Brook, 0.5	Biological and chemical monitoring	Hartland	BASS	Determine reclassification status for Aquatic Biota
Mile Brook	Biological and chemical monitoring	Springfield	BASS, LPP	Document impacts of nutrients, chloride, from agriculture and development
Mill Brook-S, 1.7	Biological and chemical monitoring	Weathersfield	BASS	Determine reclassification status for Aquatic Biota
Mill Brook-N, 11.4	Biological and chemical monitoring	West Windsor	BASS	Determine reclassification status for Aquatic Biota
Neal Brook, 0.5	Biological and chemical monitoring	Hartford	BASS	Determine reclassification status for Aquatic Biota
Okemo Brook	Biological and chemical monitoring	Ludlow	BASS, LPP	Document impacts to Chloride from roads

WATERBODY	PROJECT DESCRIPTION	LOCATION	PARTNERS*	PURPOSE
Ottauquechee River, Kedron Brook to No. Hartland Res.	Biological and chemical monitoring	Woodstock, Hartford	BASS, LPP	Document impacts on sediment, nutrients, temperature from development
Patch Brook, 1.1	Biological and chemical monitoring	Plymouth	BASS, LPP	Determine reclassification status for Aquatic Biota
Roaring Brook	Biological and chemical monitoring	Killington	BASS, LPP	Document impacts of development
Sanders Brook	Biological and chemical monitoring	Ludlow	BASS, LPP	Document impacts of sediment from logging
Seavers Brook	Biological and chemical monitoring	Springfield	BASS, LPP	Document source of sediment
Sherman Brook	Biological and chemical monitoring	Weathersfield	BASS, LPP	Document recovery from pervious toxics spill
Soapstone Brook Trib 2	Biological and chemical monitoring	Ludlow	BASS, LPP	Fair rating due to undetermined causes
Soapstone Brook Trib 3, 0.4	Biological and chemical monitoring	Ludlow	BASS	Determine reclassification status for Aquatic Biota
Spencer Brook	Biological and chemical monitoring	Springfield	BASS, LPP	no data
Spoonerville Brook, 0.5	Biological and chemical monitoring	Springfield	BASS	Determine reclassification status for Aquatic Biota
Tarbell Hill Brook, 0.8	Biological and chemical monitoring	Cavendish	BASS	Determine reclassification status for Aquatic Biota
Tinker Brook Trib, 0.8	Biological and chemical monitoring	Shrewsbury	BASS	Determine reclassification status for Aquatic Biota
Trailside Brook, Mouth to rm 1.8	Biological and chemical monitoring	Ludlow	BASS, LPP	Document impacts to Chloride from development
Twenty Mile Stream, 0.6	Biological and chemical monitoring	Cavendish	BASS	Determine reclassification status for Aquatic Biota
Upper Roaring Brook and West Branch (Approx 1.2 Miles)	Biological and chemical monitoring	Killington	BASS, LPP	Document impacts on sediment from land development, erosion, road runoff

WATERBODY	PROJECT DESCRIPTION	LOCATION	PARTNERS	PURPOSE
Whitney Brook, 0.3	Biological and chemical monitoring	Ludlow	BASS	Determine reclassification status for Aquatic Biota
Willow Brook	Biological and chemical monitoring	West Windsor	BASS	no data
LAKES				
Amherst Lake	Monitor in-lake chemistry		L&P, LMP	Assess potential for reclassification
Chestnut Pond	Monitor in-lake chemistry	Springfield	L&P, LMP	Monitor impact of agriculture
Cooks Pond	Monitor in-lake chemistry	Weathersfield	L&P, LMP	Insufficient data to determine trends
Crystal Pond	Monitor in-lake chemistry	Hartland	L&P, LMP	Insufficient data to determine trends
Deweys Mill Pond	Monitor Shoreland and Invasive Species	Hartford	L&P, LMP, VIP	Physical Habitat Assessment, Identify, Track and Prevent aquatic invasive species - Eurasian Watermilfoil
Lake Ninevah	Monitor in-lake chemistry		L&P, LMP	Assess potential for reclassification
Lake Pinneo	Monitor Shoreland and Invasive Species	Hartford	L&P, LMP, VIP	Physical Habitat Assessment, Identify, track and prevent aquatic invasive species - Eurasian Watermilfoil
Lake Rescue	Monitor Invasive Species and Increasing Spring TP Trend	Plymouth	L&P, LMP	Tributary Monitoring to determine source of increasing spring TP trend
Lake Runnemede	Monitor in-lake chemistry, Shoreland and Nutrient Trend	Windsor	L&P, LMP	Track increasing phosphorus trends -- Tributary Monitoring to determine source of increasing spring TP trend; Physical Habitat Assessment
Lakota Lake	Monitor in-lake chemistry		L&P, LMP	Assess potential for reclassification

WATERBODY	PROJECT DESCRIPTION	LOCATION	PARTNERS	PURPOSE
Mill Pond-N	Monitor in-lake chemistry, Monitor for invasive species	Windsor	L&P, LMP, VIP	No WQ data, Identify, track and prevent aquatic invasive species - Eurasian Watermilfoil
North Hartland Reservoir	Monitor Shoreland and impact of water level fluctuations	Hartland	L&P, LMP	Establish shoreland score, Document impacts water level fluctuation
North Springfield Reservoir	Monitor for invasive species	Springfield	L&P, LMP	Document impacts water level fluctuation
Stoughton Pond	Monitor impact of water level fluctuations	Weathersfield	L&P, LMP	Document impacts water level fluctuation
The Pogue	Monitor Shoreland	Woodstock	L&P, NPS	Physical Habitat Assessment
Woodward Reservoir	Monitor in-lake chemistry		L&P, LMP	Assess potential for reclassification
WETLANDS				
Beaver Pond	Wetland assessment	Weathersfield	DEC-WP	Potential wetland restoration
Beaver Pond Wetlands	Wetland assessment	Weathersfield	DEC-WP	Proposed for Class I Study
Black Pond Wetlands	Wetland assessment	Plymouth	DEC-WP	Proposed for Class I Study
Killington Flats	Wetland assessment	Killington	DEC-WP	Proposed for Class I Study
Lake Ninevah Wetlands	Wetland assessment	Mt Holly	DEC-WP	Proposed for Class I Study
Reading Pond and adjacent wetlands	Wetland assessment	Reading	DEC-WP	Proposed for Class I Study

* BASS – Biological
L&P – Lakes and Ponds Program
LMP – Lay Monitoring Program (lakes)
LPP – LaRose Partnership Program
NPS – Nation Park Service
RM – Rivers Program
VIP – VT Invasive Patrollers
WP – Wetlands Program
WPP – Watershed Planning Program

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
AR	American Rivers
ARRA	American Reinvestment & Recovery Act
B(1)	Class B(1) Water Management
B(2)	Class B(2) Water Management
BASS	Biomonitoring and Aquatic Studies Section, DEC Watershed Management Div.
BCCD	Bennington County Conservation District
BCRC	Bennington County Regional Commission
BMP	Best Management Practice
BR	Better Roads Program
BRAT	Black River Action Team
BWQC	Basin Water Quality Council
CAFO	Concentrated Animal Feeding Operations
CAP	Conservation Activity Plan
CCNRCD	Chittenden County Natural Resources Conservation District
CCP	Corridor Conservation Plan
CISMA	Cooperative Invasive Species Management Area
CNMP	Comprehensive Nutrient Management Plans
CRC	Connecticut River Conservancy
CREP	Conservation Reserve Enhancement Program
CRJC	Connecticut River Joint Commissions
CRP	Conservation Reserve Program
CSP	Conservation Security Program
CWA	Federal Clean Water Act
CWF	Clean Water Fund
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
EU	Existing Use
EWP	Emergency Watershed Protection Program
FAP	Farm Agronomic Practices
FEH	Fluvial Erosion Hazard
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FIRM	Flood Insurance Rate Maps
FOVLAP	Federation of Vermont Lakes and Ponds
FRP	Flow Restoration Plan
FSA	Farm Service Agency (USDA)
GIS	Geographic Information System
GMNF	Green Mountain National Forest
GMP	Green Mountain Power
GRH	Great River Hydro
GRWA	Green River Watershed Alliance
HUC	Hydrologic Unit Code
ICAR	Interagency Committee on Administrative Rules
IDDE	Illicit Discharge Detection and Elimination
LCAR	Legislative Committee on Administrative Rules
LCBP	Lake Champlain Basin Program
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
LWM	Large Woody Material
MAP	Monitoring and Assessment Program
MARC	Mount Ascutney Regional Commission
MCM	Minimum Control Measures
MFO	Medium Farm Operation
MPG	Municipal Planning Grant
MRGP	Municipal Roads General Permit
MS4	Municipal Separate Storm Sewer System
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
NOP	Nitrogen Optimization Plans
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
ONRCD	Ottauquechee Natural Resources Conservation District
ORG	Ottauquechee River Group
ORW	Outstanding Resource Water
PCP	Phosphorus Control Plan
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
RP	Rivers Program
RPC	Regional Planning Commission
RRP	Rock River Preservation
SCA	Student Conservation Association
SEP	Supplemental Environmental Program
SFO	Small Farm Operation
SGA	Stream Geomorphic Assessment
SHPO	State Historic Preservation Office
SPA	Source Protection Area
SVNMP	Southern Vermont Nutrient Management Program
SWG	State Wildlife Grant
SWMP	Stormwater Master Plan
SMR	Stormwater Mapping Report
TFS / T4S	Trees for Streams
TBP	Tactical Basin Plan
TMDL	Total Maximum Daily Load
TPI	Transportation Planning Initiative
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
UVLT	Upper Valley Land Trust
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
VFWD	Vermont Fish and Wildlife Department
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
VRBS	Vermont Road and Bridge Standards
VRC	Vermont River Conservancy
VSA	Vermont Statutes Annotated
VTrans	Vermont Agency of Transportation
VYCC	Vermont Youth Conservation Corp
WCNRCD	Windham County Natural Resources Conservation District
WHIP	Wildlife Habitat Incentive Program
WISPr	Water Infrastructure Sponsorship Program
WQRP	Water Quality Remediation Plan
WQS	Water Quality Standards
WRC	Windham Regional Commission
WSMD	Watershed Management Div., VT DEC
WUV	Watersheds United Vermont
WWTF	Wastewater Treatment Facility

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Appendices

Appendix A. 2018 Report Card

Table A.1. 2018 Report Card

STRATEGY	FOCUS AREA	STATUS
Identify areas in need of AEM assessment and additional BMP practices	Kedron Brook, No. Branch Black, Twentymile Stream	Carry Forward to 2023 plan
Acquire RCE on farmland located on alluvial fans	Kedron Brook/Ottauquechee confluence, Hubbard Brook, No. Branch Black, Twentymile Stream, Mill Brook	Carry Forward
Continue and expand the Portable Skidder Bridge Program	Basin-wide	Carry Forward
Remove sewer lines from hazardous locations including streambeds	Woodstock, Windsor	Carry Forward
Implement Emergency Action Plans for High and Significant Hazard dams	Basin-wide	Carry Forward
Restore degraded wetlands for habitat and water quality improvement	No. Branch Black, Twentymile Stream, Mill Brook	Carry Forward
Establish long-term funding for projects like 'Trees for Streams'	Basin-wide	Completed
Protect headwater streams and sensitive upland surface waters	North Branch Ottauquechee	Completed & On-going
Establish Lay Lake Monitoring on appropriate lakes and ponds	Amherst, Echo, Kent, Knapp 1 & 2, Lakota, Mecawee, Mill (Windsor), Ninevah, Rescue, Woodward	Completed & On-going
Develop stormwater master planning to identify and prioritize actions	Roaring Brook, East Roaring Brook (Killington), Okemo Brook, Trailside Brook (Ludlow) also: Hartford, Springfield, Windsor, Woodstock	Completed & On-going
Implement the above plans		Completed & On-going
Increase buffer plantings	Ottauquechee River, Kedron Brook, No. Branch Black, Twentymile Stream	Completed & On-going
Increase outreach and technical assistance through workshops and trainings for farmers, ag contractors and technical service providers	Basin-wide	On-going
Implement livestock exclusion practices	Kedron Brook	On-going

STRATEGY	FOCUS AREA	STATUS
Increase farm buffer establishment along surface waterways and upland wetlands	Kedron Brook, No. Branch Black, Twentymile Stream	On-going
Expand small farm NMP development courses and workshops, trainings for farmers, manure applicators and technical service providers	Basin-wide	On-going
Increase the use of cover crops	Basin-wide	On-going
Provide technical assistance to the equine community to increase participation in nonpoint source pollution prevention	Kedron Brook, Mill Brook	On-going
Continue outreach to farmers on the RAPs.	Basin-wide	On-going
Work with dam operators to mitigate flow variations and work toward run-of-river management	Connecticut River, Ottauquechee River, Black River	On-going
Pursue conservation flows through appropriate state regulatory processes	Connecticut River, Ottauquechee River, Black River	On-going
Continue active participation in the FERC relicensing process for Wilder & Bellows Falls dams, to minimize impacts to the CT River from dam operations	Connecticut River	On-going
Begin active participation in the FERC relicensing process for North Hartland and Taftsville dams, to minimize impacts to Ottauquechee River from dam operations	Ottauquechee River	Completed & On-going
Better manage forest road runoff through adherence to AMPs	Basin-wide	On-going
Enhance Flood Resiliency with funding for technical assistance and incentives for municipalities	Basin-wide	On-going
Buy-out properties that are highly vulnerable to flooding from willing sellers	Cavendish, Ludlow, Plymouth, Springfield, West Windsor, Windsor	On-going
Assess dams for structural integrity: prioritize High and Significant Hazard dams for removal or repair	Basin-wide	On-going
See Proposed Actions in Table 9. (of 2018)	Ludlow, Hartford, Killington, Springfield	On-going
Increase the number of river and floodplain restoration projects to re-establish connections to floodplains	Black River, No. Branch Black, Patch Brook, Mill Brook	On-going
Increase River Conservation Easements: support projects which incorporate channel management, riparian buffer provisions and flood resiliency	Basin-wide	On-going

STRATEGY	FOCUS AREA	STATUS
Replace geomorphologically incompatible culvert and bridges: RPCs work with towns to identify, add to capital budget, seek additional funding sources	Basin-wide	On-going
Remove dams, esp. High Hazard dams	Basin-wide	On-going
Promote & implement the Lake Wise Program to encourage lake-friendly shoreline property maintenance	Echo Lake, Lake Rescue, Lake Pauline and Mill Pond	On-going
Raise awareness about lake-friendly living and shoreland protection	All lakes and ponds	On-going
Work to control riparian and aquatic invasive plants	Hoyts Landing (Black River), Kent Pond, Mill (Windsor), Ninevah, North Hartland Reservoir, North Springfield Reservoir, Rescue	On-going
Assist municipalities to control runoff from gravel and paved roads: implement road assessment protocol to assist with prioritization; provide technical and financial resources to assist with implementation; implement Municipal Roads General Permit	Basin-wide	On-going
Address gully erosion from stormwater runoff	Ottauquechee River, Roaring Brook, Mill Brook	On-going
Monitor and assess waters with no or outdated data	see Table 8	On-going
With partners, submit applications for reclassification	see Table 13, 14, 15	On-going
Evaluate waters for ORW designation	see Table 16	On-going
Assess wetlands for potential reclassification	see Table 17	On-going
Map unmapped wetlands	Basin-wide	On-going

Appendix B. Dams

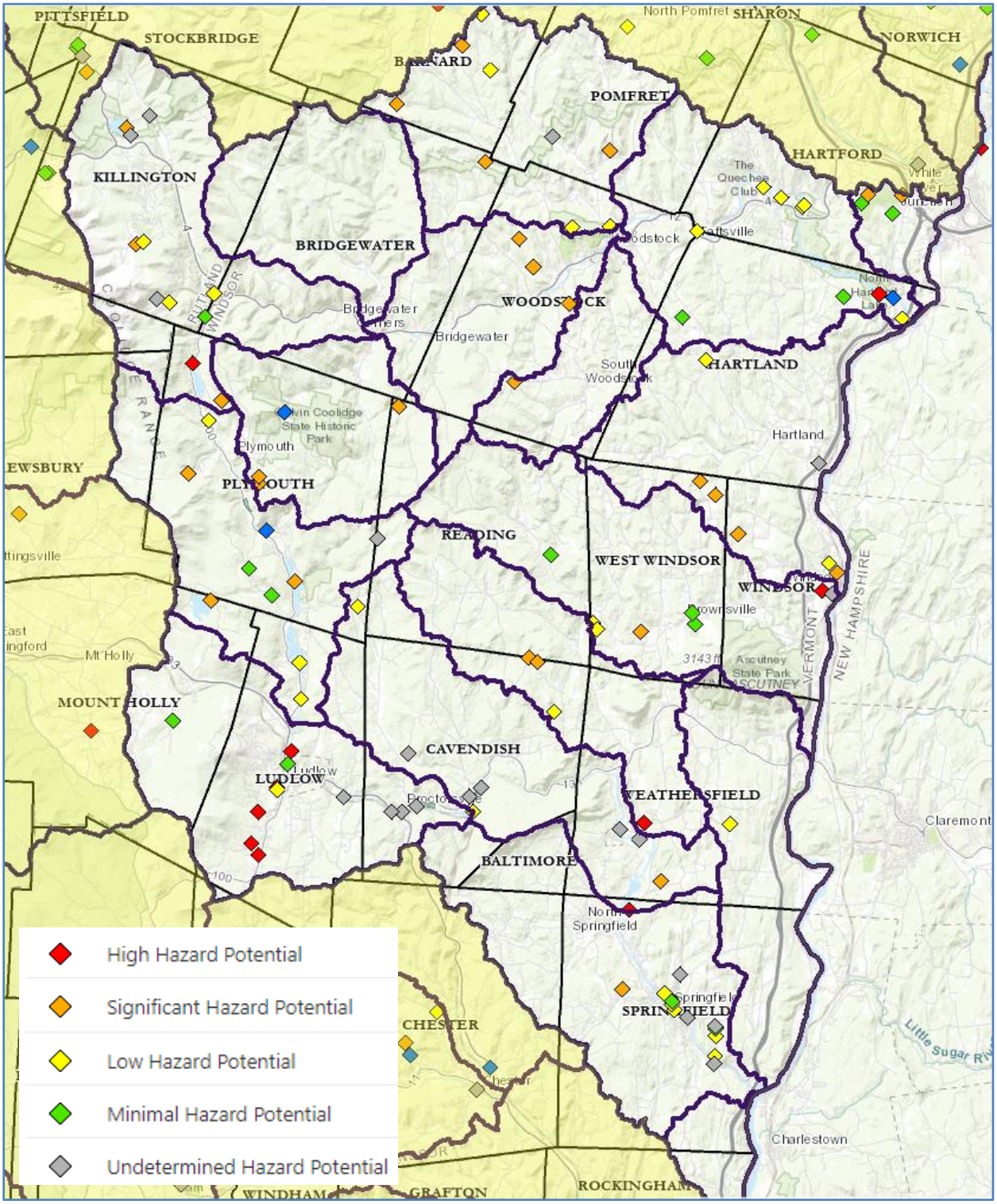

Figure B.1. Location of Dams

Table B.1. Dams and Hazard Class

DAM NAME	WATERBODY	TOWN	DAM STATUS	HAZARD CLASS
Dams of the Black River Watershed				
Amherst Lake	Echo lake tributary	Plymouth	In Service	Significant
Atherton	Black River	Cavendish	Breached	Breached
Black Bear Woolen Co	Black River	Cavendish	Breached	Breached
Black Pond	Black River	Plymouth	In Service	Low
Branch Brook	Branch Brook tributary	Mount Holly	In Service	Minimal
Carey	Black River tributary			Significant
Cavendish	Black River	Cavendish	In Service	Low
Cavendish 11	Twenty Mile Stream	Cavendish	Breached	Breached
Cavendish WWTF	Black River	Cavendish	In Service	Unknown
Colby Pond	Twenty Mile Stream	Plymouth	In Service	Low
Comtu Falls	Black River	Springfield	In Service	Minimal
Duck Pond	Black river tributary	Plymouth	Breached (partial)	Breached
Fellows	Black River	Springfield	Not in use	Low
Gilman	Black River	Springfield	In Service	Low
Jewell Brook Site No. 1	Jewell Brook	Ludlow	In Service	High
Jewell Brook Site No. 2	Grant Brook	Ludlow	In Service	High
Jewell Brook Site No. 3	Jewell Brook tributary	Ludlow	In Service	High
Jewell Brook Site No. 3 Dike	Jewell Brook tributary	Ludlow	In Service	Low
Jewell Brook Site No. 5	Sanders Brook	Ludlow	In Service	High
Knapp Brook Site #1	Knapp Brook	Cavendish	In Service	Significant
Knapp Brook Site #2	Knapp Brook	Cavendish	In Service	Significant
Lacoss	Patch Brook tributary	Plymouth	In Service	Minimal
Lake Ninevah	Patch Brook	Mount Holly	In Service	Significant
Lake Rescue	Black River	Ludlow	In Service	Low
Lovejoy	Black River	Springfield	In Service	Low
Mile Brook	Mile Brook	Springfield	----	Unknown
Muckross	Black River tributary	Springfield	In Service	Low
Murdoch	Black River	Cavendish	Breached	Breached
North Springfield	Black River	Springfield	In Service	High
Okemo Snow Pond	Black River – off stream (OS)	Ludlow	In Service	High
Okemo Snow Pond Diversion Structure	Black River	Ludlow	In Service	Minimal
Parker Brothers	Black River	Cavendish	Breached	Breached

DAM NAME	WATERBODY	TOWN	DAM STATUS	HAZARD CLASS
Perkinsville	Black River	Weathersfield	-	Low
Plymouth Notch Snowmaking Pond	Black River – OS	Plymouth	In Service	Significant
Plymouth-8	Patch Brook tributary	Plymouth	In Service	Minimal
Powerhouse	Black River	Springfield	Breached	Breached
Reading Pond	Reading Pond Brook	Reading	Breached	Breached
Reservoir Pond	Black River	Ludlow	In Service	Low
Slack (Lower)	Black River	Springfield	In Service	Low
Smithville	Black River	Ludlow	----	Breached
Soapstone	Black River	Weathersfield	----	Unknown
Springfield Reservoir	Black River tributary	Weathersfield	In Service	Significant
Springfield-10	Black River tributary	Springfield	----	Minimal
Springfield-11	Black River tributary	Springfield	----	Low
Springfield-9	Black River tributary	Springfield	----	Unknown
Stoughton Pond	North Branch Black River	Weathersfield	In Service	High
Vermont Snath	Black River	Springfield	Breached	Breached
Widow Hill	North Branch Black River tributary	Cavendish	In Service	Low
Dams of the Ottauquechee River Watershed				
Bear Pond	Falls Brook TR	Killington	In Service	Unknown
Billings Pond	Barnard Brook	Woodstock	In Service	Low
Breakneck Hill	----	Pomfret	----	Unknown
Carlton Reservoir	Ottauquechee River TR	Woodstock	In Service	Significant
Connors Pond	Kedron Brook TR	Woodstock	In Service	Significant
Cox Reservoir	Ottauquechee River TR	Woodstock	In Service	Significant
Crystal Pond	Happy Valley Brook TR	Hartland	In Service	Minimal
Deweys Mills	Ottauquechee River	Hartford	In Service	Low
Deweys Pond	Ottauquechee River TR	Hartford	In Service	Low
Gray Camp Pond	Barnard Brook TR	Barnard	In Service	Low
Hartland-6	Ottauquechee River	Hartland	----	Breached
Johnson	Ottauquechee River TR	Killington	In Service	Low
Kellogg Pond	Barnard Brook TR	Barnard	In Service	Low
Kent Pond	Kent Brook	Killington	In Service	Significant
Lake Pinneo	Ottauquechee River TR	Hartford	In Service	Low

DAM NAME	WATERBODY	TOWN	DAM STATUS	HAZARD CLASS
Lakota Lake	Richmond Brook	Barnard	In Service	Significant
Lower Moore Pond	Pinney Hollow Brook	Plymouth	In Service	Significant
Martin	Cloudland Brook TR	Pomfret	In Service	Significant
Mecawee Pond	Broad Brook TR	Reading	In Service	Significant
Mirror Lake	Roaring Brook TR OS	Killington	In Service	Low
Noble Pond	Gulf Stream TR	Bridgewater	In Service	Significant
North Hartland	Ottauquechee River	Hartland	In Service	High
Pinney Hollow	Pinney Hollow Brook	Plymouth	Removed	Removed
Quechee Mills	Ottauquechee River	Hartford	In Service	Low
Rockefeller	Woodward Reservoir TR	Plymouth	In Service	Significant
Sherburne 14	Reservoir Brook TR	Killington	In Service	Minimal
Sherburne 5	Kent Pond TR	Killington	In Service	Unknown
Snowshed Pond	Roaring Brook TR OS	Killington	In Service	Significant
Sonnenburg Ski Area	Barnard Brook TR	Barnard	In Service	Low
Sunny Acres	Ottauquechee River TR	Hartland	In Service	Minimal
Sunrise Village Lagoon	Falls Brook TR	Killington	In Service	Low
Taftsville	Ottauquechee River	Woodstock	In Service	Low
The Pogue	Barnard Brook TR	Woodstock	In Service	Low
Thundering Falls	Kent Brook	Killington	In Service	Unknown
Upper Moore Pond	Pinney Hollow Brook	Plymouth	In Service	Significant
Vondell Reservoir	Vondell Brook	Woodstock	In Service	Significant
White Current	Ottauquechee River	Hartland	In Service	Low
Woodward Reservoir	Reservoir Brook	Plymouth	In Service	High
Dams of the Connecticut River watershed				
Bronson	Lulls Brook-TR	West Windsor	In Service	Significant
Cooks Pond	Blood Brook	Weathersfield	In Service	Low
Firehouse	Mill Brook	West Windsor		Removed
Hammondsville Mine	Reading Hill Brook - OS	Reading	In Service	Minimal
Harrington	Mill Brook	West Windsor		Removed
Howland	Mill Brook-TR	West Windsor	In Service	Significant
Hurricane Lower Reservoir	Kilburn Brook	Hartford	Breached (Partial)	Significant
Hurricane Upper Reservoir	Kilburn Brook-TR	Hartford	Breached (Partial)	Minimal
Lake Runnemede	Connecticut River-TR	Windsor	In Service	Significant
Lake Runnemede Dike	Connecticut River-TR	Windsor	In Service	Low

DAM NAME	WATERBODY	TOWN	DAM STATUS	HAZARD CLASS
Martinsville	Lulls Brook	Hartland	In Service	Unknown
Mount Ascutney Effluent Pond	Mill Brook-OS	West Windsor	In Service	Minimal
Mount Ascutney Snow Pond	Mill Brook-OS	West Windsor	In Service	Minimal
Prison Pond	Hubbard Brook-TR	Windsor	In Service	Significant
Rawson	Lulls Brook-TR	West Windsor	In Service	Significant
Simonds Reservoir	Kilburn Brook-TR	Hartford	In Service	Minimal
Stokien	Weed Brook	Hartland	In Service	Low
Bellows Falls	Connecticut River	Rockingham	In Service	Unknown
Windsor (Lower)	Mill Brook	Windsor	Breached	Breached
Windsor Minerals Pond #10	Mill Brook-TR	West Windsor	In Service	Low
Windsor Minerals Pond #9	Mill Brook-TR	West Windsor	In Service	Low
Windsor Upper	Mill Brook	Windsor	In Service	High
Wright Reservoir	Connecticut River-TR	Hartford	Drained	Significant

Appendix C. Fisheries Assessment

TO: Marie Caduto; Watershed Coordinator

FROM: Bret Ladago; Fisheries Biologist

DATE: January 11, 2023

SUBJECT: Ottauquechee Watershed Fisheries Assessment

Ottauquechee Fisheries:

A variety of fish species exist within the Ottauquechee River basin, many of which support a popular recreational fishery. Naturally reproducing (wild) native Brook trout remain common in colder, higher elevation tributaries and within the mainstem above West Bridgewater. Wild populations of naturalized brown trout and rainbow trout are less common, but present within individual tributaries and mainstem reaches. Wild trout populations within the mainstem below West Bridgewater are limited, likely due to high summer temperatures and poor overall habitat quality. Hatchery-reared rainbow trout are stocked annually by VFWD (Vermont Fish and Wildlife Department) within the Ottauquechee River from Bridgewater Corners (Junction of Rt.4 & 100) to the Taftsville Dam and provide additional angling opportunities in areas with high water temperatures and low wild trout productivity. Tributary streams are not stocked and are managed as wild trout waters. Results from 2021 monitoring identified two additional streams (Kent Pond Brook and Cloudland Brook) as “very good” or class B1 waters for recreational fishing.

Water temperature monitoring conducted by VFWD in 2005, 2016 and 2021 showed mainstem water temperatures exceeding 80°F at most locations between Bridgewater and North Hartland. In 2021, water temperatures were monitored in the mainstem from Killington to Hartford in addition to the lower reaches of 5 tributaries. While elevated water temperatures in Broad Brook and the North Branch likely limit wild trout populations, temperatures within Pinney Hollow Brook, Barnard Brook, and Kedron Brook remain suitable for trout (Table 1).

Table 1. Water temperature data (ºF) between June and October from the mainstem of the Ottauquechee River and 5 tributaries. Elevation (Above mean sea level (MSL)), number of days each temperature (65,68,72,75 and 80) was reached or exceeded, the overall maximum temperature (Max Temp F) and the overall maximum of a 7-day rolling average of daily maximum temperatures (7DaymaxAVG F).

River	Elevation (feet MSL)	Lat Dec	Lon Dec	Year	Days >65F	Days >68F	Days >72F	Days >75F	Days >80F	Max Temp F	7Day max AVG F
Ottauquechee River	1170	43.65096389	-72.76924444	2021	81	46	15	6	0	79.5	73.8
Ottauquechee River	1060	43.60092778	-72.74951111	2021	63	36	10	2	0	77.0	72.8
Ottauquechee River	860	43.59283889	-72.66496111	2021	67	43	12	5	0	78.5	74.3
Ottauquechee River	830	43.58804444	-72.64407778	2021	81	53	26	11	4	83.7	78.1
Ottauquechee River	640	43.63683333	-72.47143056	2021	102	75	37	18	3	82.8	77.8
Ottauquechee River	610	43.62966000	-72.46642000	2021	97	71	36	14	3	82.8	78.2
Ottauquechee River	570	43.65127222	-72.44276944	2021	98	75	40	19	5	87.8	80.9
Pinney Hollow Brook	890	43.57032300	-72.66358900	2021	53	27	5	3	0	76.5	72.8
North Branch	860	43.59335000	-72.66105000	2021	74	45	20	8	3	82.6	76.4
Broad Brook	840	43.58492222	-72.65193611	2021	78	53	22	10	3	85.0	78.9
Kedron Brook	680	43.62762222	-72.51575556	2021	54	23	4	0	0	74.8	70.9
Barnard Brook	660	43.63486389	-72.51171389	2021	58	27	6	1	0	75.4	71.1

Lake and Pond habitat within the Ottauquechee basin is primarily composed of man-made waterbodies. Only one natural pond (View Pond) exists within the basin and three others (Woodward Reservoir, Lakota Lake, and the Pogue) are naturally occurring with artificial controls. Of these natural waterbodies, only Woodward Reservoir offers public access (VFWD owned access area). Woodward Reservoir provides fishing opportunities for largemouth bass, smallmouth bass fisheries, brown trout (stocked), rainbow trout (stocked), brown bullhead, chain pickerel, northern pike, rainbow smelt, white sucker, rock bass, and yellow perch. Woodward reservoir also serves as a water supply for snowmaking operations at Killington.

Man-made ponds within the Ottauquechee basin that provide public access and recreational fishing opportunity include:

Kent Pond - (VFWD owned dam and access area) - Fishery includes largemouth bass, pumpkinseed, Brook trout (stocked), Rainbow trout (stocked), Brown bullhead, white sucker, and yellow perch.
Vondell Reservoir - Stocked annually with Rainbow trout; rudd are also present.
Deweys Mill Pond - (Recreational access provided by the Army Corps of Engineers) Fish community includes largemouth bass, northern pike, brown bullhead, pumpkinseed, bluegill, rock bass, white sucker, bluntnose minnow, fall fish, golden shiner, creek chub and rudd. Black crappie also first appeared in this waterbody in 2014.
North Hartland Reservoir - (Recreational access provided by the Army Corps of Engineers) – Fish community includes northern pike, brown bullhead, largemouth bass, pumpkinseed, rock bass, white sucker, yellow perch, and rudd. Black crappie were recently found by VFWD in 2022.

VFWD assesses wild trout populations and important nursery areas to document high quality recreational fisheries, which are typically found in surface waters that exhibit clean and cool conditions. Waters with abundant wild self-sustaining salmonid populations supporting multiple age classes are identified below as "very good" or class B1 waters for recreational fishing. These waters support multiple age classes of trout totaling a minimum of 1,000 per mile (all species/ages/sizes), and/or 200 per mile > 6 inches (total length). In 2021, twelve streams were surveyed for potential as B(1) waters (Table 2).

It should be recognized that wild trout populations vary widely from year to year and therefore an individual population may sometimes go below or greatly exceed these values (1,000 per mile, and/or 200 per mile > 6 inches (total length)) in any given year. The upstream and downstream extent of the stream classification should be based upon consistent or improving water quality, physical habitat quality and land use conditions, as per VDEC language for class A1 waters: *"The length of river or stream reach to be recommended for reclassification shall be delineated by analyzing the extent of biological, chemical, physical habitat, and land use information available for the watershed. The decision to include tributaries to the river or stream under consideration will follow the same process.*" The reach should include all upstream habitats which are deemed essential to sustain water quality and physical habitat requirements necessary to support wild salmonid populations at a very good level.

Other waters that have not been surveyed may also support similar wild trout densities and may be identified in the future. Certain noteworthy streams are also important to support spawning and nursery habitat and are noted in table 3.

Table 2. Streams sampled by VFWD in 2021 with potential to meet criteria

Stream	Elev.	Years sampled	Trout per Mile	Pounds of Trout per Acre	Propose for B(1)?
Cloudland Brook	1000	2008, 2021	1050, 994	39.2, 26.8	Y
Curtis Hollow Brook	1040	2008, 2021	1405, 623	13.8, 18.7	N
Dailey Hollow Brook	1440	2008, 2021	703, 704	8.2, 12.7	N
Madden Brook	1170	2008, 2021	1689, 582	23.0, 4.8	N
Pinney Hollow Brook	1180	2006, 2012, 2014, 2015, 2016, 2021	1414, 765, 230, 571, 1072, 224	23.3, 16.2, 10.5, 8.9, 17.0, 7.8	N
Trib 7 (Gulf Stream)	1100	2008, 2021	1072, 215	23.1, 9.5	N

Reservoir Brook	1260	2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2012, 2013, 2014, 2016, 2021	287, 632, 842, 1285, 828, 723, 634, 545, 1197, 686, 2144, 1184, 1360, 1680, 349	20.1, 26.2, 32.9, 27.5, 41.0, 41.1, 25.6, 17.7, 30.0, 24.2, 40.7, 30.9, 24.9, 33.0, 7.9	Y
Kent Pond Brook	1580	2008, 2021	2087, 549	40.8, 27.9	Y
Pomfret Brook	740	2008, 2021	918, 443	16.0, 12.3	N
Whitman Brook	590	2008, 2016, 2021	2286, 14, 147	17.6, 0.0, 5.0	N
Whitman Brook Trib	920	2008, 2016, 2021	753, 1049, 729	8.5, 12.7, 17.0	N
Fulling Brook	540	2008, 2016, 2021	480, 1201, 479	11.1, 13.5, 16.5	N

Based on fish population surveys conducted by VFWD, 7 streams within the Ottauquechee Watershed have been identified as having very good fisheries (Class B1)/

Table 3. B1 Waters for recreational fishing in the Ottauquechee River including stream name, trout species present; Brook trout (BKT), Brown trout (BNT), and Rainbow trout (RBT), and downstream location. Cloudland Brook and Kent Pond Brook were added following sampling in 2021.

Stream	Trout Species Present	Latitude	Longitude
Roaring Brook	BKT	43.65893	-72.77409
Reservoir Brook	BKT, BNT – Important spawning tributary	43.58297	-72.7589
Madden Brook	BKT	43.58848	-72.75567
Kedron Brook	BKT, RBT	43.55778	-72.53255
Babcock Brook	BKT	43.60309	-72.45194
Cloudland Brook	BKT	43.663584	-72.512805
Kent Pond Brook	BKT	43.672865	-72.808914

Cc: Courtney Buckley; VFWD Fisheries Biologist
Will Eldridge; VFWD Aquatic Habitat Biologist

State of Vermont *Agency of Natural Resources*
Fish & Wildlife Department
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www.vtfishandwildlife.com [email] courtney.buckley@vermont.gov

Memorandum

TO: Marie Caduto,

FROM: Courtney Buckley, Fisheries Biologist

DATE: 2/17/2023

SUBJECT: Fisheries assessment for the Black River, Mills and Lulls brooks watersheds

Black River Characteristics:
The mainstem of the Black River is highly impounded by thirteen dams, including the North Springfield Reservoir (96 acres), Rescue Lake (224 acres), Echo Lake (100 acres), Lake Amherst (83 acres), and Black Pond (20 acres). Dams and their impoundments heavily impact the physical, chemical, and biological processes in the river. Dams alter the natural hydrology and sediment transport of the river system. In the Black River, there are five hydroelectric facilities currently operating, with the majority located in downtown Springfield. These facilities have the potential to entrain and impinge fish, which can cause mortality of riverine species. At least one of these facilities (Slack Dam) regularly interrupts flows which can draw down water levels and impact aquatic biota. The North Springfield Reservoir is a flood control facility operated by the Army Corps of Engineers that regulates water flow in the Black River mainstem. Flow alterations from both controlled release and "run-of-river" facilities impact natural stream processes including channel morphology and substrate composition. Large amounts of sediment accumulated in impoundments degrades channel equilibrium by depriving downstream reaches of the sediment that would naturally replenish from upstream. When the sediment from the downstream reach naturally erodes and is not replenished from upstream, considerable erosion and channel destabilization occurs. Lack of diverse sediments can degrade instream habitat for aquatic organisms.

A connected, unobstructed system allows fish to move and seek the best available habitat to meet their biological needs. Fish can small- and large-scale, daily and seasonal migrations in search of quality habitat that will provide ample feeding opportunities, cover and protection from predators, and adequate conditions for successful reproduction. Each species has a set of criteria needed to have successful reproduction, which includes water temperature, depth, and flow, as well as sediment type. Dams can limit or completely prevent safe aquatic organism passage upstream and downstream resulting in population declines or loss. For example, despite decades of restoration efforts, naturally reproducing Atlantic Salmon have been extirpated from Vermont due to dams. As a highly migratory species, Atlantic Salmon were blocked from reaching their historic spawning habitats and unable to sustain a naturally reproducing population.

Water quality degradation within the impoundment and waters downstream occur due to the increased surface area of impounded waters being exposed to more solar radiation resulting in warmer water temperatures. Compounding impacts of climate change, impoundments, and development are leading to increased water temperatures in Vermont. During periods of stressful environmental conditions like warmer summer water temperatures, fish will often migrate to cold-water refuges such as the mouths of tributary streams or to areas of groundwater inflow. Connected streams will become increasingly important as fish populations shift upstream and into tributaries seeking thermal refugia. Aquatic connectivity also allows for the recolonization of upstream habitats after catastrophic events, such as floods or toxic discharges. Furthermore, free movement within a river system helps to maintain genetic diversity of aquatic populations.

Other structures, such as poorly designed culverts, can also act as barriers to aquatic organism passage and degrade aquatic ecosystems. The failure potential and flood risk associated with culverts should also be evaluated in addition to evaluating aquatic organism passage. Factors including bankfull width, the level of sediment continuity, slope of the structure relative to the surrounding stream, approach angle of the stream, and the amount of erosion and armoring can all affect the performance and failure potential of a culvert during high flow events.

The five operational hydroelectric facilities in the Black River (Cavendish, Lovejoy, Comtu Falls, Gilman, and Fellows) are currently pursuing FERC relicensing. In 2022, NRCS and the Town of Ludlow conducted an alternatives assessment on four flood control and storm water management dams along Jewell Brook and its tributaries to determine the best option to bring these flood control dams into federal compliance with current dam safety rules.

Black River Temperature Regime and Monitoring

Elevated water temperatures have been shown to be a main factor limiting trout production in the Black River given their maximum temperature thresholds. Brook Trout are the most sensitive trout species regarding water temperature. Brook Trout prefer water temperatures below 68ºF and will experience thermal stress and mortality if water temperatures exceed for an extended period. Brown Trout are more tolerant of warmer water temperatures but will experience thermal stress above 80ºF (Kirn 2018). Even if other factors such as available cover are also limiting in an area, productive trout populations cannot exist if a stream regularly exceeds identified temperature thresholds (Kratzer and Warren 2013). Temperature monitoring has been conducted with stationary loggers at multiple locations since 1995 on the Black River and temperatures exceeding 80°F are regularly recorded suggesting temperature likely limits wild trout production in the river (Simard 2019).

Coldwater inputs are especially important in rivers that typically exceed certain temperature thresholds as they provide critical thermal refuge for cold-water fish species during the summer months (Baird and Krueger 2003). Following recommendations made in Kratzer 2017, Vermont Fish and Wildlife Department (VFWD) biologists conducts a water temperature survey in the Black River to identify opportunities for protection and improvement of trout habitat. A total of 23 stationary temperature loggers were deployed between May 18 and October 23, 2018 in the mainstem Black River from its headwaters down to the RT 106 bridge in Perkinsville, Patch Brook, Branch Brook, Jewell Brook, and Twenty Mile Stream (Figure 1, Simard 2019). Water

temperatures in the Black River upstream of the Plymouth Lake generally remained relatively cool with a majority of daily max water temperatures below 68°F, though temperatures still exceeded 72°F on several days in early July (Figure 2). However, all locations on the Black River mainstem between or below the Plymouth Lakes exceed 80°F (Figure 2). The highest water temperature recorded was 90°F at elevation 622, within the trophy trout section along VT-131 (Figure 1, 2).

Patch Brook and Jewell Brook both remained cold, with Patch Brook only briefly exceeding 72° for two days and Jewell Brook remaining in the 60's for most of the surveyed period (Figure 2). Branch Brook and Twenty Mile Stream both exceed 80°F as well, though both remained cooler than the mainstem (Figure 2). Relative water temperatures were warmest (~6-7°F warmer than the median corrected temperature ,74.2°F) in the area immediately downstream of the Lake Pauline outlet (Figure 2). The confluence of Branch Brook was substantially cooler and resulted in a nearly 4.5°F decrease in temperature (Simard 2019).

Water temperatures upstream of the Plymouth Lakes are suitable for trout, but the large surface areas of the Plymouth Lakes results in substantially warmer water downstream. The cumulative impacts of Branch and Jewell brooks and likely other tributaries has a significant positive impact on mainstem temperatures, though temperatures still surpassed 80°F at even the coolest locations. Given the Plymouth Lakes are the primary source of increased temperatures, it is unlikely that water temperatures in the Black River will ever be reduced enough to support its own robust year-round wild trout fishery (Simard 2019). However, maintaining cool water temperatures in these and other tributaries is vital to sustaining thermal refuge for fish and the observed cooling impacts on mainstem temperatures. As seen in the temperature influence of Branch Brook in 2018, a tributary that is 20°F cooler than the mainstem can decrease mainstem water temperatures by 2.8-5.8°F (Table 1). Restoration including but not limited to the removal of dams and undersized culverts, restoration of natural stream flow, and restoration of riparian conditions through tree plantings can have a cumulative positive impact on habitat and stream temperature in these tributaries, and the watershed overall.

Black River Mainstem

The Black River basin supports a wide variety of both warm and cold-water fisheries. The mouth of the Black River and its lower reach contains many warm-water fish species as are commonly seen in the Connecticut River. The lower portion of the Black River and its lower tributaries also serve as spawning areas for wild rainbow trout populations residing in the Connecticut River and native anadromous sea lamprey, a species of greatest conservation need (SGCN) which migrate up the Connecticut River from the Atlantic Ocean. Other SGCN including redbreast sunfish, and anadromous American Shad also utilize the lower Black River downstream of the Lovejoy Dam. The number of American Shad that have passed above the Bellows Falls fish ladder has only begun to increase in recent years. Improved fish passage may increase successful passage of SGCN species American Eel, Sea Lamprey, and American Shad to the Black River.

Upper reaches of the Black River mainstem and its tributaries, especially above the Cavendish Dam, are managed for wild Brook Trout (a SGCN), and Brown Trout populations. The Black River mainstem downstream of the Cavendish Dam is wide, shallow, and thermally impaired. Water temperatures throughout the summer months are too high to support wild trout

populations. However, fishing pressure, spring flows, and abundant access provide good conditions for a successful and very popular "put and take" trophy trout fishery. Recent creel surveys indicate that the current management strategy provides high catch rates, high levels of fish "recycling" increasing the value of each trout stocked, while allowing anglers to harvest their daily limit of two fish. Long-term survival of the stocked trout is low due to summer water temperatures which is validated by a decrease in catch rates over the season.

Black River Tributaries

Patch Brook

The median maximum daily temperature in Patch Brook in 2018 was 63°F, 6.5°F cooler than the mainstem site just upstream and decreased the median maximum daily temperature in the mainstem by 2.5°F (Black 6, Figure 2). Very good number of Brook Trout were observed at elevations 1476 and 1240 in 2016. A subsequent survey at elevation 1240 was conducted in 2022, which showed a decrease in the number of Brook Trout present though the population would still be considered very good (Table 2). Trout populations are very variable year to year and additional sampling is needed to determine any populations trends in Patch Brook. Riparian conditions along Patch Brook are in fairly good condition with wide forested streambanks on both sides of the stream. Patch Brook Road parallels the stream for a majority of its length and exists entirely within the riparian area. Road wash and erosion during high flow rain events may increase sedimentation and threaten the roadway. Fortunately, Patch Brook has good longitudinal connectivity for aquatic organisms to move up and downstream through the main stream channel.

Branch Brook

The median maximum daily temperature at the most downstream site in Branch Brook (Branch1030) was 65°F, 7°F cooler than the mainstem site just upstream of the confluence (Black 8, Figure 2). In 2019, temperature monitoring was conducted at two additional upstream sites (elevation 1362 and 1454) between May 17-November 8, 2019 and showed cooler water temperatures upstream (Figure 3). Water temperatures at Branch1454, did not exceed 71°F and remained in the high 50s to low 60s. Median maximum daily temperature at Branch1030 was 2°F cooler than 2018, but varied more over the season (Figure 3). The slightly warmer temperatures at the two downstream sites are likely due to the numerous smaller tributaries that enter Branch Brook downstream of Branch1454 and lack of shade from intact riparian buffers along VT-103 downstream of Greenstand Road. Brook trout populations in Branch Brook at elevations 1620 and 1740 were very good during 2016 surveys with healthy spawning numbers at the upstream site, and a healthy adult population at both sites (Table 2).

There are a number of undersized culverts that partially or fully impede aquatic organism passage within Branch Brook and its tributaries. These culverts should be re-evaluated and considered for full replacement to provide natural stream conditions and full passage for aquatic organisms.

Jewell Brook, and its tributaries Grant and Sanders brooks

Jewell Brook boasts the healthiest, most robust trout population seen in southern Vermont, with exceptional numbers of YOY Brown Trout. Annual surveys of the trout population have been conducted since 2013 at elevation 943, and each sampling event with the exception of 2016 and

2018 have shown exceptional trout population numbers. Surveys upstream have shown very good number of trout as well. The Brown Trout population has been increasing in Jewell Brook over the last decade while Brook Trout populations have remained stable (Table 2, Figure 5). It is possible that with the increase in Brown Trout downstream in Jewell Brook, Brook Trout populations are moving upstream and into the tributaries to avoid competition. Water temperature monitoring has been conducted annually at Jewell943 as well, and shows that the stream remains cold throughout the year. Median maximum summer water temperature since 2018 has been 62°F and water temperatures have only exceeded 68°F 8 times (Figure 4). Jewell Brook had a similar influence on downstream mainstem temperatures when compared to Branch and Patch Brook (Figure 2).

Water temperature was 56°F in Grant Brook during a trout population survey on August 9, 2022 indicating cold water temperatures through the summer which was reflected in the exceptional trout population observed during the survey. A total trout population of 5570 trout per mile was estimated for Grant Brook at elevation 1410. Both Brook and Brown Trout were present, though a majority of the trout present were Brook Trout. Sampling at the same site was conducted in 2007 and estimated 2725 trout per mile, of which only 63 were Brown Trout. Previous sampling in Grant Brook showed very good numbers of Brook Trout at elevation 1850 in 2016 (Table 2). Additional sampling is needed to determine if Brown Trout are present upstream as well. Sanders Brook sampling showed 2609 trout per mile in 2008, of which 311 were Brown Trout. Sampling in 2022 showed an exceptional trout population in Sanders Brook as well, with 3013 trout per mile (Table 2). Water temperature was 65°F at the time of sampling (August 3, 2022). A majority were Brook Trout YOY similar to Grant Brook, suggesting these stream provide excellent spawning and rearing habitat for trout.

Twenty Mile Stream

Median maximum water temperature in 2018 was 68°F and reach a maximum of 82°F. There was a 0.9°F decrease in median maximum water temperature between the mainstem site upstream and downstream of Twenty Mile Stream, which was smaller than the other tributaries but shows that Twenty Mile Stream still has important cooling potential to the mainstem (Table 1, Figure 2). Trout population surveys have been conducted at elevations 800, 980, 1045, 1215, and 1336 though recent surveys have only been conducted at 1336 due to low trout populations at lower elevations. A survey at elevation 980 only returned one Brown Trout and water temperature was 75°F. However, water temperature at elevation 1336 in Twenty Mile Stream was 10°F cooler on the same day collected in the late afternoon. When elevation 1336 was sampled for trout a few days later, mid-morning water temperature was 60°F and had nearly exceptional numbers of Brook Trout present. Trout population estimates for TwentyMile1336 were similar between 2016 and 2022 sampling events, with more YOY present in 2022 (Table 2). Cool water temperature and high numbers of YOY suggest the upper reaches of Twenty Mile Stream provide high quality spawning and rearing habitat for Brook Trout, and especially provide temperature refuge for trout at lower elevations.

A driving survey of stream crossings and riparian conditions between elevation 980 and 1336 was conducted in 2022. Stream crossings downstream of 1336 provide adequate aquatic organisms passage, though culverts upstream are undersized and may only provide partial passage. Riparian conditions along Twenty Mile Stream Road north of the junction with Davis

Road are very poor. Over 2.5 miles of the stream runs through agricultural fields with no shade where the stream is completely exposed to solar radiation resulting in significant warming of water temperatures. Improving riparian conditions throughout this reach is a high priority for the VFWD to improve habitat conditions both in Twenty Mile Stream and the mainstem Black River. Landowner outreach, conservation easements, and/or extensive riparian restoration is vital for this area.

North Branch Black River
Annual trout population surveys have varied at elevation 665 in the North Branch of the Black River. Very good numbers of trout have only been seen at this site in 2014, though 2022 showed the second highest population estimate of 805 trout per mile (Table 2). More Brown Trout are present than Brook Trout at this site (Figure 6). Very few adult trout have been collected from this site which indicated that water temperature and instream habitat does not provide high quality spawning, rearing, or holding habitat. Habitat connectivity in this reach is a higher priority to allow fish to reach better habitat including cooler water temperatures. Median maximum summer water temperature from annual monitoring at NorthBranchBlack665 since 2018 was 68°F. Water temperature has varied from year to year but has exceeded 72°F annually and reached 79.6°F in 2018 (Figure 4).

A trout population survey was also conducted upstream at elevation 1081 of the North Branch of the Black River in 2016. Population estimates were similar to the downstream annual site, though more YOY and small adults were found upstream, and no Brown Trout were present (Table 2) More sampling needs to be done at higher elevation in the North Branch and its tributaries to identify high quality habitat and temperature refugia to inform management. Fortunately, there aren't any impediments to aquatic organisms passage within the mainstem of the North Branch. There are several stream crossings in the tributaries close to their confluences that provide no or limited upstream passage. Riparian conditions along the North Branch can be improved which will help to keep water temperatures from uninhabitable.

Black River Lakes and Ponds
Through an effort to increase accessibility to fishing in Vermont, VFWD biologists worked to simplify fishing regulations and decrease the number of tables in the Vermont Fishing Rules and Regulations beginning January 1, 2022. As a result, a number of previously seasonally closed waters were opened to ice fishing including Lake Amherst, Colby Pond, and Knapp Pond 1 & 2.

Several lakes exist along the mainstem of the Black including Black Pond (20 acres), including Lake Amherst (83 acres), Echo Lake (100 acres), Lake Rescue (224 acres), and the North Springfield Reservoir (96 acres). The Plymouth Lakes, consisting of Lake Amherst, Echo Lake, and Lake Rescue, provide variety of fishing opportunities and boat access via access areas maintained by the Vermont Fish and Wildlife Department. Lake Amherst is stocked annually with Rainbow Trout and had been stocked with Lake Trout until 2014. Echo Lake is stocked annually with Lake Trout and Rainbow Trout, and Lake Rescue is stocked annually with Brown Trout, Lake Trout, and both 1-year and 2-year Rainbow Trout. These lakes also support other fish species including Yellow Perch, Chain Pickerel, Rock Bass, Largemouth Bass, Smallmouth Bass, Brown Bullhead, Black Crappie, and Rainbow Smelt.

Colby Pond (21 acres), located in Plymouth along the headwaters of Twenty Mile Stream, is currently stocked annually with both 1- and 2-year Brook Trout. Brown Trout stocking ended in 2017. Rock bass and golden shiners are also present. Boat access via access areas maintained by the Vermont Fish and Wildlife Department.

Knapp Pond #1 (30 acres), Knapp Pond #2 (42 acres), and Stoughton Pond (560 acres), located on the North Branch of the Black River. Knapp Pond #1 is stocked annually with 1- and 2-year Rainbow Trout while Knapp Pond #2 is stocked annually with 1- and 2-year Brook Trout. The Knapp Ponds have low species diversity including Brown Bullhead and Fathead Minnow. Fathead Minnows were discovered in both Knapp Ponds in 2007, likely following an illegal introduction and the use of baitfish for fishing, either alive or dead, was prohibited at the Knapp Ponds until 2011. Knapp Ponds were closed seasonally until 2022 when VFWD opened a number of lakes and ponds to ice fishing. Anglers were able to catch a number of Brook Trout in both ponds, suggesting Brook trout are surviving the summer and fall which was not known previously. More investigation into potential holdover of stocked fish is needed to determine whether management changes should be made to accommodate increased angling pressure in the winter. Anglers are also harvesting baitfish from the Knapp ponds as well.

While Stoughton Pond is stocked with 2-year Rainbow Trout, it is also a popular Largemouth Bass fishery. Other species including Yellow Perch, Golden Shiner, White Sucker, and Pumpkinseed are also present in Stoughton Pond. A boat ramp maintained by the US Army Corps of Engineers is located at Stoughton Pond. High turbidity levels in the pond following Tropical Storm Irene led to heavy sedimentation that reduced aquatic vegetation and smothered other important habitat, potentially negatively impacting the bass population in subsequent years (Cox 2012, Cox 2014). Data from annual bass population surveys reflect a decline in the Largemouth Bass population following Tropical Storm Irene (Buckley 2020). However, the highest catch rate for quality Largemouth Bass was seen in 2021, though total catch rates were still below pre-Irene values (Figure 7, Buckley 2022). Total catch rates reached pre-Irene levels in 2022. Additionally, Stoughton Pond has far exceeded the Vermont statewide 75th percentiles for both quality and preferred Largemouth Bass a number of times over the last decades indicating a quality fishery with ample fish over 12 and 15 inches (Table 3, Figure 7).

Little is known about the fish community in Lake Ninevah and more information is needed. A survey of the bass population in the lake was conducted in 2019, though few Largemouth and Smallmouth Bass were collected. A majority of the sample were Smallmouth Bass and total catch rates (catch per unit of effort, CPUE) were low (Buckley 2020). However, catch rates of quality Smallmouth Bass were just below the statewide 75th percentile, while catch rates of preferred and memorable Smallmouth Bass were just above the statewide 75th percentile (Table 6, Figure 8). This sampling suggests the Smallmouth Bass population skewed toward larger fish with little reproduction occurring. It is more likely that either the sampling method did not adequately collect all size classes of fish, or an event that resulted in the loss of the 2018 young of the year (YOY) occurred. More information is needed through additional sampling.

Mill Brook Characteristics and Temperature Monitoring

Water temperatures in Mill Brook are generally conducive to trout populations. In 2015, water temperatures briefly reached 70°F at both sampling sites in Mill Brook, but only had maximum

7-day means around 68°F (Will 2016). Water temperatures were similar in 2018 with a median maximum temperature of 63°F, and a maximum temperature of 75°F (Will 2019).

Mill Brook Mainstem and Tributaries

Mill Brook is considered a cold-water fishery and supports native populations of brook and Brown Trout. Other fish species present in Mill Brook include Northern Redbelly Dace, Fathead Minnow, Blacknose Dace, Longnose Dace, White Sucker, Longnose Sucker, Creek Chub, and Slimy Sculpin.

Population estimates from two annual sampling sites on Mill Brook in recent years indicate trout populations are generally stable, but low relative to more productive waters in the state (Table 4, Figure 9, 10). Brook Trout were stocked annually through an approximately 1.2 mile stretch of Mill Brook along the West Windsor and Reading town line, though stocking ceased in 2017.

Mill Brook Lakes and Ponds

Windsor Upper Dam is located approximately 1 mile upstream of the Connecticut River along Mill Brook in the town of Windsor. The impoundment, Mill Pond, is a popular recreational area for swimming, boating, and fishing. Mill Pond is currently stocked annually 2-year Rainbow Trout. The pond also contains White Sucker, Longnose Sucker, Brown Bullhead, Golden Shiner, Common Shiner, Creek Chub, Yellow Perch, Bluegill, and Fallfish. Black Crappie were observed for the first time in Mill Pond during a fish community survey in 2022 due to an illegal introduction. Bass populations surveys have not occurred frequently enough to elucidate trends in the populations, though sampling event in 2009 and 2022 show similar catch rates (Figure 11). Water levels in Mill Pond have been lowered twice in the last ten years for maintenance and beach replenishment purposes, which may have had a negative impact on the Largemouth Bass population. As seen in Stoughton Pond, while these populations may decline following a disturbance event, they do rebound with 3-5 years so long as habitat, temperature, and water levels remain relatively stable.

Hubbard Brook Mainstem and tributaries

Hubbard Brook does not flow through Windsor Grasslands WMA, but abuts the northeastern boundary. A number of tributaries to Hubbard Brook within the Windsor Grasslands WMA and the mainstem were sampled to assess trout presence and population to inform stream management on state lands. Three of the 6 sampling events showed very good numbers of Brook Trout at those sites, with one in 2016 showing exceptional number of adult Brook Trout (Table 5). Riparian conditions and full aquatic organisms passage are VFWD priorities for these streams to maintain very good numbers of Brook Trout in Hubbard Brook and its tributaries.

Hubbard Brook Lakes and Ponds

An assessment of the fisheries and temperature influence of the Prison Pond dam was conducted in 2018. Prison Pond is a small, less than 1-acre artificial impoundment on Windsor Grasslands WMA located at the end of Pond Road. The pond is created by an 18-foot-tall stone, concreate, and gravity dam, has a maximum depth of approximately 14 feet, and drains into one of the tributaries to Hubbard Brook on the WMA. The pond was originally built for water supply, and later for fire suppression or as a small farm pond, but it no longer serves these functions. The pond has a watershed size of approximately 0.3 mi^2 located mostly within Windsor Grasslands

WMA and is fed by two small perennial streams. Many crayfish were seen in the pond, but no fish were observed or captured. The lack of fish in the pond indicates a self-sustaining population never established as a result of the past stocking efforts, and that wild fish from downstream were unable to pass the dam. Based on these observations, Prison Pond is unlikely to provide much more than a marginal warm-water fishery. Upstream of the pond, temperatures never exceed 63°F and typically remained below 60°F. However, maximum temperatures downstream regularly exceed and remained above 72°F and exceed 80°F on seven different days. Prison Pond dam is altering the aquatic community by creating a passage barrier, and by substantially increasing water temperature downstream by slowing water movement and increasing the surface area that is exposed to solar radiation. In addition to increasing water temperature, Prison Pond dam may also negatively impact sediment transport, water quality, aquatic connectivity, lotic habitat, and the overall health of the system (VFWD data, Simard 2019).

Lake Runnemede is a 63-acre, 13 ft deep lake in Windsor that is characterized by numerous natural freshwater springs. The lake does not allow boats due to the presence of Ogden's Pondweed and other rare aquatic plants. Lake Runnemede is a popular ice fishing pond due to reports of large Northern Pike. The lake is not stocked by VFWD and other species present are Bluegill, Pumpkinseed, Rock Bass, Largemouth Bass, Yellow Perch, Brown Bullhead, Chain Pickerel and Common Carp. A creel survey was conducted in the winter of 2020 to collect more information on fisheries in the lake. Catch rates and angler satisfaction were relatively high compared to other waters around the state, suggesting that the waterbody is a popular ice fishing destination (Buckley 2020).

Lulls Brook Mainstem and Tributaries

Annual temperature monitoring is conducted in Lulls Brook at elevation 575. Lulls Brook reached 83°F in 2018 but has only exceeded 72°F twice since. Water temperature vary in Lulls Brook more than the other annual sites, but typically remains in the 60's (Figure 4).

Only Brook Trout have been observed in Lulls Brook and its tributaries. Brook Trout populations have varied year to year since annual sampling began in 2013. Very good number of Brook Trout were observed in 2015 but not any other years. Habitat in this site is cool and better suited for YOY which are seen in good numbers year to year (Figure 12, Table 6). However, very good numbers of Brook Trout were observed at elevation 1151 and in Densmore Hill, Cady, and Weed brooks in 2016 (Table 6).

Management Opportunities

1. **Work to improve riparian corridors and thermal conditions:** Elevated water temperatures (Figures 2, 3, 4) can be moderated through instream and riparian cover. Much of the mainstem of the Black River, especially from the confluence of the Connecticut River upstream through Springfield, is highly developed and has little to no vegetated riparian corridor. Improving or providing riparian corridors along the main stem of the Black River and its tributaries, especially in highly developed areas, would help shade the stream and maintain cooler water temperatures needed for trout.

Advocating for dam removal, where appropriate, would also improve water temperatures as impoundments created by dams increase water surface area enhancing exposure to solar radiation.

2. **Work to improve aquatic habitat connectivity:** Providing aquatic connectivity by evaluating and replacing culverts which impede access to the cooler tributaries would benefit native species that have the propensity to seek thermal refuge in the warm summer months. Advocating for dam removal, where appropriate, would also improve aquatic connectivity through the system. To maintain or improve aquatic connectivity, downstream passage for resident fish species should continue to be provided at all hydroelectric facilities within the watershed. Continuing to maintain or improve these passage facilities would greatly benefit other species.

3. **Work to improve instream habitat complexity and diversity:** Post-Tropical Storm Irene impacts, including berming, instream channelization, and removal of instream cover including boulders and wood inevitably impacted aquatic biota. Windshield surveys following Irene identified nearly 12,500 feet of major impacts and over 2,500 feet of minor impacts along the mainstem and North Branch of the Black River and over 3,000 feet of major impacts along the mainstem of Mill Brook and Bailey Brook, a headwater tributary. Other tributaries within the basins were not evaluated. Complex and diverse habitat is essential to healthy ecosystems. Restoring instream complexity and access to floodplains would improve the overall quality of the system leading to positive impacts on fish populations (Kirn 2012). Additionally, addressing areas with sediment runoff and erosion will help benefit streams and riparian ecosystems.

4. **Work to improve flows:** Maintaining or improving flow management at hydroelectric and existing flood control facilities would benefit downstream species. Rapid fluctuations in flows can strand fish or displace them downstream. Fluctuations may also expose or destroy spawning areas containing eggs or newly hatched fish, including those of native spawning sea lamprey. Hydro-electric facilities should continue to be operated in run-of river mode. Efforts should be made to require continuous flow at hydro-electric facilities that are known to cause interruptions.

5. **Work to stop the spread of exotic species and pathogens:** A variety of non-native fish species and harmful pathogens are present in Vermont or surrounding states. Preventing future introductions of these exotic species and pathogens will allow healthy fisheries to continue.

6. **Work to identify and designate B1 High Quality Fishing – Wild Salmonid Streams:** The VDFW assesses wild trout populations and important spawning and nursery areas to document reaches which support very high quality recreational fisheries, which are typically found in surface waters that exhibit cool water temperatures and complex habitat conditions. Abundant wild trout populations are defined as supporting multiple age classes of one or more species of wild trout (brook, brown, rainbow trout) at levels generally equal to or greater than 1,000 fish/mile and/or 20 pounds/acre. It should be

recognized that wild trout populations vary widely from year to year and therefore an individual population may sometimes go below or greatly exceed these values in a given year. Other waters that have not been surveyed may also support similar wild trout densities and should be identified in the future. Certain streams also support important spawning and nursery habitat. Based upon fish population surveys conducted by VDFW these fisheries exist in the following waters:

- • ***Jewell Brook*** – Ludlow
- • ***Grant Brook –*** Ludlow
- • ***Sanders Brook*** – Ludlow
- • ***Twenty Mile Stream*** – Cavendish
- • ***North Branch Black*** – Upstream of intersection with Ascutney Basin Road
- • ***Sherman Brook*** –
- • ***Hubbard Brook*** – Windsor.

7. **Consider Outstanding Water Resources designation for the following streams due to their high-quality habitat, cold-water refugia, and very good and/or exceptional wild trout populations.** Very good wild trout populations are defined as supporting multiple age classes of one or more species of wild trout (Brook, Brown, Rainbow trout) at levels generally equal to or greater than 1,000 fish per mile and/or 200 fish greater than 6 inches per mile and/or 20 pounds per acre. Exceptional wild trout populations are defined as supporting multiple age classes of one or more species of wild trout (Brook, Brown, Rainbow trout) at levels generally equal to or greater than 3,000 fish per mile and/or 400 fish greater than 6 inches per mile and/or 40 pounds per acre.
    - Jewell Brook
    - Grant Brook
    - Sanders Brook
    - Hubbard Brook
    - Patch Brook
    - Branch Brook

Sincerely,

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Table 1. Expected change mainstem Black River temperature downstream of four assessed tributaries at four temperature differences between the tributary and the Black River. The expected changes are calculated using a mass balance equation approach that uses the estimated flow (cubic feet per second (CFS)) at the assumed aquatic baseflow (ABF, 0.5 CSM) of the Black River upstream (US) of each tributary and of the tributaries themselves (Simard 2019).

	Drainage Area (mi^2)		CFS at ABF		% Increase in ABF from	Change in mainstem temperature (°F) when tributary is X°F cooler			
Location	**US**	**Tributary**	**US**	**Tributary**	**Tributary**	**2**	**5**	**10**	**20**
Patch Brook	26.8	5.7	13.4	2.9	21.4	-0.35	-0.88	-1.76	-3.52
Branch Brook	39	16.1	19.5	8.1	41.3	-0.58	-1.46	-2.92	-5.84
Jewell Brook	58.1	9.4	29.1	4.7	16.1	-0.28	-0.70	-1.39	-2.78
Twenty Mile Stream	84.3	14.9	42.2	7.5	17.7	-0.30	-0.75	-1.50	-3.00

Table 2. Estimates of trout populations in the Black River watershed from VFWD electrofishing surveys conducted within the last 10 years. **Bold** indicates surveys that showed very good wild trout densities of 1000 trout per mile and/or 200 trout >6in per mile. An * indicates surveys that showed exceptional wild trout densities of 3000 trout per mile and/or 400 trout >6in per mile.

Site Name	Year Sampled	Total Trout per mile	Brook Trout per mile				Brown Trout per mile			
			Total	YOY	YOY-6 in	>6 in	Total	YOY	YOY-6 in	>6 in
Tinker2203	**2017**	1139	1139	166	952	21				
GreatRoaring1276	**2016**	1386	1386	969	380	38				
Patch1476	**2016**	1188	1188	502	581	106				
Patch1240	**2016**	1619	1619	598	872	149				
	2022	935	935	800	86	49				
BranchBrook1620	**2016**	1045	1045	248	688	110				
Unnamed1740	**2016**	2112	2112	1267	792	53				
Jewell2239	**2016**	1056	1056	739	317	0				
Unnamed1646	2016	898	898	264	634	0				
Grant1850	**2016**	1742	1742	370	1373	0				
Grant1410	**2022***	5570	3899	2517	1225	156	1671	1604	0	67

Sanders1260	**2022***	3013	2578	1770	745	62	435	373	62	0
Jewell943	**2013***	2851	1214	915	211	88	1637	1214	370	53
	2014*	2094	1021	686	246	88	1074	757	246	70
	2015*	5755	2288	1778	387	123	3467	3326	70	70
	2016	1795	1056	387	528	141	739	158	528	53
	2017*	5069	1091	774	88	229	3978	3872	88	18
	2018	2834	546	299	194	53	2288	1725	458	106
	2019*	3682	471	328	86	57	3211	2783	328	100
	2020*	5773	704	352	194	158	5069	4259	510	299
	2021*	4734	757	458	246	53	3978	3027	493	458
	2022*	7603	933	669	246	18	6670	5597	704	370
Twentymile1336	**2016**	2095	2095	1135	807	153				
	2022	2821	2821	2479	262	81				
NorthBranch Black1081	2016	277	277	173	35	69				
NorthBranch Black665	2013	145	40	26	0	13	106	106	0	0
	2014	1016	79	79	0	0	937	871	0	66
	2015	383	40	26	0	13	343	330	0	13
	2016	211	79	0	13	66	132	0	13	119
	2017	198	119	119	0	0	79	0	0	79
	2018	158	40	0	13	26	119	79	0	40
	2019	145	92	79	13	0	53	26	13	13
	2020	515	26	26	0	0	488	475	0	13
	2021	172	106	13	53	40	66	0	0	66
	2022	805	119	119	0	0	686	647	0	40
Knapp890	2022	976	976	727	115	134				
Sherman783	**2013**	827	827	122	438	268				
Sherman763	**2016**	2504	2504	1710	669	124	*Upstream of 131 Culvert*			
Sherman762	**2016**	1584	1584	343	924	317	*Downstream of 131 Culvert*			
Baltimore522	2017	716	716	655	20	41				

Table 3. Minimum lengths for six size categories used for population index calculations for Largemouth and Smallmouth Bass. Sizes are presented in millimeters with approximate inches in parentheses.

Species	Stock	Quality	Preferred	Memorable	Trophy	Legal
Largemouth Bass	200 (8)	300 (12)	380 (15)	510 (20)	630 (25)	254 (10)
Smallmouth Bass	180 (7)	280 (11)	350 (14)	430 (17)	510 (20)	254 (10)

Table 4. Estimates of trout populations in Mill Brook (South of Mount Ascutney) and its tributaries from VFWD electrofishing surveys conducted within the last 10 years. Bold indicates surveys that showed very good wild trout densities of 1000 trout per mile and/or 200 trout >6in per mile. An * indicates surveys that showed exceptional wild trout densities of 3000 trout per mile and/or 400 trout >6in per mile.

Site Name	Year Sampled	Total Trout per mile	Brook Trout per mile				Brown Trout per mile			
			Total	YOY	YOY-6 in	>6 in	Total	YOY	YOY-6 in	>6 in
Bailey1048	2013	391	147	122	12	12	244	122	73	49
	2014	293	196	159	12	24	98	12	24	61
	2015	636	367	293	12	61	269	244	0	24
	2016	587	306	171	98	37	281	257	12	12
	2017	183	110	86	12	12	73	12	12	49
	2018	232	159	86	12	61	73	73	0	0
	2019	330	196	24	110	61	134	73	24	37
	2020	660	416	354	37	24	244	208	0	37
	2021	281	183	37	49	98	98	0	37	61
	2022	794	562	477	37	49	232	208	0	24
Mill810	2013	437	60	30	0	30	377	272	15	91
	2014	573	302	272	15	15	272	151	0	121
	2015	317	287	211	15	60	30	0	0	30
	2016	256	121	0	45	75	136	75	0	60
	2017	151	106	91	0	15	45	0	0	45
	2018	498	75	60	0	15	422	407	0	15
Mill488	**2016**	1309	1309	612	697	0				
Mill323	2016	986	704	123	563	18				

Table 5. Estimates of trout populations in Hubbard Brook (Connecticut River Tributary) from VFWD electrofishing surveys conducted in 2016 and 2018. Bold indicates surveys that showed very good wild trout densities of 1000 trout per mile and/or 200 trout >6in per mile. An * indicates surveys that showed exceptional wild trout densities of 3000 trout per mile and/or 400 trout >6in per mile.

Site Name	Year Sampled	Total Trout per mile	Brook Trout per mile				Brown Trout per mile			
			Total	YOY	YOY-6 in	>6 in	Total	YOY	YOY-6 in	>6 in
HubbardUnk863	2016	864	864	144	624	96				
	2018	1140	1140	917	174	50				
HubbardUnk862	2016	898	898	422	370	106				
HubbardPrison839	2018	440	440	342	24	73				
HubbardPrison790	**2016***	7260	7260	660	5940	660				
Hubbard720	**2016**	1502	1502	117	1197	188				

Table 6. Estimates of trout populations in Lulls Brook and its tributaries from VFWD electrofishing surveys conducted within the last 10 years. Bold indicates surveys that showed very good wild trout densities of 1000 trout per mile and/or 200 trout >6in per mile. An * indicates surveys that showed exceptional wild trout densities of 3000 trout per mile and/or 400 trout >6in per mile.

Site Name	Year Sampled	Total Trout per mile	Brook Trout per mile				Brown Trout per mile			
			Total	YOY	YOY-6 in	>6 in	Total	YOY	YOY-6 in	>6 in
Lulls1151	**2016**	1252	1252	540	614	98				
DensmoreHill890	**2016**	1505	1505	739	713	53				
Cady900	**2016**	2614	2614	1927	634	53				
Weed770	**2016**	1346	1346	554	766	26				
Lulls575	2013	211	211	145	26	40				
	2014	516	516	399	82	35				
	2015	1214	1214	1069	0	145				
	2016	342	342	171	76	95				
	2017	496	496	381	57	57				
	2018	929	929	856	0	73				
	2019	570	570	323	76	171				
	2020	817	817	779	19	19				
	2021	182	182	82	50	50				
	2022	570	570	494	0	76				

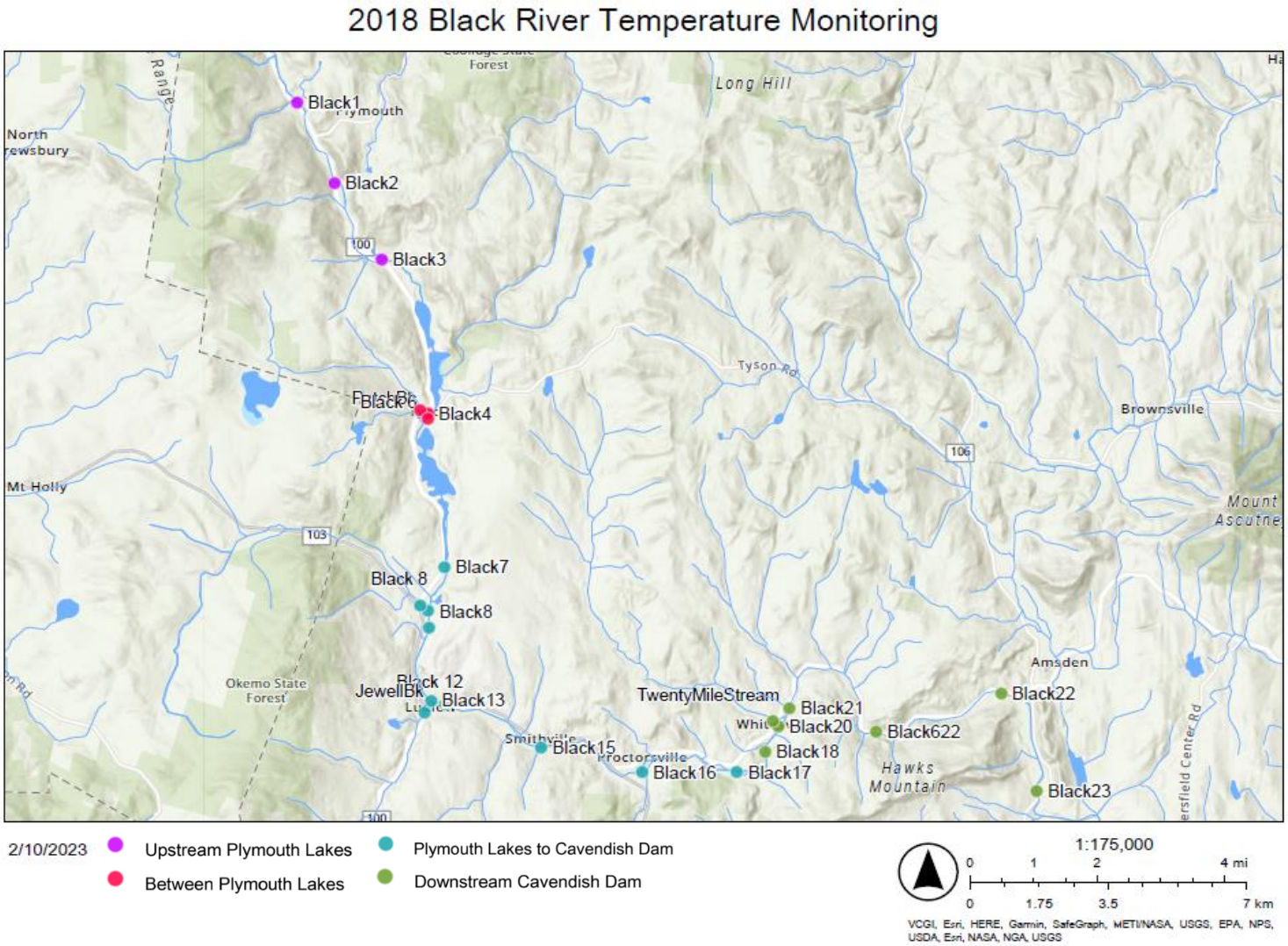

Figure 1. Distribution of water temperature monitoring station in the mainstem Black River, Patch Brook, Branch Brook, Jewell Brook, and Twenty Mile Stream in 2018.

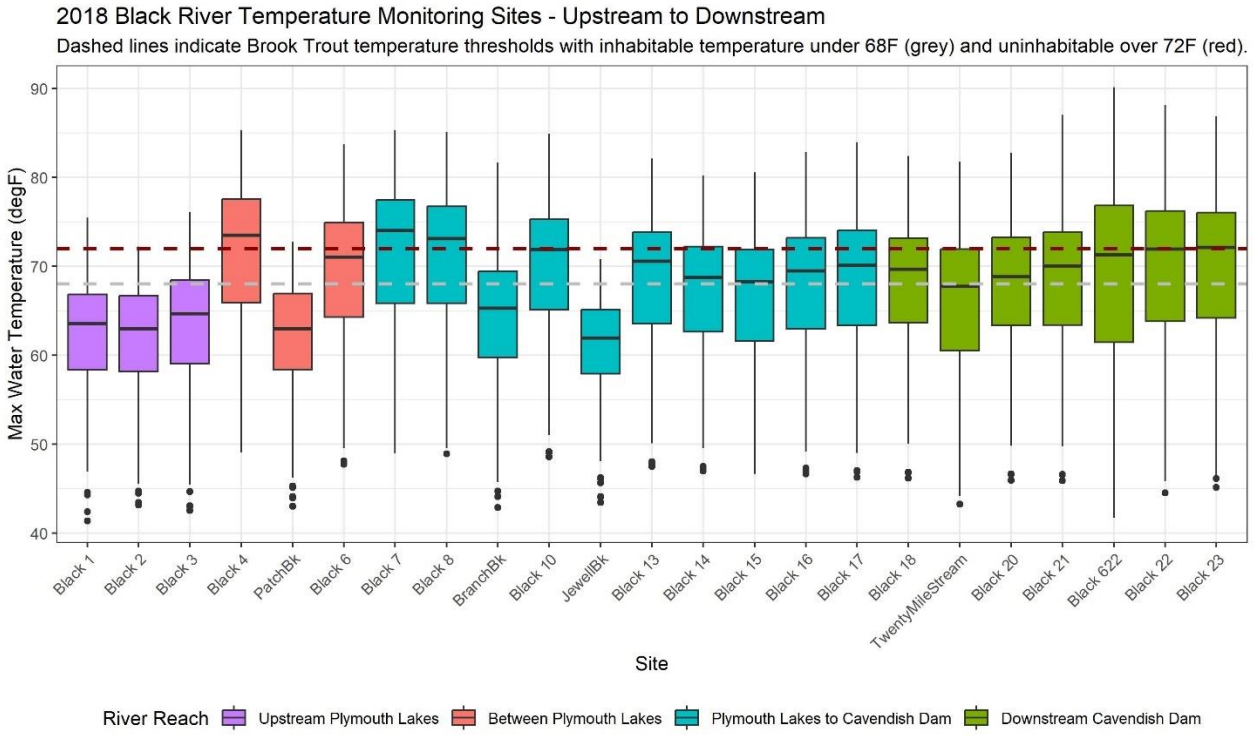

Figure 2. Boxplot comparison of maximum daily water temperature recorded at each site between May 18 and October 23, 2018. Boxes indicates first (lower) quartile, median, third (upper) quartile maximum daily water temperature, and whiskers indicate minimum and maximum recorded values. Dashed lines indicate Brook Trout temperature tolerance thresholds with grey line indicating tolerable water temperatures and red line indicating water temperatures at which fish experience thermal stress and mortality.

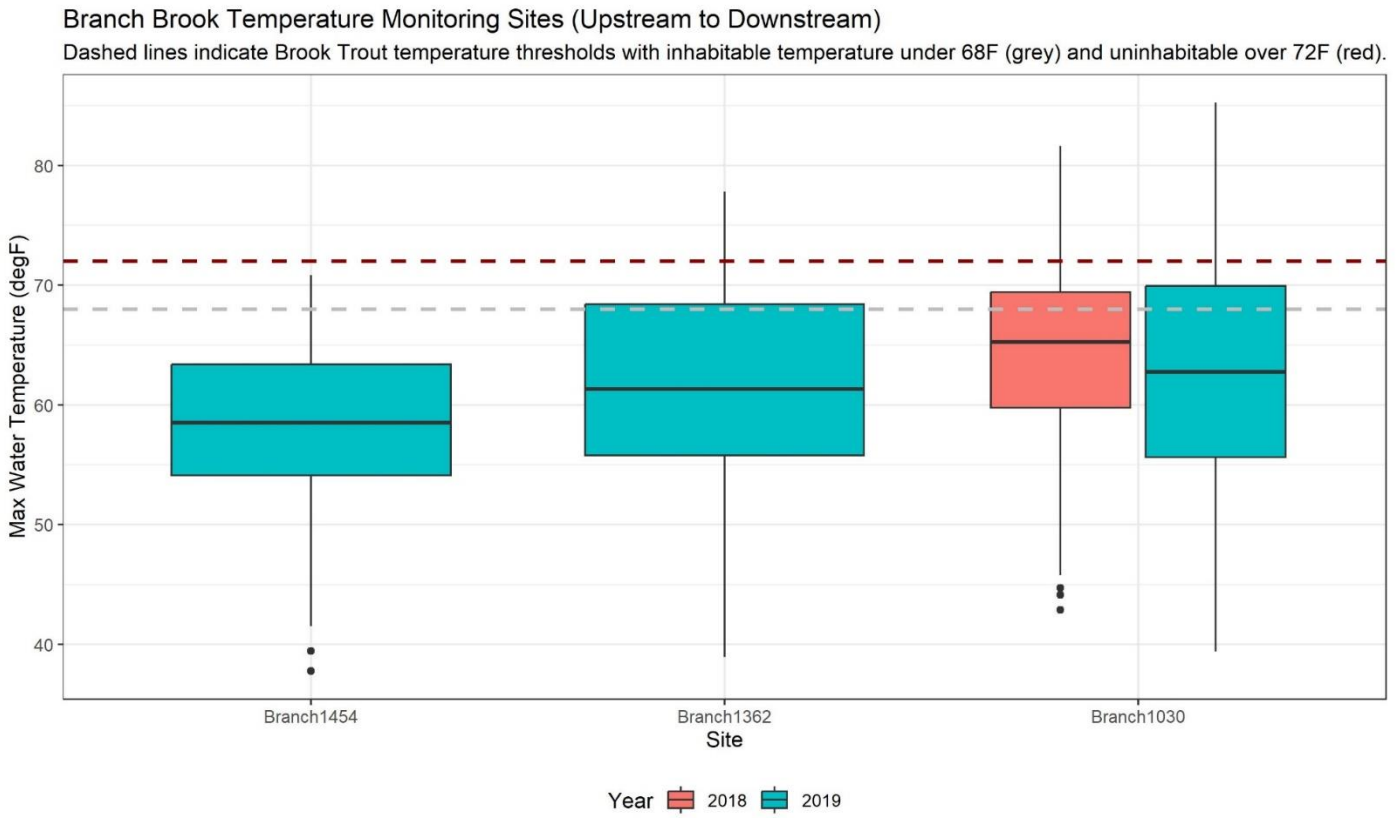

Figure 3. Boxplot comparison of maximum daily water temperature recorded at three elevations in Branch Brook in 2018 and 2019. Boxes indicates first (lower) quartile, median, third (upper) quartile maximum daily water temperature, and whiskers indicate minimum and maximum recorded values. Dashed lines indicate Brook Trout temperature tolerance thresholds with grey line indicating tolerable water temperatures and red line indicating water temperatures at which fish experience thermal stress and mortality.

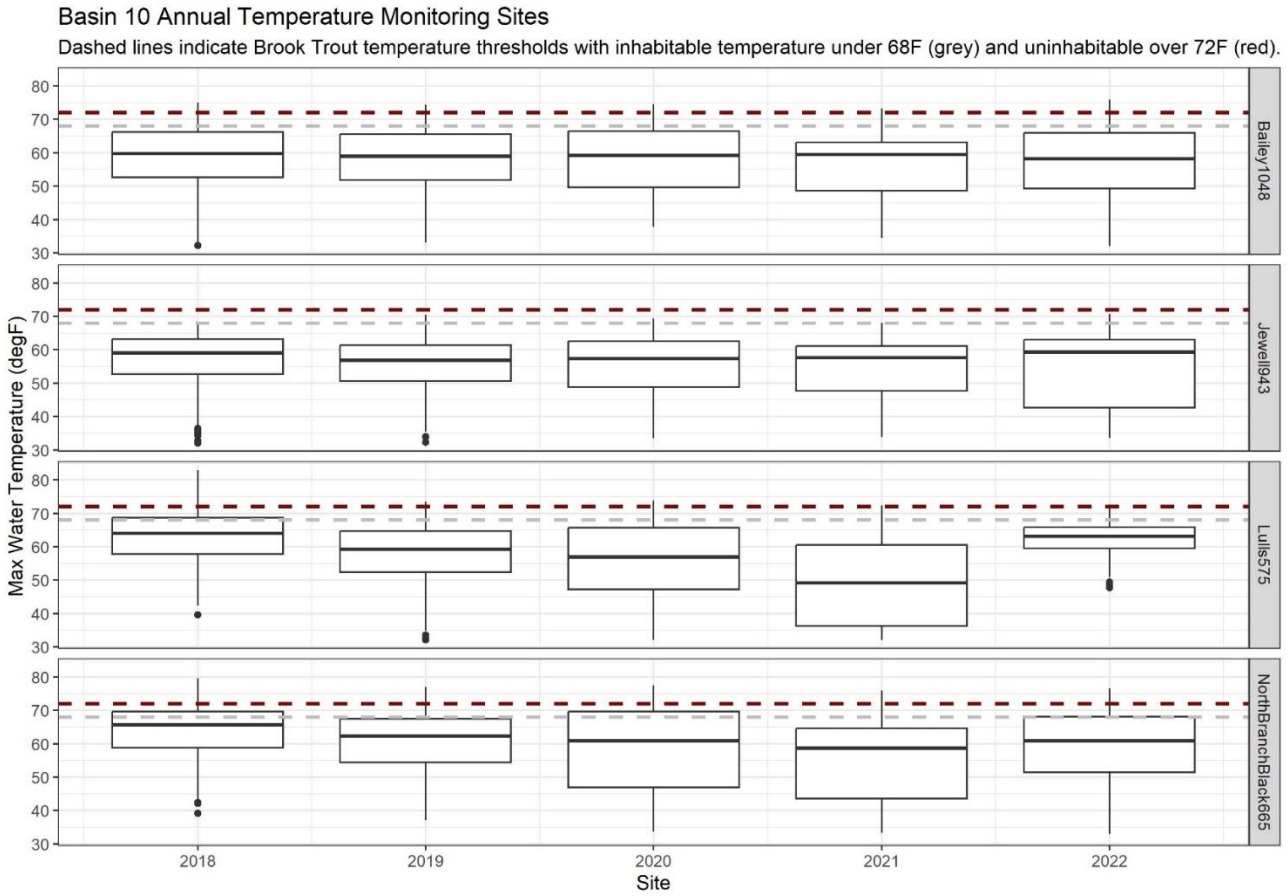

Figure 4 . Boxplot comparison of maximum daily water temperature recorded at 4 annual temperature monitoring sites with Basin 10 from 2018 to 2022. Boxes indicates first (lower) quartile, median, third (upper) quartile maximum daily water temperature, and whiskers indicate minimum and maximum recorded values. Dashed lines indicate Brook Trout temperature tolerance thresholds with grey line indicating tolerable water temperatures and red line indicating water temperatures at which fish experience thermal stress and mortality.

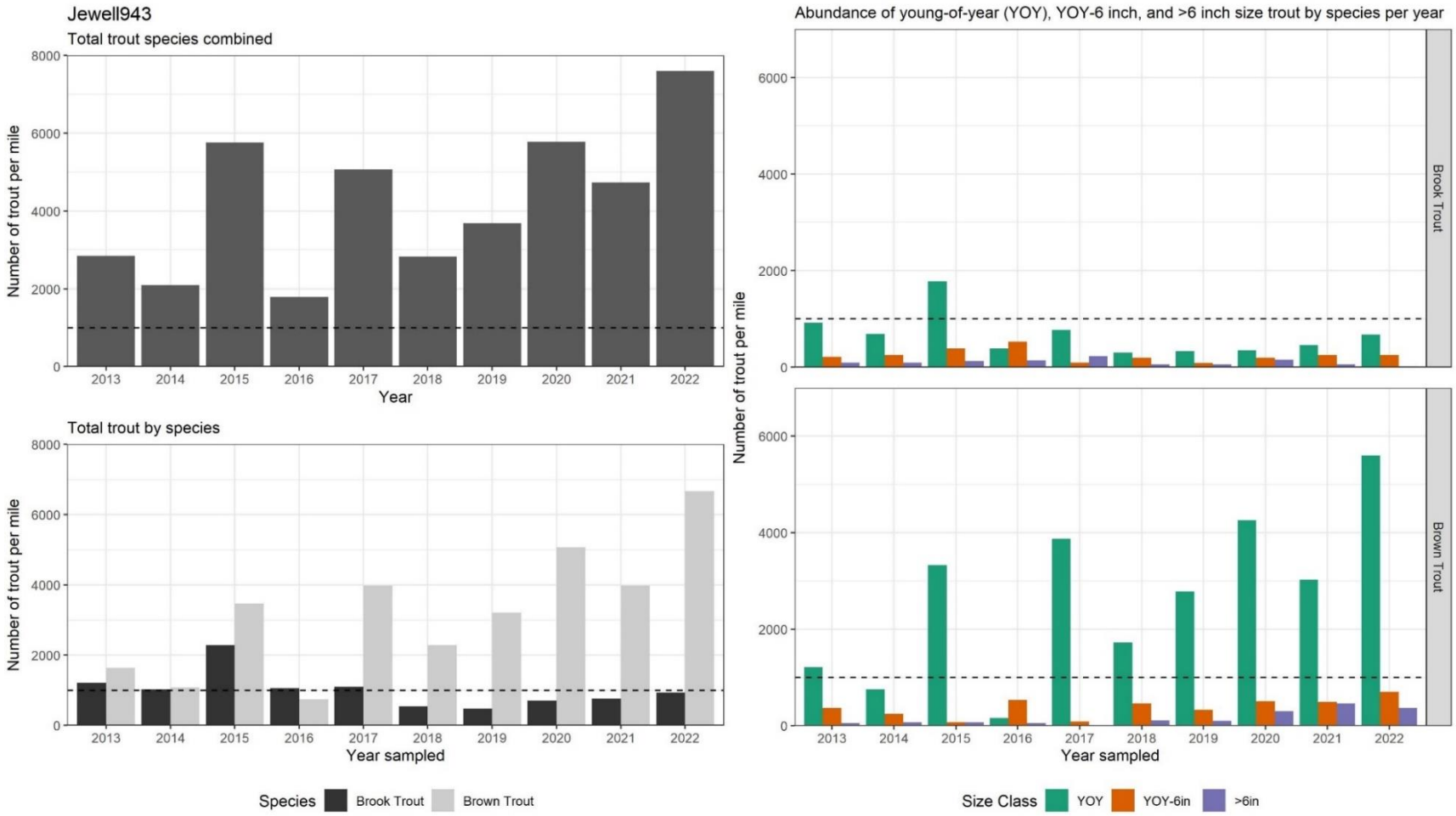

Figure 5. Trends in trout population abundance in Jewell Brook at elevation 943 by year as total fish per mile. Abundances are shown by species and size class (young of the year (YOY), YOY-6inches, and fish greater than 6 inches). Dotted line shows 1000 fish per mile threshold indicative of very good population abundance.

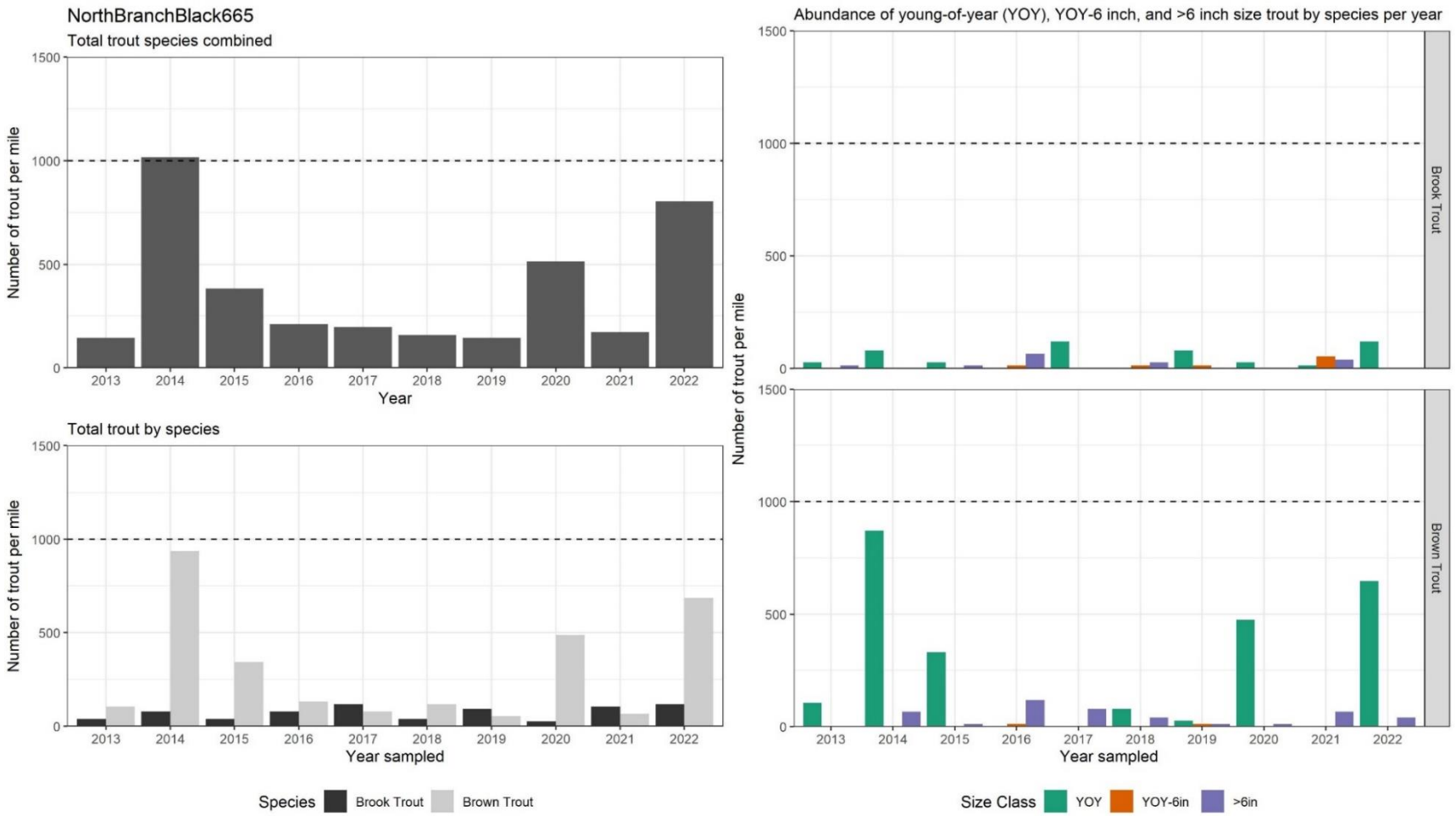

Figure 6. Trends in trout population abundance in the North Branch of the Black River at elevation 665 by year as total fish per mile. Abundances are shown by species and size class (young of the year (YOY), YOY-6inches, and fish greater than 6 inches). Dotted line shows 1000 fish per mile threshold indicative of very good population abundance.

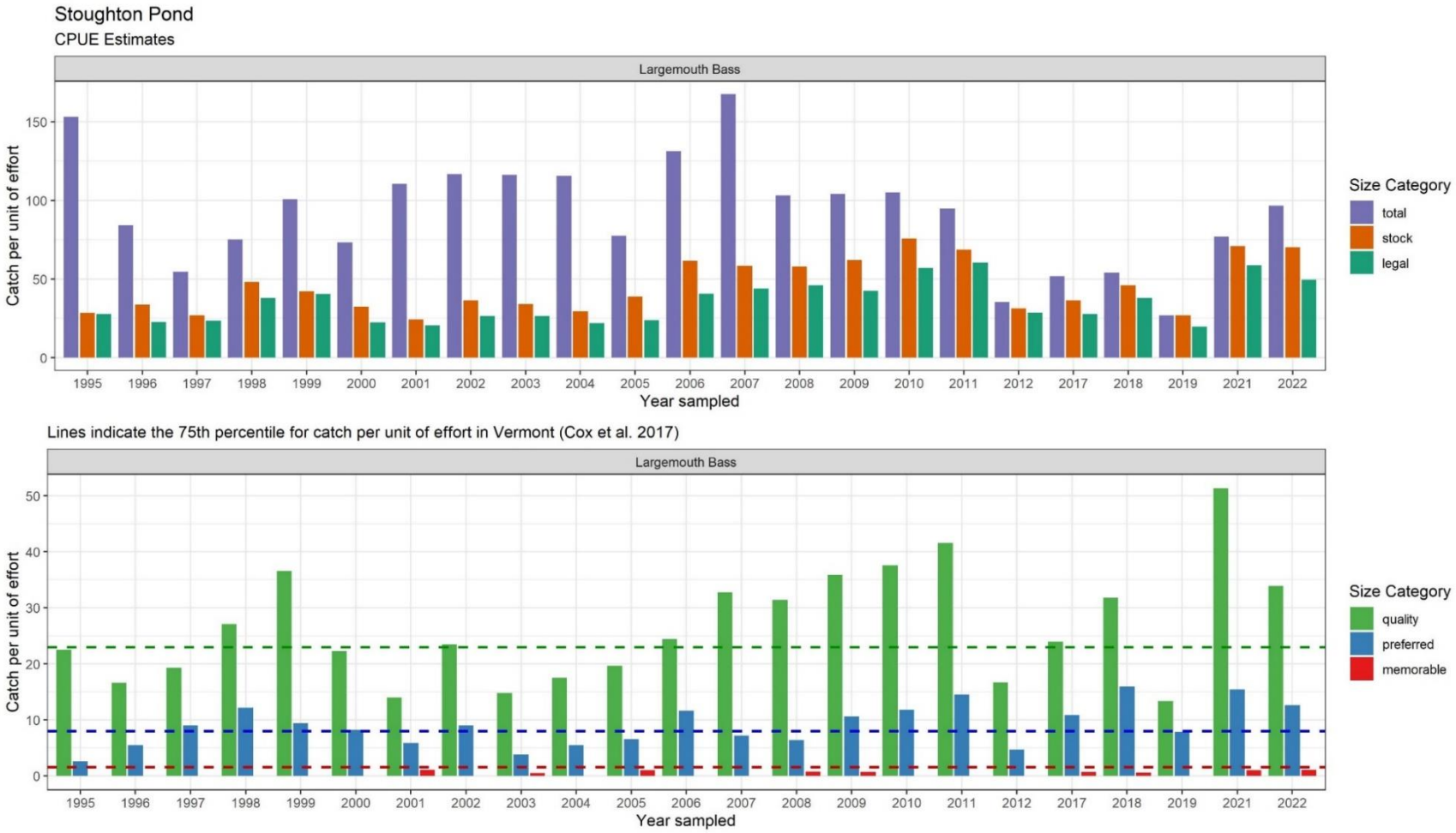

Figure 7. Trends in Largemouth Bass electrofishing catch rates as catch per unit of effort, CPUE in Stoughton Pond. The VT 75the percentile was calculated from a total of 557 sampling events in Vermont from 1988 to 2015 (Cox et al. 2017).

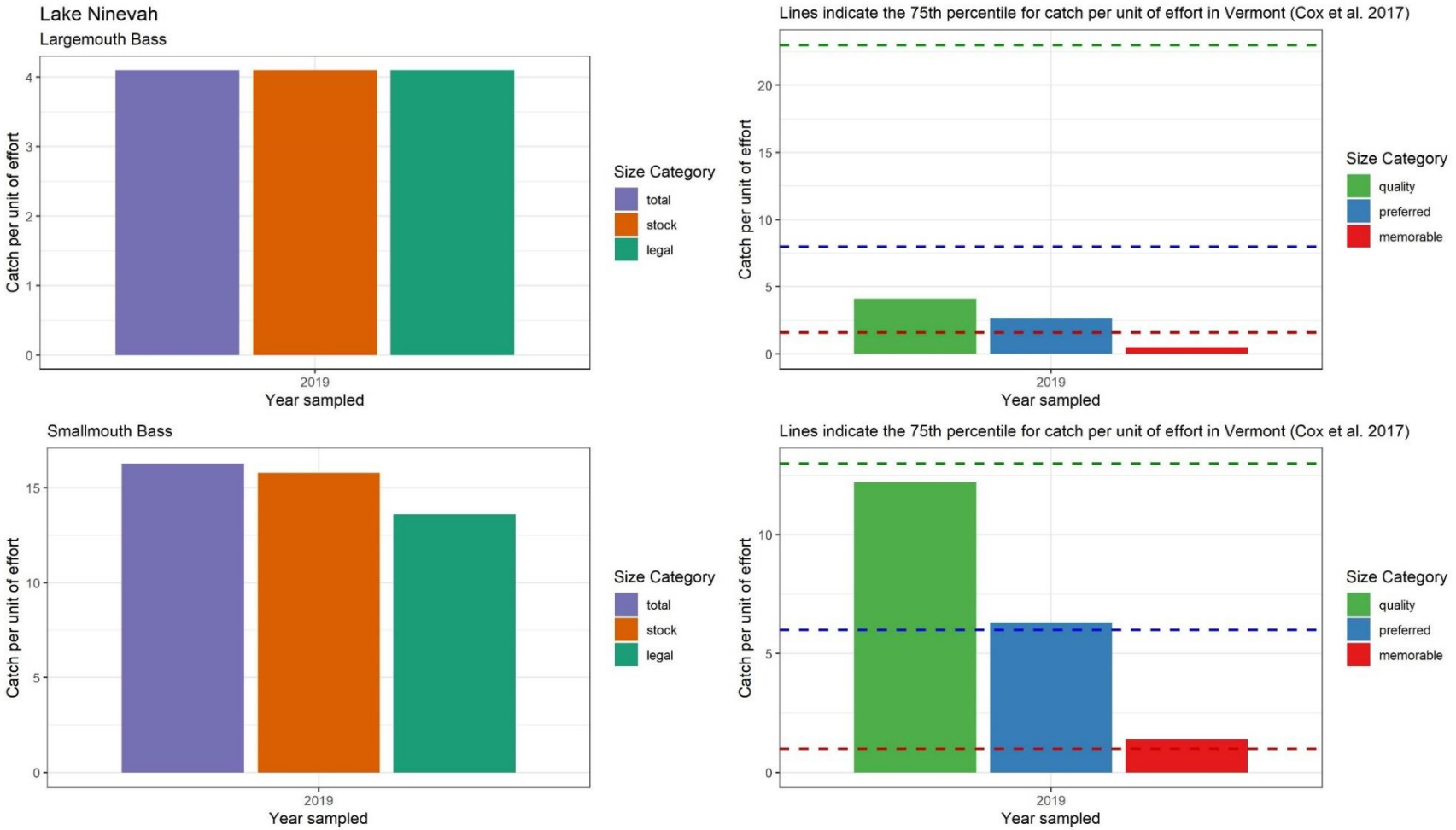

Figure 8. Largemouth Bass electrofishing catch rates as catch per unit of effort, CPUE in Lake Ninevah. The VT 75the percentile was calculated from a total of 557 sampling events in Vermont from 1988 to 2015 (Cox et al. 2017).

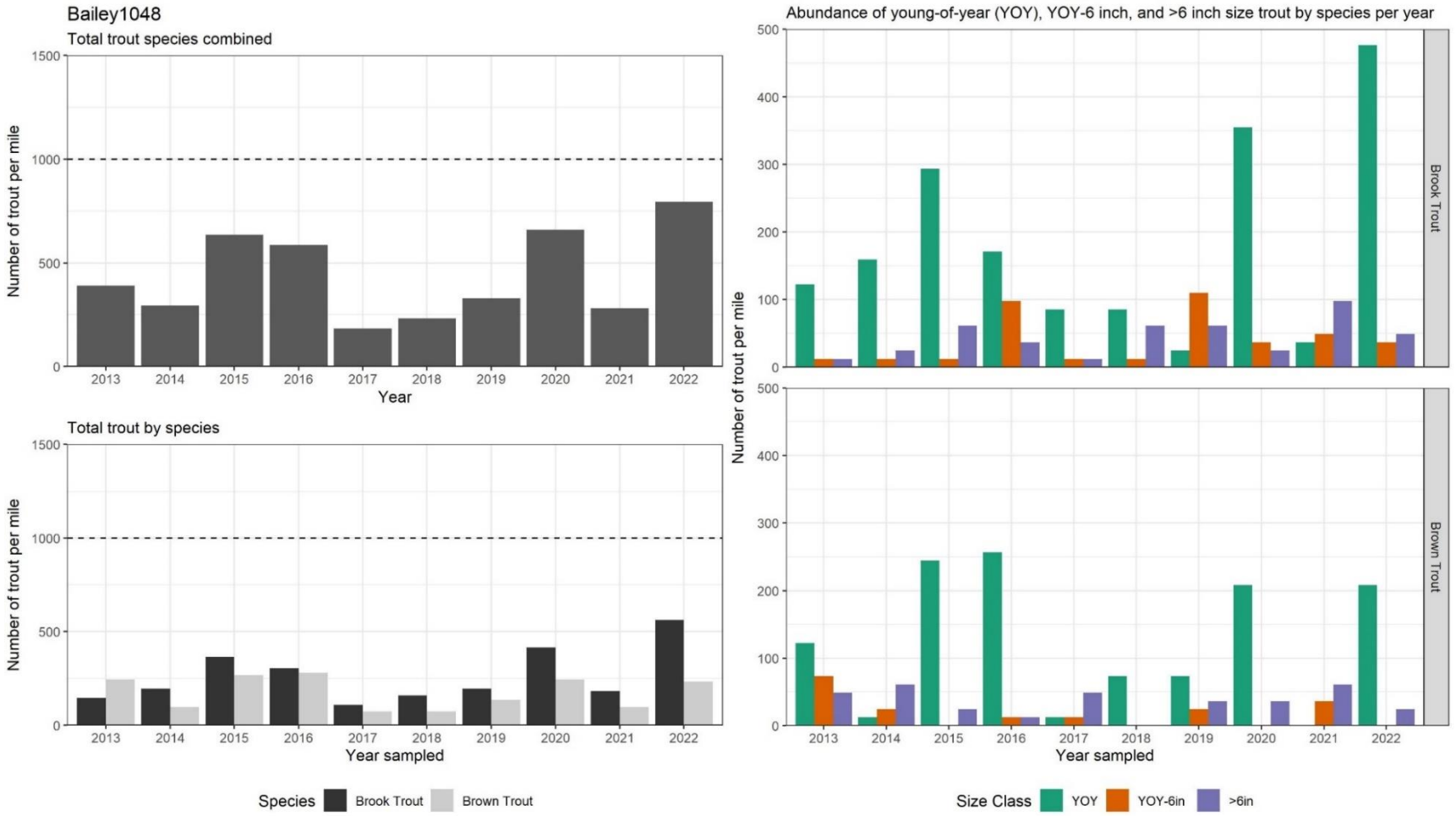

Figure 9. Trends in trout population abundance in Bailey Mill Brook at elevation 1048 by year as total fish per mile. Abundances are shown by species and size class (young of the year (YOY), YOY-6inches, and fish greater than 6 inches). Dotted line shows 1000 fish per mile threshold indicative of very good population abundance.

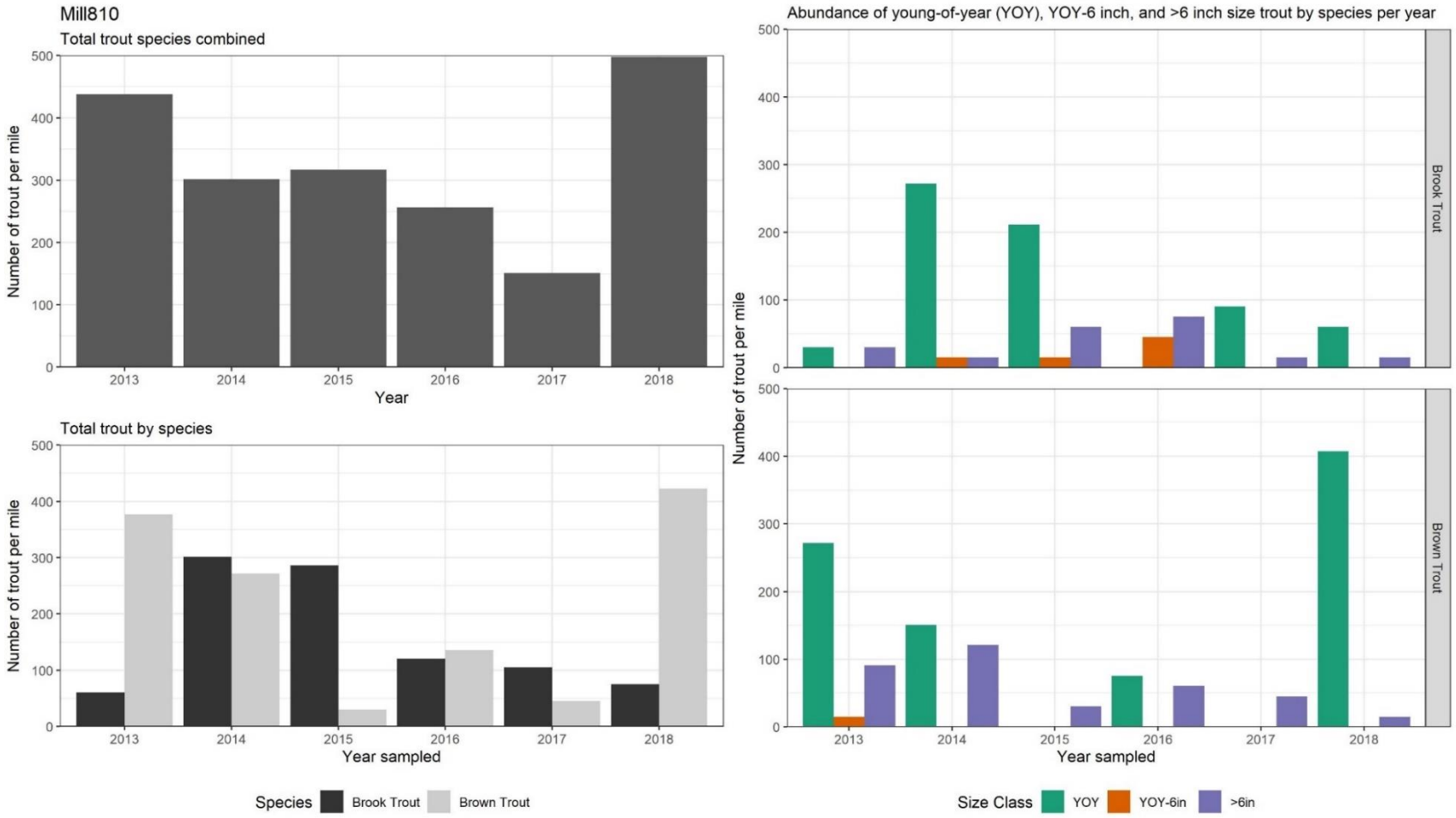

Figure 10. Trends in trout population abundance in Mill Brook at elevation 810 by year as total fish per mile. Abundances are shown by species and size class (young of the year (YOY), YOY-6inches, and fish greater than 6 inches). Dotted line shows 1000 fish per mile threshold indicative of very good population abundance.

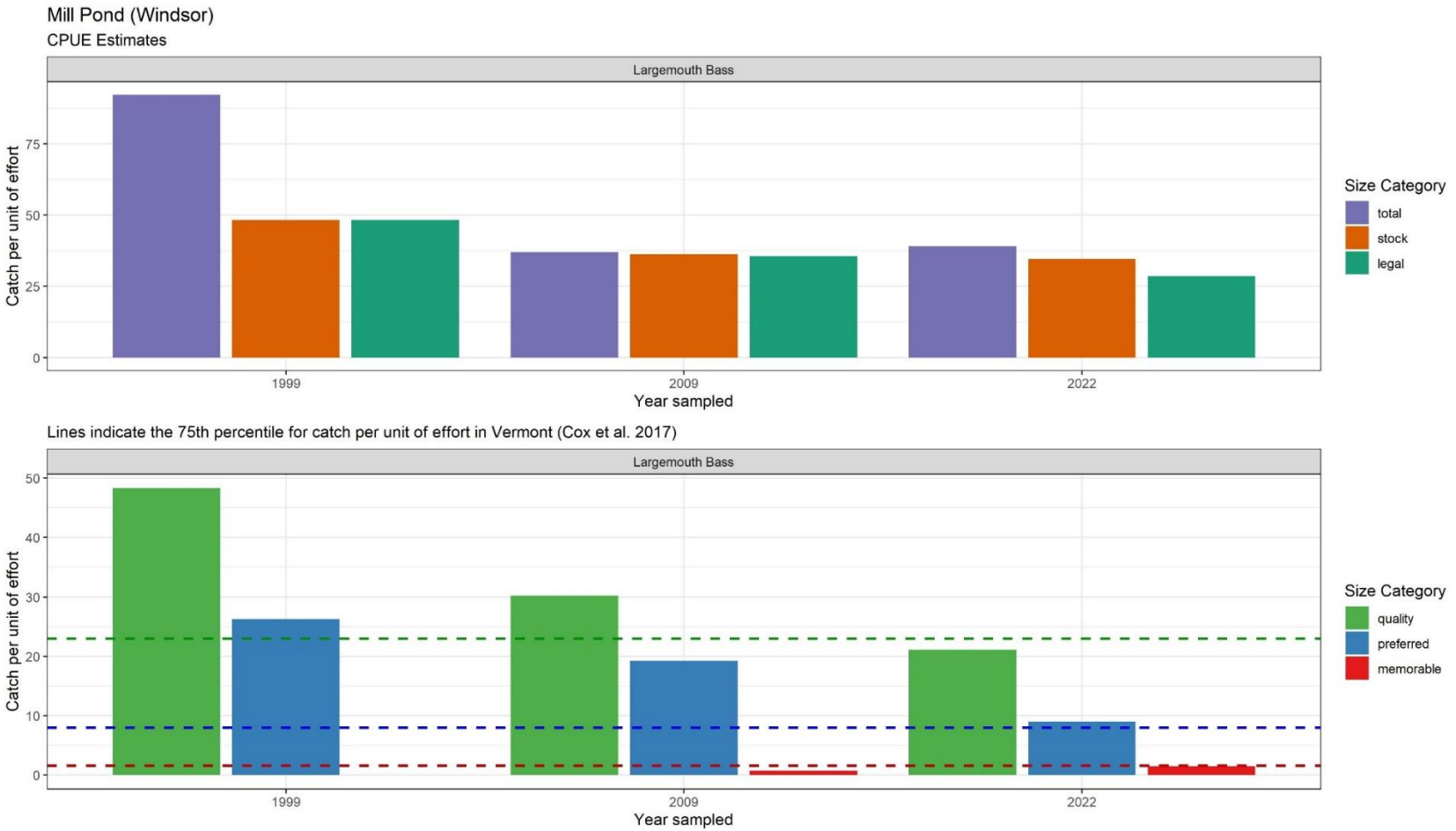

Figure 11. Trends in Largemouth Bass electrofishing catch rates as catch per unit of effort, CPUE in Mill Pond, Windsor. The VT 75the percentile was calculated from a total of 557 sampling events in Vermont from 1988 to 2015 (Cox et al. 2017).

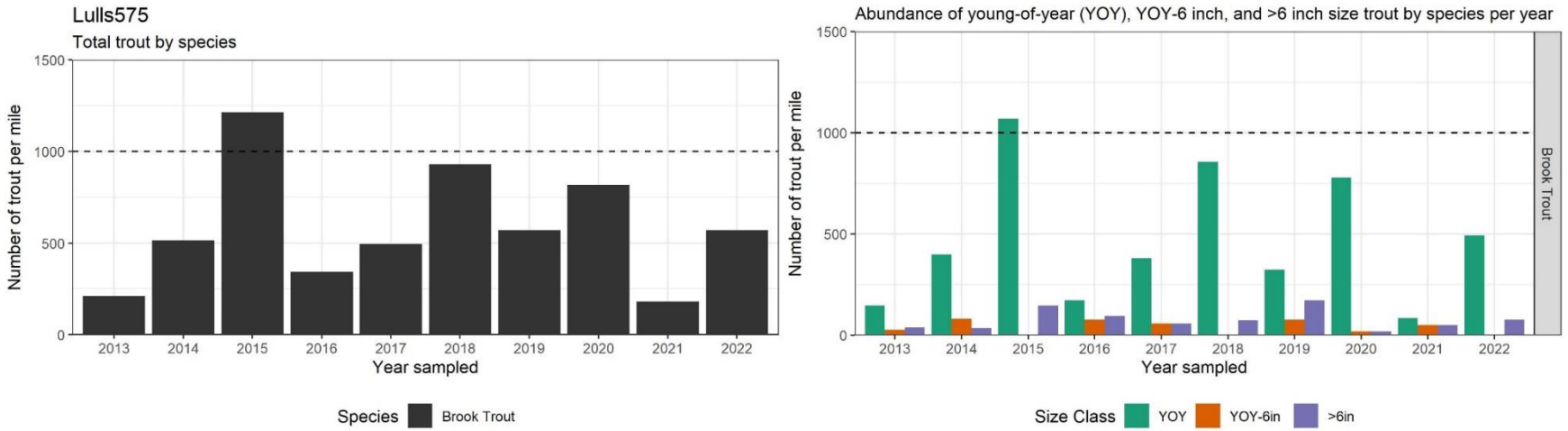

Figure 12. Trends in trout population abundance in Lulls Brook at elevation 575 by year as total fish per mile. Abundances are shown by species and size class (young of the year (YOY), YOY-6inches, and fish greater than 6 inches). Dotted line shows 1000 fish per mile threshold indicative of very good population abundance.

Appendix D. Municipal Planning and Water Resources Matrix

Table D.1. Municipal Protections Matrix

TOWN	FLOOD REGULATIONS	FLOODWAY CONDITIONS	SPECIAL FLOOD HAZARD AREA CONDITIONS	FLOOD REGULATIONS LAST UPDATED	NFIP	COMP. STORAGE
Baltimore	Flood Hazard Area Regulations	No FEMA identified Special Flood Hazard Area within town.	No FEMA identified Special Flood Hazard Area within town. Locally designated areas.	2009	Yes	
Barnard	Unified Zoning and Subdivision: Flood Hazard Overlay District	Encroachments and development prohibited	New development, new fill, and storage prohibited. Non-substantial improvements allowed.	2012	Yes	No
Bridgewater	Flood Hazard Area Regulations	Development prohibited, and only minor improvements allowed	New development and substantial improvements must elevate lowest floor 1 ft above BFE. All development shall be reasonably safe from flooding: designed and anchored to prevent flotation, collapse, release, and movement of the structure; constructed with materials resistant to flood damage; construction methods that minimize flood damage; and service facilities located in areas to prevent water from entering.	2006	Yes	No
Cavendish	Flood Hazard Area Regulations	Encroachments and development prohibited. Improvements within existing footprint allowed. Functionally dependent buildings allowed.	New construction and substantial improvement 1' above BFE.	2007	Yes	

TOWN	FLOOD RESILIENCY ELEMENT	NO ADVERSE IMPACT (NAI) STANDARD	RIVER CORRIDOR PROTECTION	ROAD AND BRIDGE STANDARDS	LOCAL HAZARD MITIGATION PLAN	LHMP EXPIRATION DATE	LEOP	ERAF RATE (%)
Baltimore	Yes	No	Interim	Yes	Yes	9/12/2023	Yes	17.5
Barnard	Yes		No	Yes	No	Expired	Yes	7.5
Bridgewater	No		No	Yes	Yes	11/18/2025	Yes	7.5
Cavendish	Yes	No	Yes	Yes	Yes	5/4/2022	No	7.5

TOWN	STEEP SLOPE/RIDGELINE DEVELOPMENT	STORMWATER/LID REQUIREMENTS
Baltimore	No adverse impact under Conditional Use Review. Subdivision standards say…"shall not ordinarily be subdivided."	Section 7.7 enables the PC to require stormwater management plans, sediment/erosion control plans. Section 7.9 requires that subdivisions be designed to minimize grading, cut and fill, to retain, insofar as possible, the natural contours, limit stormwater runoff, and conserve the natural cover and soil
Barnard	Town Plan includes an objective to "protect steep slopes and ridgelines from inappropriately sited development," a goal to "ensure slopes greater than 25 degrees should remain predominantly in forest cover," "development in these areas should be permitted only if it can be demonstrated that it will have safe access and not be detrimental to the environment," and a recommendation that "future revisions to the Zoning Bylaw should consider using elevation in restricting development." The Zoning Bylaw prohibits digging or creating pits on steep slopes, it says that "disturbance of steep slopes greater than 25% shall be minimized," and it requires subdivisions on slopes greater than 25% to require a licensed professional engineer to certify that they do not pose a landslide or erosion risk.	Subdivisions standards state that stormwater shall be handled by an erosion control plan prepared by a licensed professional engineer for control of erosion, sediment, and runoff during and following development. Conditional use development standards require stormwater and erosion control and state that drainage must control stormwater runoff, prevent erosion, and protect neighboring land and roads from undue impacts. No increase is allowed in off-site stormwater runoff in terms of volume or peak discharge.
Bridgewater	One of the Town Plan objectives is "to protect steep slopes, soils, forests, water, and other natural resources and provide open spaces for wildlife and habitat." Steep slopes are considered a Critical Natural Area of the Town, and policies in the Plan state that steep slopes should remain predominantly in forest cover, that development of steep slopes should be considered carefully in order that it not be detrimental to the environment, and land above 2,500 feet should be maintained predominantly in a natural wilderness state. As a portion of the Rural Area land use section, the plan includes slopes greater than 15% as low density areas.	None
Cavendish	No zoning	No zoning

TOWN	FLOOD REGULATIONS	FLOODWAY CONDITIONS	SPECIAL FLOOD HAZARD AREA CONDITIONS	FLOOD REGULATIONS LAST UPDATED	NFIP	COMP. STORAGE
Hartford	Flood Hazard Area Regulations	Development prohibited.	New development and substantial improvements must elevate lowest floor 1 ft above BFE. All development shall be reasonably safe from flooding: designed and anchored to prevent flotation, collapse, and movement of the structure; constructed with materials resistant to flood damage; construction methods that minimize flood damage; and service facilities located in areas to prevent water from entering.	2007	Yes	No
Hartland	Flood Hazard Area Regulations	No fill, storage areas, and new development prohibited	New development and substantial improvements must elevate lowest floor 1 ft above BFE. All development shall be reasonably safe from flooding: designed, operated, and anchored to prevent flotation, collapse, release, and movement of structure, chemicals, or hazardous materials; constructed with materials resistant to flood damage; construction methods that minimize flood damage; service facilities located in areas to prevent water from entering; and located so as to minimize conflict with floodwaters and natural channel movement.	2007	Yes	No
Ludlow	Flood Hazard Area Regulations (includes Local Flood Hazard Areas)	New Development is prohibited in the Floodway. Substantial improvements require conditional use review.	New structures and substantial improvements require conditional use review. 1' of BFE. Establishes small stream setbacks for named streams.	2014	Yes	
Plymouth	Zoning Ordinance: Flood Hazard Protection Overlay	Development prohibited, and only improvements to existing structures allowed.	Includes the River Corridor: new principal structures and new net fill are prohibited.	2013	Yes	No

TOWN	FLOOD RESILIENCY ELEMENT	NO ADVERSE IMPACT (NAI) STANDARD	RIVER CORRIDOR PROTECTION	ROAD AND BRIDGE STANDARDS	LOCAL HAZARD MITIGATION PLAN	LHMP EXPIRATION DATE	LEOP	ERAF RATE (%)
Hartford	Yes		No	Yes	No	Expired	Yes	7.5
Hartland	Yes		No	Yes	Yes	12/1/2025	Yes	7.5
Ludlow	Yes	No	No	Yes	Yes	12/14/2023	Yes	12.5
Plymouth	No		Yes	Yes	No	Expired	Yes	12.5

TOWN	STEEP SLOPE/RIDGELINE DEVELOPMENT	STORMWATER/LID REQUIREMENTS
Hartford	Hartford's Zoning Ordinance contains the Rural Lands, Agricultural Lands, and Wildlife Connector Overlay District which state that development should be located down-slope of ridgelines and prominent hills in areas where ridgelines and hillsides are easily visible from existing roadways, and development shall be considered relative to the availability of less visible locations on-site.	Hartford's Zoning Regulations require a conditional use permit which will be issued given that a proposed project disturbs the least possible riparian vegetation, erosion and sediment control methods are followed, and development manages and treats stormwater runoff to filter pollutants. Specific applications for development must include a description of the practices that will be used to protect water quality of stormwater runoff and an erosion control plan. Hartford's subdivision regulations require: a project provide an adequate stormwater drainage system with culverts and drainage areas that accommodate runoff from the development's upstream drainage area or a 25 year storm event (a 4% chance of occurring annually); a project expose the smallest possible area possible at any one time during development; land should not be left exposed during winter months; temporary vegetation or mulching and structural measures may be required to protect exposed areas; sediment basins shall be installed and maintained to remove sediment from entering runoff; 4 inches of topsoil shall be provided to cover all finished slopes; and embankments are to be planted with stabilizing ground cover and seeded with grass to prevent erosion.

TOWN	STEEP SLOPE/RIDGELINE DEVELOPMENT	STORMWATER/LID REQUIREMENTS
Hartland	Hartland's Town Plan includes a policy to prohibit development on slopes steeper than 25% unless development will not be harmful to the environment or health of the community. A second policy states that development on slopes from 15-25% require special provisions to make sure they do not result in erosion or sedimentation	Hartland's Town Plan includes recommendations that development proposals should be designed to minimize the amount of impermeable surfaces and provide for on-site stormwater treatment to enable groundwater recharge, and that the Town of Hartland will continue to participate in Act 250 and other State permit application reviews to ensure that approvals are conditioned on proper water quality protection safeguards. This will include locating activities and structures at least a 50 foot buffer from surface waters, with a larger setback distance in areas of steep slope or highly erodible soils; requirements for a detailed erosion and sedimentation control plan demonstrating proper controls during and after construction; a detailed stormwater management plan with appropriate stormwater treatment; and other recommended land use management practices.
Ludlow	Section 490 Ridgeline Protection Overlay District	Stormwater management/erosion control plans may be required for projects subject to the ridgeline overlay provisions
Plymouth	Plymouth's Town Plan identifies areas of high elevation above 2,500 feet and steep slopes greater than 15% as Significant Natural and Fragile Areas. It contains a policy to "protect steep slopes and ridgelines from inappropriately sited development" and a recommendation that steep slopes shall remain predominantly forest cover and development will be allowed only if it can be demonstrated that it will not be detrimental to the environment. The Town Plan also states that residential development in the Village, Vacation-Resort, Mountain-Recreational, and Rural Residential zoning districts/land areas shall avoid steep slopes and high elevations. It also states that development on ridgelines shall not break the silhouette of the hill. Plymouth's zoning ordinance says that subdivisions shall exclude from development land that has steep slopes greater than 25%.	Commercial and Industrial conditional use standards in the Zoning Ordinance require that parking lots shall be bordered with a buffer area landscaped in a manner that integrates the parking area with an overall landscaping plan for the site, and that the removal of existing trees shall be minimized to integrate the site with the surrounding landscape and to enhance environmental quality.

TOWN	FLOOD REGULATIONS	FLOODWAY CONDITIONS	SPECIAL FLOOD HAZARD AREA CONDITIONS	FLOOD REGULATIONS LAST UPDATED	NFIP	COMP. STORAGE
Pomfret	Flood Hazard Area Regulations	Development prohibited, and only minor improvements allowed	New development and substantial improvements must elevate lowest floor 1 ft above BFE. All development shall be reasonably safe from flooding: designed and anchored to prevent flotation, collapse and movement of the structure; constructed with materials resistant to flood damage; construction methods that minimize flood damage; and service facilities located in areas to prevent water from entering.	2007	Yes	No
Reading	Flood Hazard Area Regulations	Development in the floodway is prohibited unless demonstrated by an engineer that no increase in flood levels will occur.	Residential - at or above BFE. Non-Residential - at or above 1' above BFE.	2007	Yes	
Springfield	Flood Hazard Regulations	Development in the floodway is prohibited unless demonstrated by an engineer that no increase in flood levels will occur.	New construction and substantial improvement 2' above BFE (elevation, dry-, or wet-floodproofed)	2021 (Currently in adoption process as of 1.27.22)	Yes	
Weathersfield	Flood Hazard Area Regulations	Development in the floodway is prohibited unless demonstrated by an engineer that no increase in flood levels will occur.	New construction and substantial improvement 1' above BFE.	2013	Yes	
West Windsor	Stand-alone Flood Hazard Regulations	Development in the floodway is prohibited unless demonstrated by an engineer that no increase in flood levels will occur.	New construction and substantial improvement 1' above BFE.	2018	Yes	

TOWN	FLOOD RESILIENCY ELEMENT	NO ADVERSE IMPACT (NAI) STANDARD	RIVER CORRIDOR PROTECTION	ROAD AND BRIDGE STANDARDS	LOCAL HAZARD MITIGATION PLAN	LHMP EXPIRATION DATE	LEOP	ERAF RATE (%)
Pomfret	No		No	Yes	No	Expired	Yes	7.5
Reading	Yes	No	Yes	Yes	Yes	5/4/2022	Yes	17.5
Springfield	Yes	No	No	Yes	Yes	12/14/2023	Yes	12.5
Weathersfield	Yes	No	No	Yes	Yes	10/26/2023	Yes	12.5
West Windsor	Yes	No	Currently Considering (as of 1.27.22)	Yes	Yes	6/8/2023	Yes	12.5

TOWN	STEEP SLOPE/RIDGELINE DEVELOPMENT	STORMWATER/LID REQUIREMENTS
Pomfret	Pomfret's Zoning Ordinance consists of a Ridgeline and Hillside Conservation Area, which includes all land within 750 feet from primary ridges. The Ordinance identifies the importance of ridges and hillsides to the scenic quality of Pomfret, the rural and pastoral character and personality of the Town, and to the current and future well-being of Pomfret's residents. It states that the preservation and conservation of Pomfret's ridges and hillsides are essential to maintaining Pomfret's rural and pastoral character, and that the protection of this natural beauty in Pomfret's landscape is a matter of public use. Development and use of these areas should be in a manner which will not detract from nor adversely affect the scenic qualities of the Town, and development should take place in a manner compatible with important natural environmental assets of the Town.	None
Reading	None - But there is a Ridgeline Protection Overlay District	Stormwater provisions apply to mineral extraction operations under Section 4.5.
Springfield	Slopes over 20% require erosion control and stormwater management plans.	Grading and drainage plan is required part of application for site plan, current use and flood hazard review. Erosion control and stormwater management provisions apply to many types of development, including mobile home parks, filling of low areas, steep slopes (20%+), and modifying the buffer standards.
Weathersfield	Development shall cause minimal disturbance to the natural landscape in areas of slopes over 25%	Adequate provisions shall be made for the management of erosion, sedimentation and storm water runoff. For all projects undergoing Site Plan Review, except one- or two-family dwellings, appropriate storm water management measures shall be incorporated into the final site design. The Zoning Board of Adjustment may require a storm water management and erosion control plan.
West Windsor	Development on slopes >25% requires DRB review and an erosion and sedimentation control plan under Section 3.5.	All development on a gradient in excess of 25% is subject to DRB review. All development on slopes in excess of 25% require an erosion and sediment control plan.

TOWN	FLOOD REGULATIONS	FLOODWAY CONDITIONS	SPECIAL FLOOD HAZARD AREA CONDITIONS	FLOOD REGULATIONS LAST UPDATED	NFIP	COMP. STORAGE
Windsor	Flood Hazard Review	Development in the floodway is prohibited unless demonstrated by an engineer that no increase in base flood levels will occur.	New construction and substantial improvement 1' above BFE.	2015	Yes	
Woodstock Town	Zoning Regulations: Flood Hazard District	Development prohibited.	New development and substantial improvements must elevate lowest floor 1 ft above BFE. All development shall be reasonably safe from flooding: designed and anchored to prevent flotation, collapse, and movement of the structure; constructed with materials resistant to flood damage; construction methods that minimize flood damage; adequately drained to reduce exposure to flood hazards; and located so as to minimize conflict with floodwaters and natural channel movement.	2010	Yes	No
Woodstock Village	Zoning Regulations: Flood Hazard District	Development prohibited.	New development and substantial improvements must elevate lowest floor 1 ft above BFE. All development shall be reasonably safe from flooding: designed and anchored to prevent flotation, collapse, and movement of the structure; constructed with materials resistant to flood damage; construction methods that minimize flood damage; and service facilities located in areas to prevent water from entering.	2012	Yes	No

TOWN	FLOOD RESILIENCY ELEMENT	NO ADVERSE IMPACT (NAI) STANDARD	RIVER CORRIDOR PROTECTION	ROAD AND BRIDGE STANDARDS	LOCAL HAZARD MITIGATION PLAN	LHMP EXPIRATION DATE	LEOP	ERAF RATE (%)
Windsor	Yes	No	No	Yes	Yes	12/3/2026	Yes	12.5
Woodstock Town	Yes		No	Yes	No	Expired	Yes	7.5
Woodstock Village	Yes		No	Yes	No	Expired	Yes	12.5

TOWN	STEEP SLOPE/RIDGELINE DEVELOPMENT	STORMWATER/LID REQUIREMENTS
Windsor	No adverse impact under Conditional Use Review.	Section 5.2 enables the DRB to require a stormwater management and erosion control plan for projects subject to site plan review.
Woodstock Town	The Zoning Regulations include a Steep Slopes and Fragile Soils portion of the Conservation District. General standards for planned development state that proposed development shall provide for the preservation of steep slopes; that buildings should not be located in sensitive areas such as steep slopes; that development shall not result in adverse impact on fragile environments (which includes steep slopes); and that steep slopes are priority areas where clearing should be avoided to protect wildlife habitat, prevent erosion, and prevent sedimentation resulting from stormwater runoff. Development on slopes greater than 15% require conditional use review, and development, regrading, and clearing of vegetation is prohibited on slopes with a grade greater than 25%. Development on slopes greater than 15% shall be sited, constructed, and slopes stabilized to minimize risks to surface waters; house sites, sewage, and parking shall be located on the flattest portion of the land; and development of roads and driveways should minimize crossing steep slopes and should follow topographic contours to minimize soil and vegetation disturbance.	Article VI in Zoning Regulations: Stormwater-Low Impact Development requires permit applications to include a condition site assessment, an erosion & sediment control plan, and a stormwater management plan. Low impact development design is preferred. Development must minimize land disturbance; preserve natural areas; and manage water, prevent erosion, and control sediment during construction according to pre-development and construction site standards. Development is also subject to stormwater management standards that include vegetative and landscaping controls that naturally manage surface runoff, standards for building on steep slopes, strategies to reduce impervious surfaces, and low impact integrated management practices.
Woodstock Village	The Conservation District in the Zoning Regulations includes Steep Slopes over 25%. Lots with steep slope characteristics as identified in the overlay zone shall be reviewed for suitable sewage disposal, access for emergency vehicles, drainage, and erosion control. New development that adds more than 10,000 sq. ft. of impervious area - roofs, decks, patios and driveways - shall be reviewed to ensure on-site retention of stormwater.	Applications for development shall include the location of facilities for the control and disposal of stormwater. Zoning Regulations include a Conservation District that aims to reduce the impact of stormwater runoff and prevent soil erosion.

Appendix E. Regional Plan Conformance

Two Rivers-Ottauquechee
REGIONAL COMMISSION

March 28, 2023

John Beling, Commissioner
Vermont Department of Environmental Conservation
Vermont Agency of Natural Resources
One National Life Drive
Montpelier, Vermont 05620

Dear Commissioner Beling,

Thank you for allowing TRORC the opportunity to provide comments to the Agency on the Draft Basin 10 Tactical Basin Plan pursuant to 10 VSA, Chapter 47, §1253(d) and §29A-103(e)(2-3) of the Vermont Water Quality Standards, both of which direct the Secretary of the Agency Natural Resources to consult with regional planning commissions in developing basin plans to consider conformance with the goals and objectives of regional plans.

The draft Basin 10 Plan includes major portions of Plymouth, Bridgewater, Woodstock, Hartford, Hartland, Pomfret, and Barnard. TRORC staff was involved in developing the Draft Basin Plan, and hosted a stakeholder meetings and provided updates to basin progress tables. These Board comments pertain to the subsequent February 2023 draft. Our comments are based on our current 2020 Regional Plan.

Conformance of Draft Basin 10 Plan with the TRORC Regional Plan

The draft Basin 10 Tactical Basin Plan is in conformance with TRORC's Regional Plan.

Specific Draft Tactical Basin Plan Comments

TRORC appreciates the addition of the social equity and climate change strategies with this draft of the plan. Specifically, the strategies that address water quality in villages are critically important to drive development to our villages in order to protect upland watersheds and address social equity issues with housing.

The Draft Basin Plan lists the North Branch of the Ottauquechee River as a candidate Outstanding Resource Water (of which the basin currently has none) as well as proposed for A1 reclassification. TRORC supports A1 reclassification and asks that the Plan call for ORW designation and will support a local petition.

TRORC supports the reclassification of surface waters that have been outlined in the Draft Basin Plan from B2 to A1 and from B2 to B1. TRORC encourages the final Basin 10 Plan to go further than the Draft and identify as many surface water bodies for reclassification to B1 or A1 for as many existing uses that the characteristics of those waters support. TRORC understands that the Agency feels it must support the reclassification process with data. TRORC agrees. But TRORC believes the level of data needed is far less, and ANR data thresholds are an unnecessary impediment to protecting waters. For example, all waters are classified as A1 due to being above 2,500 feet in

William B. Emmons, III, Chair ~ Peter G. Gregory, AICP, Executive Director
128 King Farm Rd. Woodstock, VT 05091~ 802-457-3188 ~ trorc.org
Barnard ~ Bethel ~Bradford ~ Braintree ~ Bridgewater ~ Brookfield ~ Chelsea ~ Corinth ~ Fairlee ~ Granville ~ Hancock ~ Hartford ~ Hartland
Newbury ~ Norwich ~ Pittsfield ~ Plymouth ~ Pomfret ~ Randolph ~ Rochester ~ Royalton ~ Sharon ~ Stockbridge ~ Strafford ~ Thetford
Topsham ~ Tunbridge ~ Vershire ~ West Fairlee ~ Woodstock

elevation, but those same waters are now B2 as soon as they pass below that elevation despite still being in undeveloped forests. We support B1 reclassification for many of these high upland streams.

The Draft discusses where both fishing and swimming are acknowledged to be widespread. However, the Draft Basin Plan is not proposing to widely designate these, especially swimming, as existing uses. TRORC's stance is that fishing and swimming should be formally noted as an existing use in all perennial streams in Basin 10 and throughout the entire TRORC region. The VWQS defines "Existing use" as a use that has actually occurred on or after November 28, 1975, in or on waters, regardless of whether or not the use is presently occurring." It is likely that many, many places have been used for fishing and swimming over the last 42 years.

We greatly appreciate the partnership and working relationship with the Agency that has been developed on water quality planning, water quality restoration, and project implementation. If you have any questions or would like any clarification on any of these comments, please let me know.

Sincerely,

Peter G Gregory AICP
Executive Director

CC: TRORC Board of Directors
TRORC Clean Water Advisory Committee
Kevin Geiger, Pete Fellows, Sydney Steinle
Marie Caduto, DEC

William B. Emmons, III, Chair ~ Peter G. Gregory, AICP, Executive Director
128 King Farm Rd. Woodstock, VT 05091~ 802-457-3188 ~ trorc.org
Barnard ~ Bethel ~Bradford ~ Braintree ~ Bridgewater ~ Brookfield ~ Chelsea ~ Corinth ~ Fairlee ~ Granville ~ Hancock ~ Hartford ~ Hartland
Newbury ~ Norwich ~ Pittsfield ~ Plymouth ~ Pomfret ~ Randolph ~ Rochester ~ Royalton ~ Sharon ~ Stockbridge ~ Strafford ~ Thetford
Topsham ~ Tunbridge ~ Vershire ~ West Fairlee ~ Woodstock

Mount Ascutney
Regional Commission

March 30, 2023

John Beling, Commissioner
Vermont Department of Environmental Conservation
1 National Life Drive, Main 2
Montpelier, VT 05620

SUBJECT: **Recommendations regarding conformance of the draft Ottauquechee, Black Rivers & Connecticut River Direct Tributaries (Basin 10) Tactical Basin Plan with the 2022 MARC Regional Plan**

Dear Commissioner Beling,

The Mount Ascutney Regional Commission (MARC) would like to commend the Department of Environmental Conservation (DEC) Watershed Planning Program, and specifically Basin Planner Marie Caduto, on the comprehensive analysis contained in the draft *Ottauquechee, Black Rivers & Connecticut River Direct Tributaries Tactical Basin Plan* (Basin 10 Plan). We appreciate the opportunity to work with Marie and other DEC staff to strengthen municipal, regional and public participation in the Tactical Basin Planning process.

The MARC is highly supportive of and active in the planning process for the protection and improvement of surface and groundwater resources throughout southern Windsor County. We consider Tactical Basin Planning to be integral in that process. The MARC works with our member municipalities to develop, adopt and implement policies that achieve water quality protection and improvement, and have used prior iterations of the Basin 10 Plan innumerable times to do so. We are eager to continue cooperating with DEC on the development and implementation of Tactical Basin Plans in the future.

BACKGROUND
MARC has the opportunity to provide recommendations to the Agency of Natural Resources regarding tactical basin plans pursuant to the following sections of Vermont Statutes Title 10, Chapter 47, §1253(d)

- *(2)(G) … the Secretary [of Natural Resources] shall: develop, in consultation with the regional planning commission, an analysis and formal recommendation on conformance with the goals and objectives of applicable regional plans.*
- *(3)(D) … [the regional planning commissions are to] assist the Secretary in implementing a project evaluation process to prioritize water quality improvement projects within the region to assure cost effective use of State and federal funds.*

Basin 10 includes major portions of the MARC municipalities of Baltimore, Cavendish, Chester, Ludlow, Reading, Springfield, Weathersfield, West Windsor, and Windsor. The MARC reviewed the draft *Ottauquechee, Black Rivers & Connecticut River Direct Tributaries Tactical Basin Plan* that was issued for RPC review in March 2023. The primary purpose of MARC's review was to analyze the relative conformance of the draft Basin 10 Plan with the goals, policies, and recommendations of the *2022 Mount Ascutney Regional Commission Regional Plan*.

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Ascutney, VT 05030
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CONFORMANCE WITH THE REGIONAL PLAN

The draft *Ottauquechee, Black Rivers & Connecticut River Direct Tributaries Tactical Basin Plan* is in conformance with and supportive of the 2022 MARC Regional Plan, specifically with the following Regional Plan goals, policies and recommendations:

GOALS:

- All inhabitants and wildlife should be provided with a healthy living environment through improvement and maintenance of the air, water, and soil quality.
- Irreplaceable natural and fragile areas, outstanding resource waters, rare and endangered species and their habitats, and significant scenic features should be protected and preserved.
- Promote reclassification of pristine water resources to afford further protection.
- Protect groundwater as a public trust.
- Maintain and improve water quality in accordance with 10 V.S.A. §6068(a).

POLICIES:

- Headwater streams, gorges, waterfalls, and cascades and the land around these important resources must be protected. Outstanding Resource Water (ORW) designations for these areas should be considered where deemed appropriate.
- Development must not result in undue degradation of any surface water resource.
- When any alternative exists, developments shall not be sited on soils that are: a) Susceptible to flooding; b) Located in identified river corridor areas; and c) Not suited for foundations and/or septic systems.
- Development proposals for shallow soils shall provide and conform to an erosion control plan for construction activities and a site drainage plan.

The following table details how the Basin Plan objectives by sector are in conformance with and supportive of specific goals, policies and recommendations of the 2022 MARC Regional Plan.

Basin 10 Plan Priority Strategies	Conformance with select goals, policies and recommendations of the 2022 MARC Regional Plan
AGRICULTURE: Work on agricultural lands along the Connecticut River to establish and enhance riparian buffers following the stabilization of water level fluctuations from hydropower production	This strategy helps to implement policy 8 of the Natural Resources chapter, which states "Maintain undisturbed buffers of vegetation along watercourses, lakes, ponds and wetlands in order to protect shorelines, provide shading to prevent undue increase in stream temperatures, minimize effects of erosion, sedimentation and other sources of pollution, and maintain scenic, recreational, and habitat values in accordance with *ANR Riparian Buffer and Corridor Technical Guidance (2005)*."
DEVELOPED LANDS – STORMWATER: Prioritize projects, develop final designs and implement stormwater treatment projects identified in Stormwater Master Plans and Stormwater Mapping Reports	This priority strategy will help to reduce sediment and nutrient pollution to surface waters, aiding in implementation of the broad Regional Plan goal of maintaining and improving water quality as stated in Natural Resources Goal #5 on page 115. Design and construction of stormwater treatment practices (STPs) will also help reduce peak flood elevations, which helps promote flood resilience in alignment with numerous goals, policies and recommendations listed in the Regional Plan.
DEVELOPED LANDS – ROADS: Provide technical support to towns to implement MRGP projects identified through REIs, LWAP's, and gully erosion inventories that are having significant water quality impacts	This strategy helps to implement policy #12 on page 6 of the Regional Transportation Plan, which states "Maintenance of the existing transportation system shall minimize water pollution, in accordance with the current *Vermont Town Highway Codes and Standards*, State stormwater rules, the Municipal Roads General Permit, and other best management practices."
WASTEWATER: Provide outreach on the Village Wastewater Solutions to communities without wastewater treatment, and seek funding for planning	Encouraging wastewater solutions in designated Village Centers helps promote multiple implementation actions outlined in the Implementation Chapter of the Regional Plan, including "Seek funding to implement wastewater system improvements in Cavendish," "Assist Weathersfield

and implementation of priority projects that have community support	to seek funding for a wastewater/water feasibility study to further Perkinsville Village Center revitalization efforts," and "Assist Weathersfield to seek funding for a wastewater feasibility study to further Ascutney Village Center revitalization efforts.
NATURAL RESOURCES: Support and enhance riparian buffer plantings throughout the landscape	This strategy helps to implement policy 8 of the Natural Resources chapter, which states "Maintain undisturbed buffers of vegetation along watercourses, lakes, ponds and wetlands in order to protect shorelines, provide shading to prevent undue increase in stream temperatures, minimize effects of erosion, sedimentation and other sources of pollution, and maintain scenic, recreational, and habitat values in accordance with *ANR Riparian Buffer and Corridor Technical Guidance (2005).*"
RIVERS: Buy-out properties that are highly vulnerable to flooding from willing sellers	This strategy helps to implement numerous high priority mitigation projects identified in the Emergency Management element of the Regional Plan on pages 108-111.
WETLANDS: Restore degraded wetlands for habitat and water quality improvement	This priority strategy serves to support innumerable goals and policies of the Regional Plan which seek to preserve and restore wetlands and their beneficial functions.
CLIMATE CHANGE ADAPTATION: Work to maintain connectivity with wildlife populations across the Connecticut River to New Hampshire	Maintaining habitat connectivity through minimizing development impacts on ANR-mapped habitat connectors is a primarily goal listed in the Natural Resources Chapter of the Regional Plan.

PLAN CONFORMANCE CONCLUSION

The draft *Ottauquechee, Black Rivers & Connecticut River Direct Tributaries Tactical Basin Plan* is in conformance with and supportive of the 2022 MARC Regional Plan.

Thank you for your consideration. If you desire clarification on this letter, please do not hesitate to contact Chris Yurek at cyurek@marcvt.org or (802) 674-9201 Ext. 119. Please note that the MARC will provide additional staff level comments once the formal public review draft is issued.

Sincerely,

Jason Rasmussen

Digitally signed by Jason Rasmussen
Date: 2023.03.30 17:13:56 -04'00'

Jason Rasmussen, AICP
Executive Director

Cc: Chris Yurek, MARC Planner
Marie Caduto, DEC Basin 10 Planner

Appendix F. Responsiveness Summary of Public Comments