Deerfield River & Lower Connecticut River Tactical Basin Plan

Green River, Guilford

December 2019 | Public Draft

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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Emily Boedecker, Commissioner Date

Department of Environmental Conservation

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Julie Moore, Secretary Date

Agency of Natural Resources

Cover Photo: Green River in Guilford – Marie L. Caduto

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[1] Ibid.

Basin 12 Towns

Brattleboro
Dover
Dummerston*
Glastenbury
Guilford
Halifax
Marlboro
Readsboro
Searsburg
Somerset
Stamford*
Stratton
Sunderland*
Vernon
Wardsboro*
Whitingham
Wilmington
Woodford

Towns in Major Sub-watersheds

Deerfield Watershed

Deerfield River
Dover
Glastenbury
Readsboro
Searsburg
Somerset
Stamford
Stratton
Sunderland
Wardsboro
Whitingham
Wilmington
Woodford

Green River
Brattleboro
Guilford
Halifax
Marlboro
Wilmington

North River
Halifax
Marlboro
Whitingham
Wilmington

Connecticut River Watershed

Connecticut River
Brattleboro
Dummerston
Vernon

Fall River
Guilford
Vernon

Broad Brook
Brattleboro
Guilford
Vernon

Whetstone Brook
Brattleboro
Dummerston
Marlboro

* - towns with small areas in the Basin

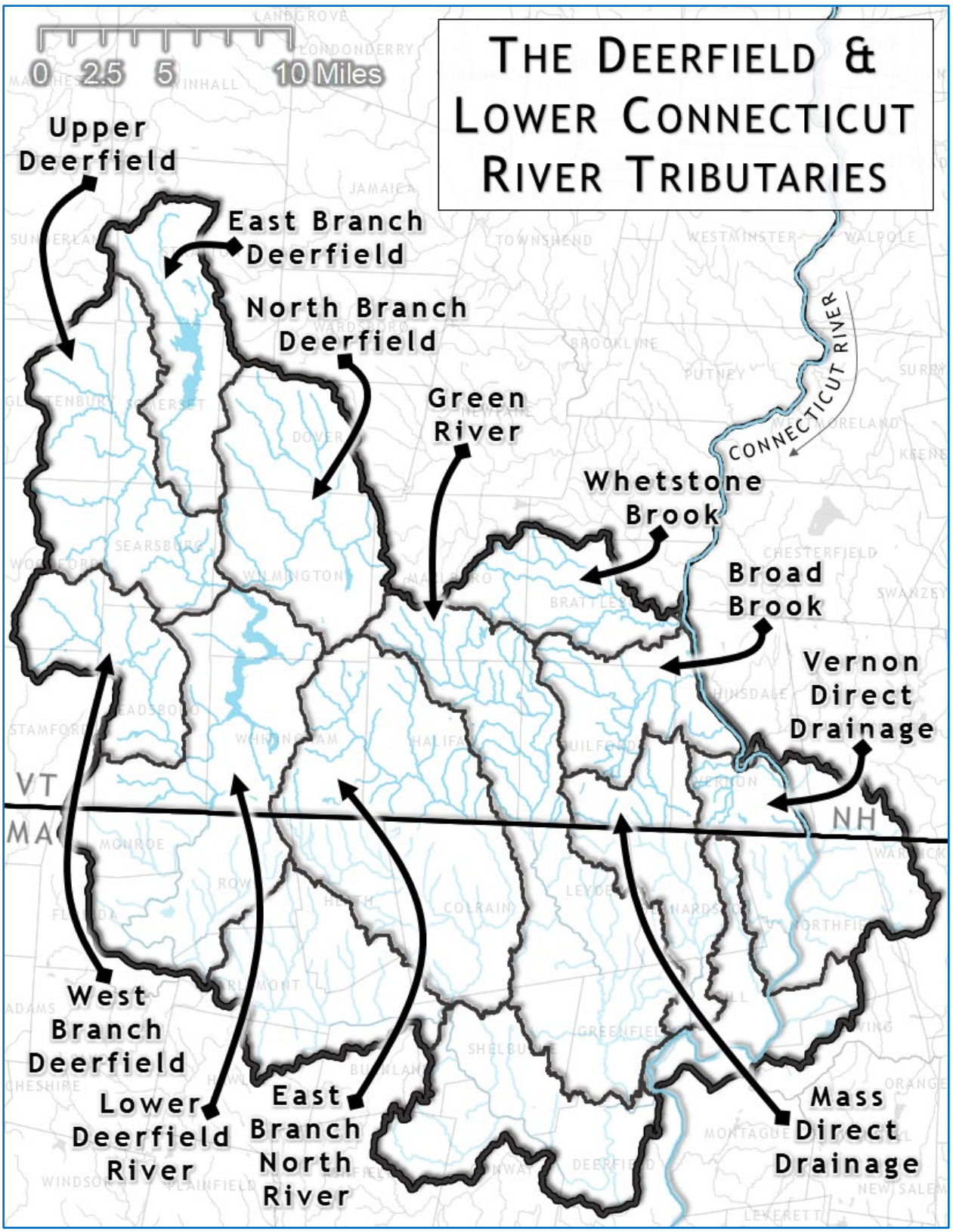
THE DEERFIELD & LOWER CONNECTICUT RIVER TRIBUTARIES
0 2.5 5 10 Miles
Upper Deerfield
East Branch Deerfield
North Branch Deerfield
Green River
Whetstone Brook
Broad Brook
Vernon Direct Drainage
West Branch Deerfield
Lower Deerfield River
East Branch North River
Mass Direct Drainage
CONNECTICUT RIVER
VT
MA
NH

Figure 1.

Executive Summary

The Deerfield Tactical Basin Plan (TBP) provides an assessment of watershed condition and identifies current and future strategies to protect high quality waters and restore impaired water resources based on the approaches set forward in the Vermont Surface Water Management Strategy (VSWMS).

The five chapters in this plan provide a framework for understanding Basin 12, including its unique characteristics and water quality issues, and where and how to carry out priority actions to protect, maintain, enhance, and restore water quality in the Basin.

Chapter 1

- Basin Description
- Condition of Waters--Lakes, Rivers, and Wetlands

Chapter 2

- Priority waters for surface water protection

Chapter 3

- Priority waters for surface water restoration
- TMDL updates

Chapter 4

- Water Quality Regulations and Strategies

Chapter 5

- Implementation actions and strategies
- Monitoring recommendations

The Deerfield River descends from the towns of Glastenbury and Stratton in the southern Green Mountains of Vermont. It flows through south central Vermont and crosses the Vermont-Massachusetts border before it joins the Connecticut River. The Deerfield River in Vermont has four branches: North, South, East and West. Two more of the Deerfield's main tributaries, the East Branch of the North River and the Green River, originate in Vermont and enter the Deerfield River in Massachusetts. The Deerfield River system drains 14 towns and 318 square miles in Vermont and 347 square miles in Massachusetts.

Included in Basin 12 is a short reach of the Connecticut River mainstem, from the mouth of the West River in Brattleboro south to the Massachusetts border as well as Whetstone, Broad and Newton Brooks and the Fall River draining directly into the Connecticut River.

The Deerfield is the second most forested, the least developed, and the least cultivated basin in the State of Vermont (Figure 4). Forested land covers 82% of the Basin.

Approximately 60% of the land in the Basin is under some form of protection due to inclusion in the Green Mountain National Forest, Great River Hydro ownership, private conservation or Use Value Appraisal (Current Use).

Extensive opportunities exist in the Basin for protection and reclassification where water quality and habitat conditions show that aquatic biota and fisheries are in exceptional condition and meet the criteria of Class A(1) or B(1). Seven waters are being recommended for A(1) for Aquatic Biota and three for B(1). Vermont Department of Fish and Wildlife (VDFW), Fisheries Division is recommending 13 waters for B(1). Outstanding Resource Water designation is being proposed for four lakes and two gorges. Three wetlands are being put forward for further study to determine if they meet Class 1 wetland criteria.

While river and stream conditions for aquatic life, aesthetics, swimming and boating in the Basin exceed state-wide averages (Figure 6.), many lakes and ponds are either unassessed or impacted by acid and mercury entering with precipitation (Figure 9). Increasingly, cyanobacteria blooms are impacting swimmability of waters in the state. The current status of cyanobacteria in Basin 12 is not known and would benefit from further assessment.

Stressors do impact the Basin in numerous areas. Ski resort development degrades water quality in the North Branch Deerfield River. High levels of bacteria are found in the North Branch Deerfield River and Whetstone Brook. Extensive areas have been physically altered by straightening, channel relocation and riverbed manipulation. Additionally, natural flows and water temperatures are altered by six hydroelectric dams and reservoirs and water withdrawals for snowmaking.

Six separate Total Maximum Daily Loads (TMDLs) or Water Quality Remediation Plans (WQRPs) are in place addressing five pollutants: acidity, bacteria, mercury, nitrogen and stormwater.

Only 4.6 percent of the Basin is in agricultural land use with Newton Brook in Vernon being the only agriculturally impaired water. Stormwater runoff and road runoff bring sediment and nutrients into waterways throughout the Basin.

Actions to implement projects that address these impacts and those to protect water resources are documented in the on-line Watershed Projects Database. Overarching strategies and actions are listed in Table 17.

What is a Tactical Basin Plan

Tactical basin planning is carried out for the Agency of Natural Resources (VANR) by the Watershed Management Division's Monitoring and Assessment, Program (MAP) in coordination with watershed partners. Tactical basin plans are developed in accordance with the Vermont Surface Water Management Strategy (VSWMS) and the Vermont Water Quality Standards (VWQS) to protect, maintain, enhance, and restore the biological, chemical, and physical integrity of Vermont's water resources. The basin-specific water quality goals, objectives, strategies, and actions described in the TBPs aim to protect public health and safety and ensure public use and enjoyment of Vermont waters.

The TBP process allows for the issuance of plans for Vermont's fifteen basins every five years, as required by statute 10 V.S.A. § 1253. The plans incorporate the U.S Environmental Protection Agency's (EPA) 9-element framework for watershed plans (Environmental Protection Agency, 2008) and meet obligations of the Vermont Clean Water Act. Updating a basin plan includes: 1. monitoring water quality and summarizing existing information, 2. assessing and analyzing water quality data, 3. identifying strategies and projects to protect and restore waters, 4. seeking public comment and finalizing the plan, and 5. ongoing plan implementation and tracking throughout the planning cycle.

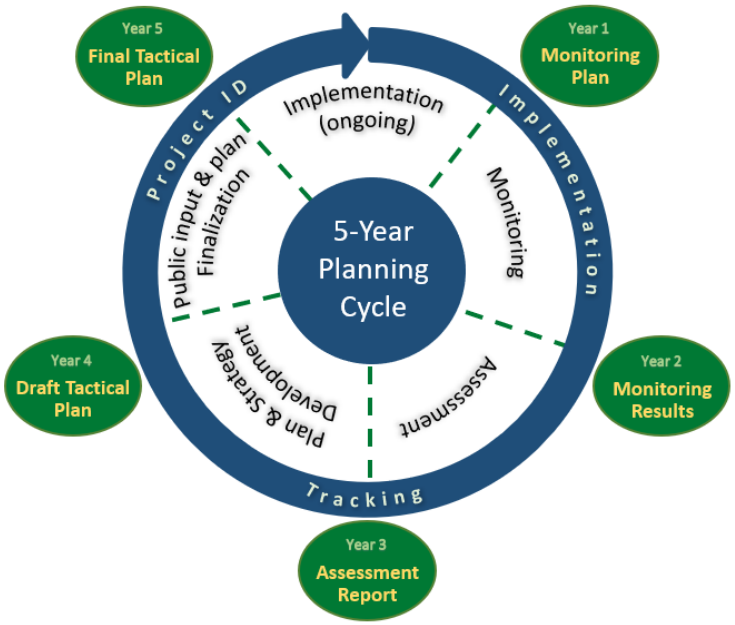

Figure 2. Steps in the Tactical Basin Planning

Tactical basin plans can be considered a strategic guidebook for protecting and restoring Vermont's surface waters for VANR and watershed partners. Plans identify causes and sources of pollution and opportunities for protecting waters through outstanding resource water designation and reclassification. Plans also identify pollutant reductions needed to restore water quality, including those necessary to meet Total Maximum Daily Load targets. Plan implementation tables list strategies to foster education and outreach, and targeted restoration actions that are eligible for federal and

state funding. The plan's strategies, described in Chapter 5's strategy table, target overarching objectives that are tracked via the online Watershed Projects Database (WPD) which lists individual projects that will meet these objectives. The WPD is continuously updated to capture project information from

- the TBP process,
- on the ground assessments and
- emerging projects due to natural and/or anthropogenic events.

The 2014 Basin 12 Water Quality Management Plan identified sixty-two action items of which half have been implemented or are in progress by VANR and its watershed partners. A report card of this progress can be viewed in Appendix A. The 2019 tactical plan builds upon those original plan recommendations by promoting specific, geographically explicit actions in areas of the basin that have been identified for intervention, using environmental modeling and on-the-ground monitoring and assessment data. This updated tactical basin plan will serve for the next five-years to address water quality concerns across land use sectors and improve aquatic habitat.

A. Vermont's Clean Water Acts

The Vermont Clean Water Act, Act 64, addresses water quality throughout Vermont by addressing the sectors that have potential to cause pollution. These sectors are agriculture, developed lands, wastewater, roads and natural resources processes. Agricultural non-point source water quality programs and the application of the Required Agricultural Practices (RAPs) on small, medium, and large farms is managed by the Agency of Agriculture, Food and Markets (VAAFM). Stormwater discharges from new and existing development, industrial and municipal stormwater discharges, and runoff from state and municipal roads are managed through the Vermont Departments of Environmental Conservation (VDEC) and Agency of Transportation (AOT). While the Vermont Department of Forests, Parks and Recreation (VDFPR) and VDEC, in tandem, address water quality runoff from forest silvicultural activities. Regulations specific to these new requirements are covered in detail in the legislation summary.

Act 64 also establishes the requirement that all water quality improvement actions undertaken by the State be integrated by means of TBPs, and establishes partnerships with regional planning commissions, conservation districts, and other organizations to support this work. TBPs encourage communities to take protective measures that will restore, maintain and enhance water quality in all areas, but do not preclude

development that is consistent with municipal bylaws, regional and municipal plans, and with applicable state and federal regulations.

The Clean Water Service Delivery Act, Act 76 of 2019, establishes a water quality project delivery framework to support Vermont's clean water goals. Act 76 secures a new long-term funding source for the Clean Water Fund. Three of the most fundamental aspects of this law are:

1. **Provides assurances to meet non-regulatory targets**: Act 76 prioritizes program delivery and funds for non-regulatory projects. Non-regulatory projects include small-scale green stormwater management practices, conservation initiatives on Vermont farms, and natural resource restoration projects such as easements, wetlands restoration, or vegetated buffer plantings. While not required, these projects are essential to achieve the water quality goals
2. **Phosphorus reduction targets:** Act 76 places a greater emphasis on achieving phosphorous reduction targets set for each watershed.
3. **Establishes Clean Water Service Providers**: new regional organizations called clean water service providers (CWSP). CWSPs will be established in each major watershed to identify, implement and maintain local water quality projects.

B. Vermont Water Quality Standards

The Vermont Water Quality Standards (VWQS) establish the minimum or maximum limits for certain water quality parameters at specific locations for the purpose of managing waters to support their designated uses. Designated uses include aquatic biota and habitat; swimming & contact recreation; boating; fishing; public water supply and crop irrigation. In Vermont, Water Quality Standards include both Water Classification Orders and the Regulations Governing Water Classification and Control of Quality.

The VWQS define biological integrity as "the ability of a body of water to support and maintain a community of organisms that has the expected species composition, diversity, and functional organization comparable to that of the water in its natural condition." The health of a biological community reflects the level of combined human-induced stresses acting upon it. Aquatic communities that are most impacted often suffer from an accumulation of multiple stressors.

These VWQS are intended to achieve the goals of the State's water quality policy (10 V.S.A. § 1250), as well as the objective of the federal Clean Water Act (33 U.S.C. § 1251 et

seq.) which is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters.

C. Assessment Methodology

The Agency of Natural Resources' Watershed Management Division (WSMD) in VDEC assesses the health of a waterbody using biological, chemical and physical criteria. Most of this data can be accessed through the Vermont Integrated Watershed Information System, online data portal.

VDEC uses monitoring and assessment data[2] to assess individual surface waters in relation to VWQS as outlined in the 2016 DEC Assessment and Listing Methodology. The four categories used to assess Vermont's surface water are **full support, stressed, altered** and **impaired**. Waters that currently support designated and existing uses and meet water quality standards are placed into the full support or stressed categories. Waters that do not meet VWQS are placed in the altered or impaired categories.

Water Quality Assessment Reports compile and interpret water quality monitoring information from throughout the Basin, and, where possible, link that information to the causes of observed problems and the sources of pollutants. These reports also highlight waters of notable high quality.

Water quality classifications in Vermont are based on a designated use being supported. Waters where actual conditions fully support a designated use and conditions meet or exceed the criteria for a specific water quality classification are recommended for reclassification in the basin planning process. Waters may also be petitioned for reclassification by the public.

Volunteer Monitoring Programs and Data

VDECs monitoring programs are supported and enhanced by volunteer monitoring programs statewide. In close partnership with local watershed groups and lake associations water quality data is collected throughout the state during the seasons of highest recreational use and for specific studies. The VDEC supports volunteer water quality monitoring effort through the LaRosa Partnership Program.

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[2] Appendix A of the Vermont DEC Water Quality Monitoring Strategy 2011-2020

Volunteer monitoring groups collecting water quality data through the LaRosa Partnership Program include:

- Connecticut River Conservancy (CRC)
- Deerfield River Watershed Alliance (DRWA)
- Southeastern Vermont Watershed Alliance (SeVWA)

DRWA began monitoring the Deerfield, Green and East Branch of the North River in 2017 and SeVWA has been monitoring Whetstone Brook since 2004. CRC has coordinated three "Samplepalooza" events on the Connecticut River.
All three of these programs participate in the LaRosa Partnership Program which provides free laboratory testing of volunteer collected water samples throughout the State. Data from these programs can be found at The LaRosa Volunteer Water Quality Monitoring Analytical Services Partnership

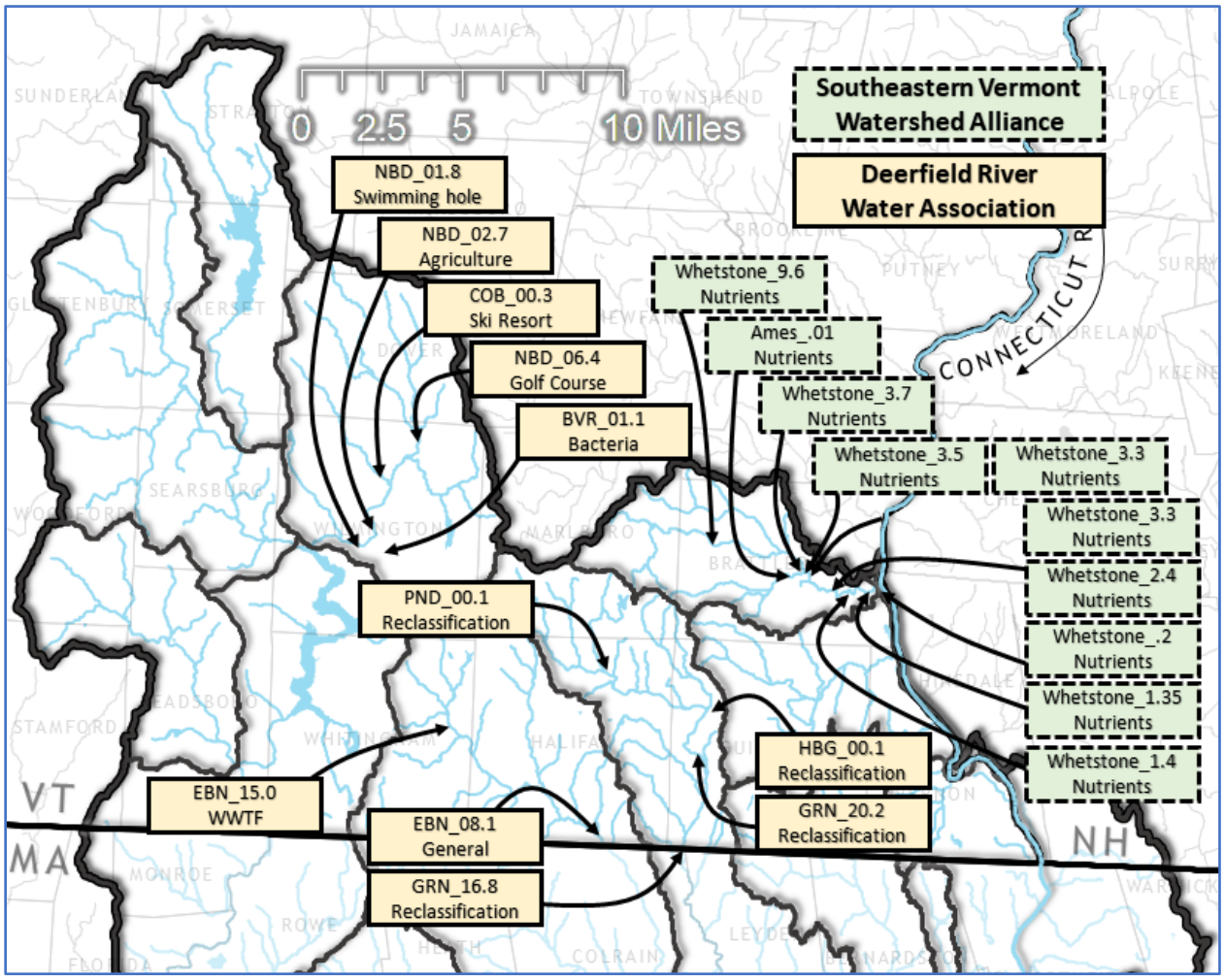

Figure 3. Volunteer Monitoring

Climate Change in Vermont

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

The impact of increased runoff and streamflow in a watershed depends heavily on local land use and land cover. These impacts are exacerbated in developed areas with extensive impervious cover, the excess runoff can increase stormwater volume and velocity thereby mobilizing larger pollutant loads[3]. In addition, increased streamflow will increase bed and bank erosion and deliver more sediments downstream. In areas where non-point source pollution is a concern (e.g., agricultural lands, residential areas), more runoff can increase sediment, nutrient, and pathogen loading to surface waters[4]. Changes in climate increasingly require watershed restoration projects to incorporate stormwater and non-point source runoff controls to counteract pollutant transport as well as the potential for higher peak flows.

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

On the other end of the spectrum, higher temperatures are predicted to lead to more episodic droughts[5]. Potential impacts may include drier soils decreasing water levels in wetlands and headwater streams and higher water temperatures throughout the watershed impacting aquatic life.

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[3] (Galford, et al., 2014).
[4] (Galford, et al., 2014
[5] https://climatechange.vermont.gov/our-changing-climate/what-it-means/farms-forests

Chapter 1 Basin Description and Condition

The Deerfield River descends from the towns of Glastenbury and Stratton in the southern Green Mountains of Vermont. It flows through south central Vermont and crosses the Vermont-Massachusetts border before it joins the Connecticut River. The Deerfield River has four branches in Vermont: North, South, East and West. Two more of the Deerfield's main tributaries, the East Branch of the North River and the Green River, originate in Vermont and enter the Deerfield River in Massachusetts. The Deerfield River system drains 14 Vermont towns in two counties and is about 318 square miles in area.

A short reach of the Connecticut River mainstem is included in Basin 12. From the mouth of the West River in Brattleboro south to the Massachusetts border, the Connecticut River is controlled by two hydroelectric dams. The Vernon dam and the Turners Falls dam in Montague, MA alter flows throughout the thirteen-mile reach.

Draining directly into the Connecticut River are Whetstone, Broad and Newton Brooks and the Fall River. Whetstone Brook drains 25.5 square miles; Broad Brook 23.8 square miles; Newton Brook 4.4 square miles; and the Vermont portion of the Fall River, 10.4 square miles. These waters are also included in this plan.

Current Land Use

Basin 12 is the second most forested, the least developed, and the least cultivated basin in the State of Vermont. Forested land covers the greatest area at 82% (Figure 4). Due to the large areas covered by the Harriman and Somerset reservoirs created for hydroelectric water storage, open Water covers 2%. Wetlands make up 5%, agricultural crop land 4.6%, and developed land areas cover 4.7%.

Over 27% of the Basin is part of the Green Mountain National Forest which covers most of the western basin, including almost all of the Upper Deerfield, and most of the East and West Branches. With the addition of lands owned by Great River Hydro, almost all the Basin 12 land in Stratton, Somerset, Glastenbury, Woodford and Stamford is under some form of land protection and close to 100% forested.

Other conserved lands, either public or private, cover 10% and Use Value parcels (Current Use) encompass another 20% of the Basin, leaving only 40% of the entire Basin without some level of protection (Figure 5).

Agriculture occurs mostly along the valleys of the Deerfield and Connecticut Rivers and Whetstone Brook, producing a limited amount of row crops and large amounts of hay for both dairy and horse operations.

Developed areas are concentrated around Brattleboro and West Brattleboro and in and around the ski areas Mount Snow and the Hermitage, in Dover and Wilmington.

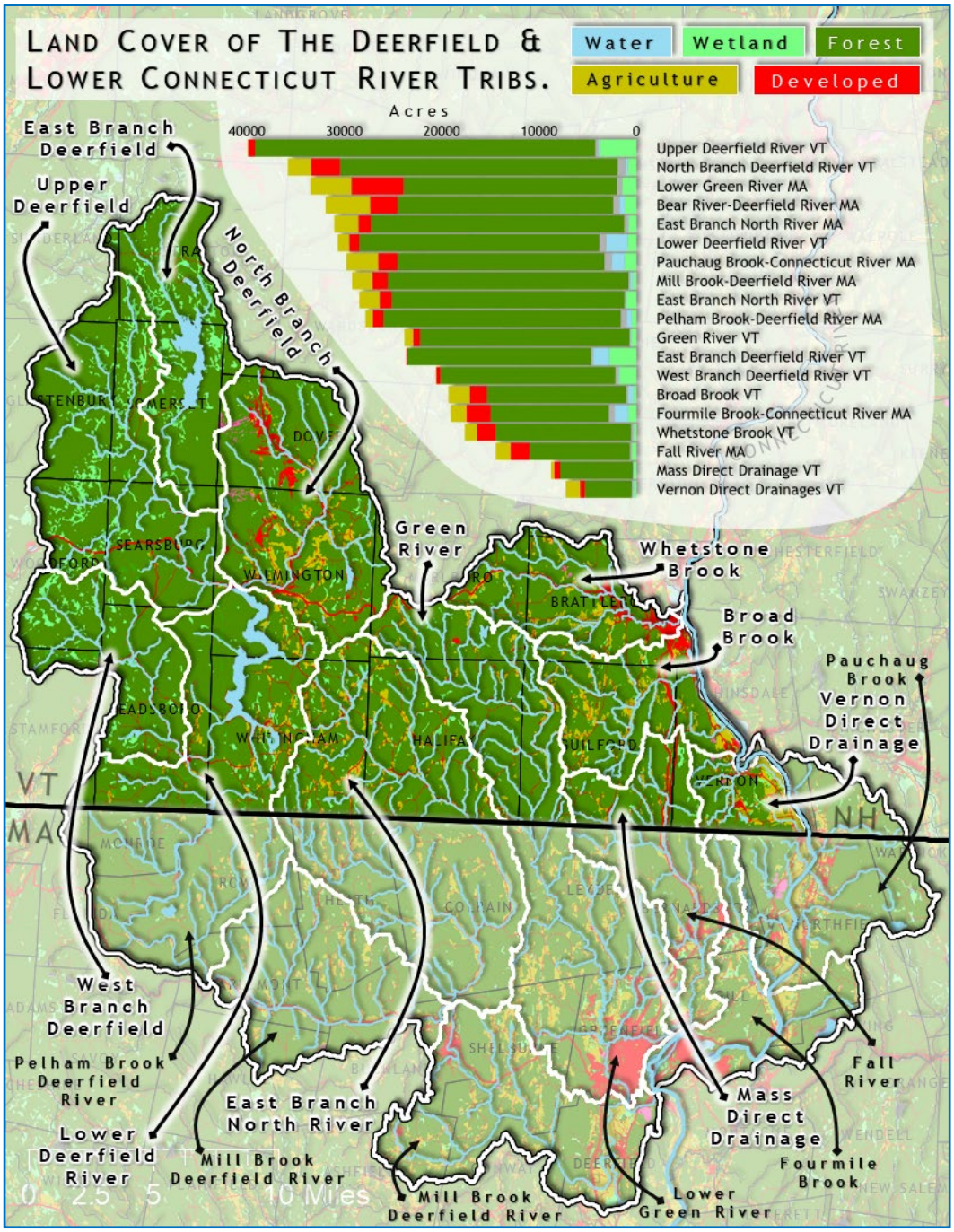

Figure 4. Land Cover

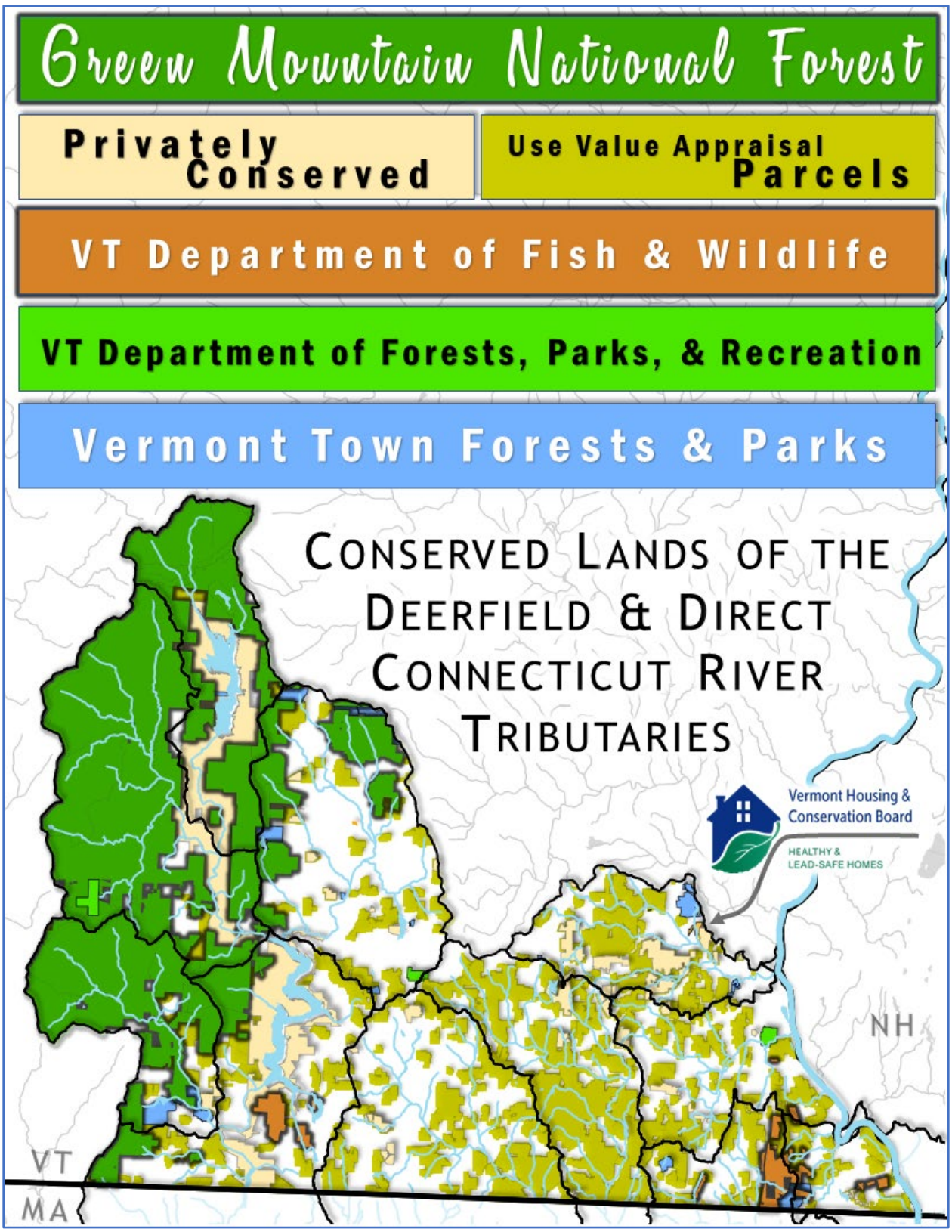

Figure 5. Conserved Lands

However, stressors do impact the Basin in numerous areas. Ski resort development degrades water quality of the North Branch Deerfield River. High levels of bacteria are found in the North Branch Deerfield River and Whetstone Brook. Extensive areas have been physically altered by straightening, channel relocation and riverbed manipulation. And natural flows and water temperatures are altered by hydroelectric dams and water withdrawals for snowmaking.

Condition of Rivers

The majority of the Basin's waters are in good to excellent condition with regards to aquatic biota (Figure 6). The majority of the region is forested with dispersed areas of small village development. However, extensive development around two major ski areas on the North Branch Deerfield and urban development in Brattleboro increases

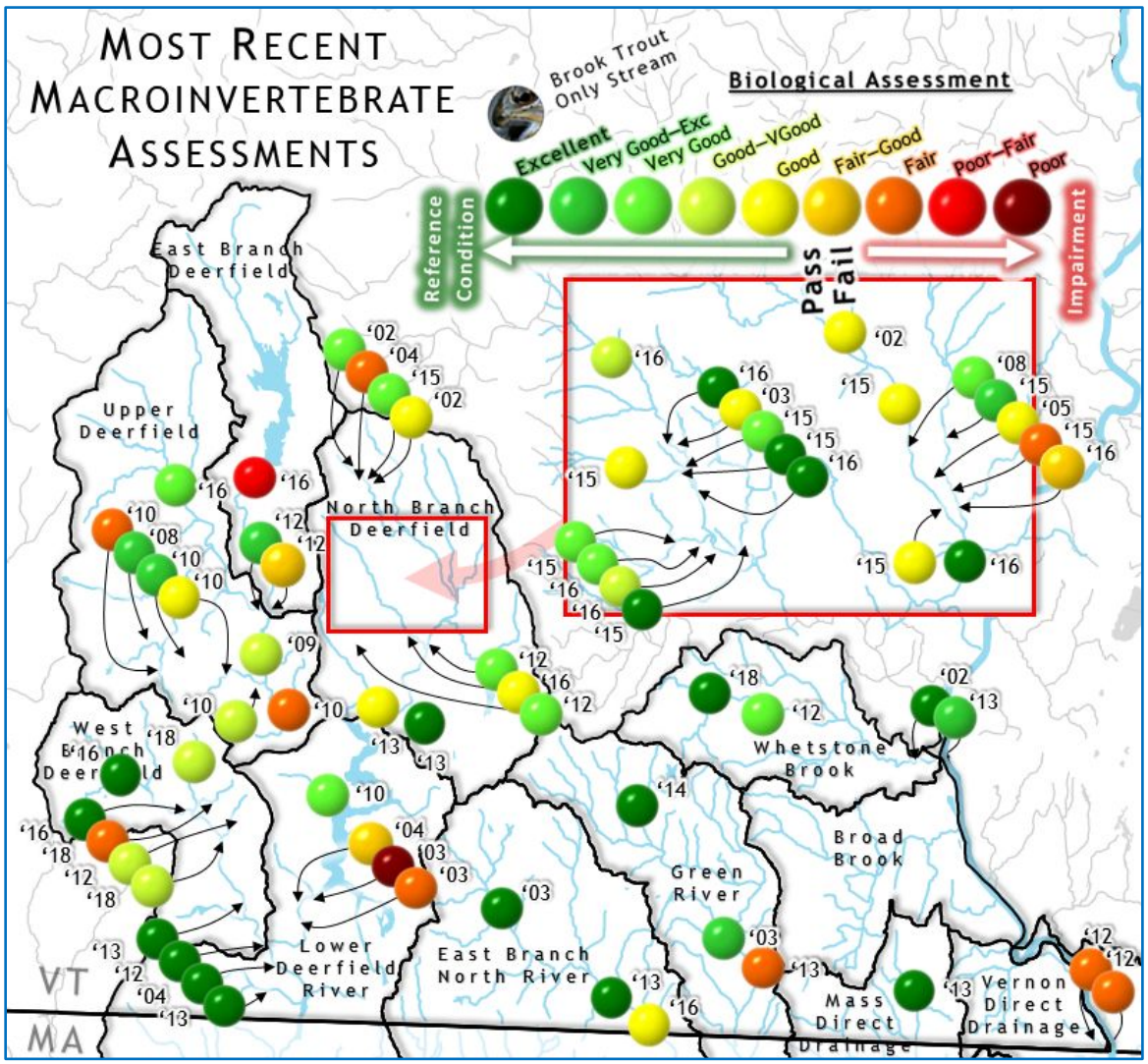

Figure 6. Macroinvertebrate Biological Conditions

stormwater runoff and chloride concentrations in these areas. There are 54 known dams in the Basin impacting flows, sediment transport and aquatic organism passage on the mainstem rivers as well as tributaries and streams.

Flow alteration is the most prevalent stressor[6] in the streams and rivers of the Basin. Leading pollutants include acid and mercury deposition, *E. coli* bacteria, excess nutrients and temperature modifications – both hot and cold.

In many Basin tributaries fish communities are impacted by low acidity and low productivity of headwater streams (Figure 7).

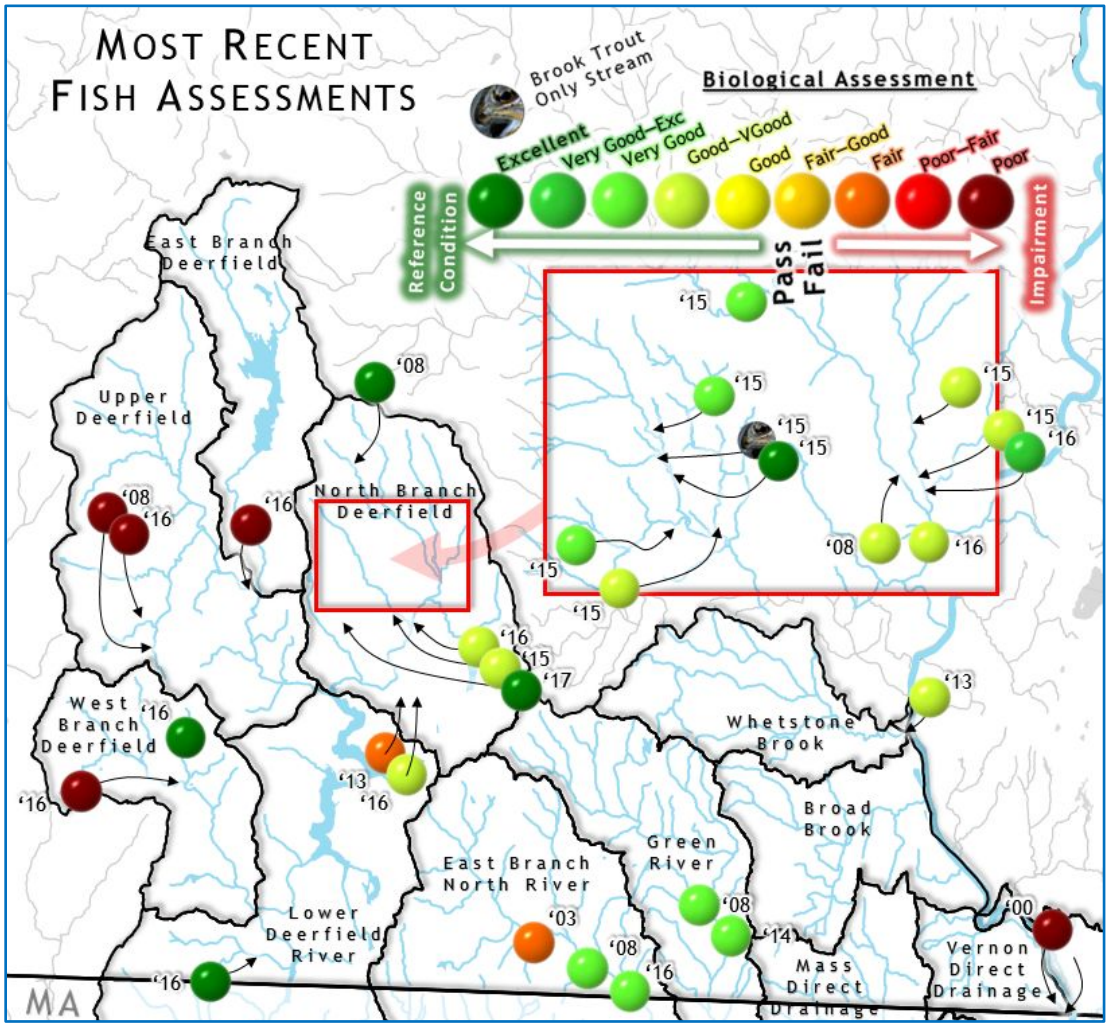

Figure 7. Fish Community Biological Conditions

[6] See VSWMS for pollutant definitions.
http://www.anr.state.vt.us/dec/waterq/wqd_mgtplan/swms_appB.htm.

Excellent water quality in many of the tributaries, along with striking geologic formations create many popular swimming holes on rivers, streams and lakes. Broad Brook falls and gorge may be the best example and is being nominated as a candidate for Outstanding Resource Water based on its aesthetic value and swimming use.

Figure 8 compares the conditions of assessed rivers and streams in the Basin with assessed rivers statewide for five designated uses. For most designated uses Basin rivers exceed the state-wide average for full support of these uses.

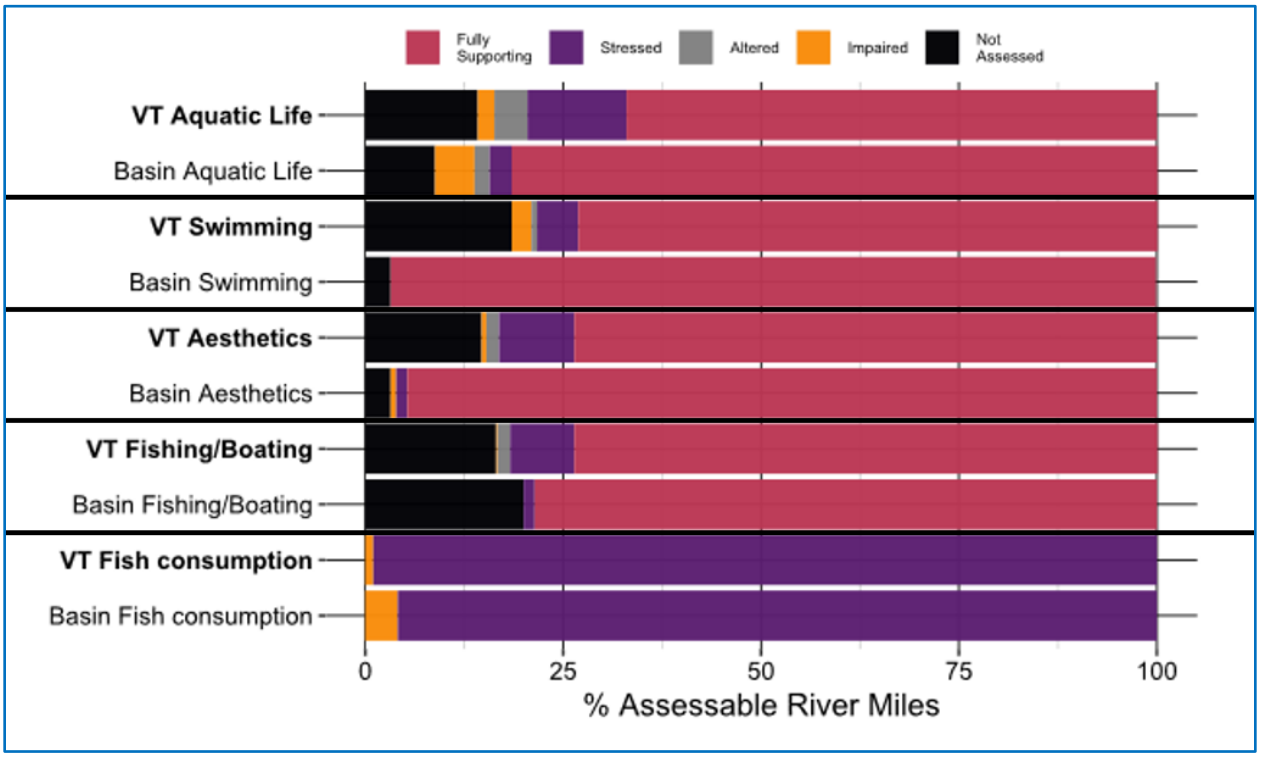

Figure 8. Use Conditions of Assessed Rivers and Streams

Condition of Lakes and Ponds

There are 17 lakes and ponds in the Deerfield Basin that are 20 acres or greater, which total approximately 4,000 acres. The largest is Harriman Reservoir (2,040 acres), followed by Somerset Reservoir (1,568 acres), Sadawga Lake (194 acres), and Sherman Reservoir (160 acres). Harriman Reservoir is the second largest lake found entirely in Vermont. All of these lakes have dams that elevate the water levels.

Lake and pond water quality and habitat conditions are monitored through numerous programs including the Spring Phosphorus and Lake Assessment Programs and by the Lay Monitoring Program. While many lakes and ponds fully support the requirements of the VWQS, a number are impacted by acidification, and several exhibit high levels of

mercury in fish. Both acid and mercury result from atmospheric deposition from sources outside of Vermont and are exacerbated by local geological conditions and water level manipulation.

Lake-specific data is analyzed and compiled to create the Vermont Lake Score Card. The Score Card rates Vermont lakes in terms of nutrient trend, invasive species, mercury, and shoreland condition. Figure 9. provides a comparison of the conditions of lakes in this basin with lakes statewide. Individual lake assessments can be reviewed from the Vermont Lakes Scorecard.

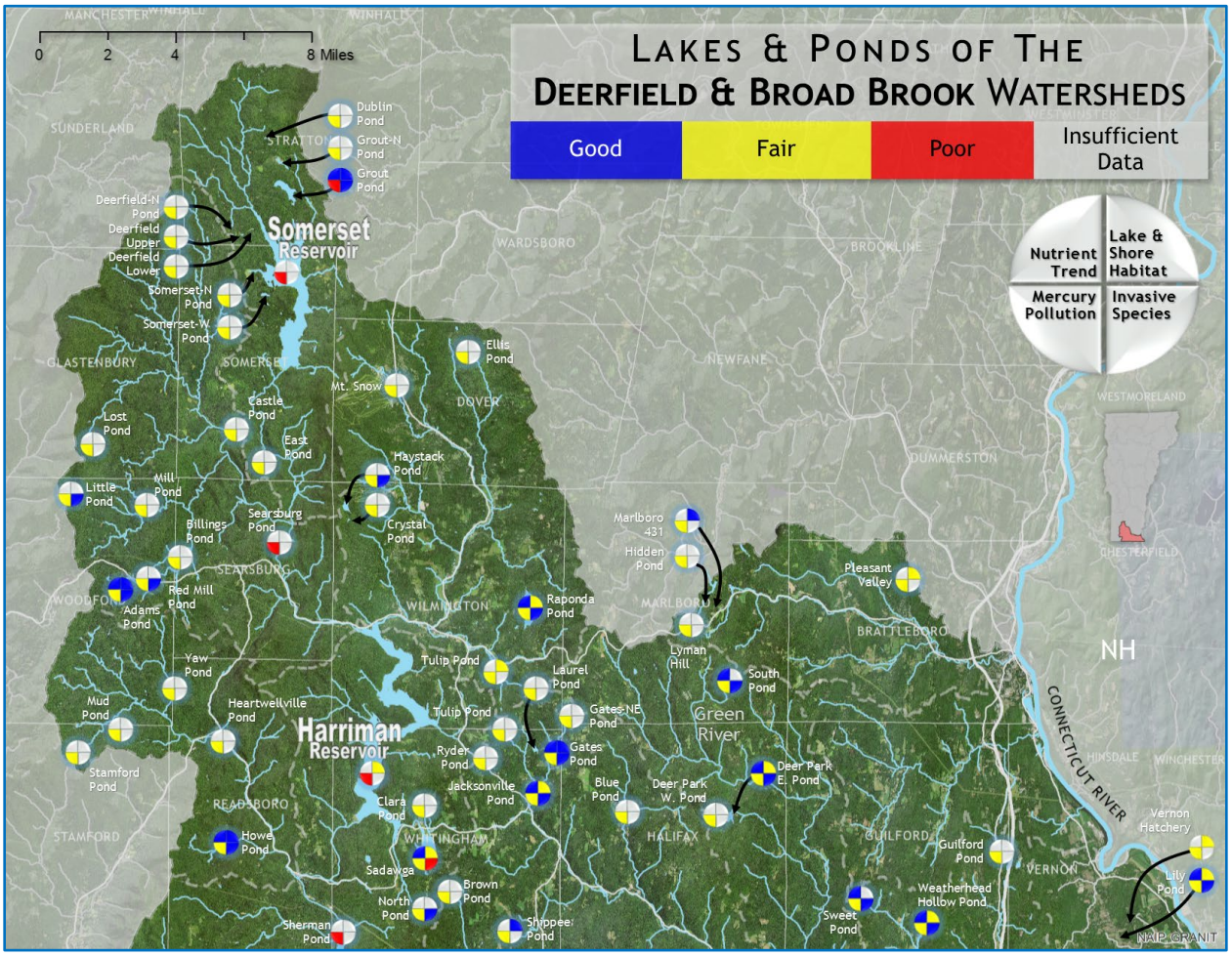

Figure 9. Lake Score Card Conditions

Figure 10 compares the conditions of assessed lakes and ponds in the Basin with those assessed statewide for five designated uses. Fewer Basin lakes and ponds have invasive species and more have good habitat conditions. However due to the extent of acid and mercury impaired lakes in the region the water quality status is below state averages.

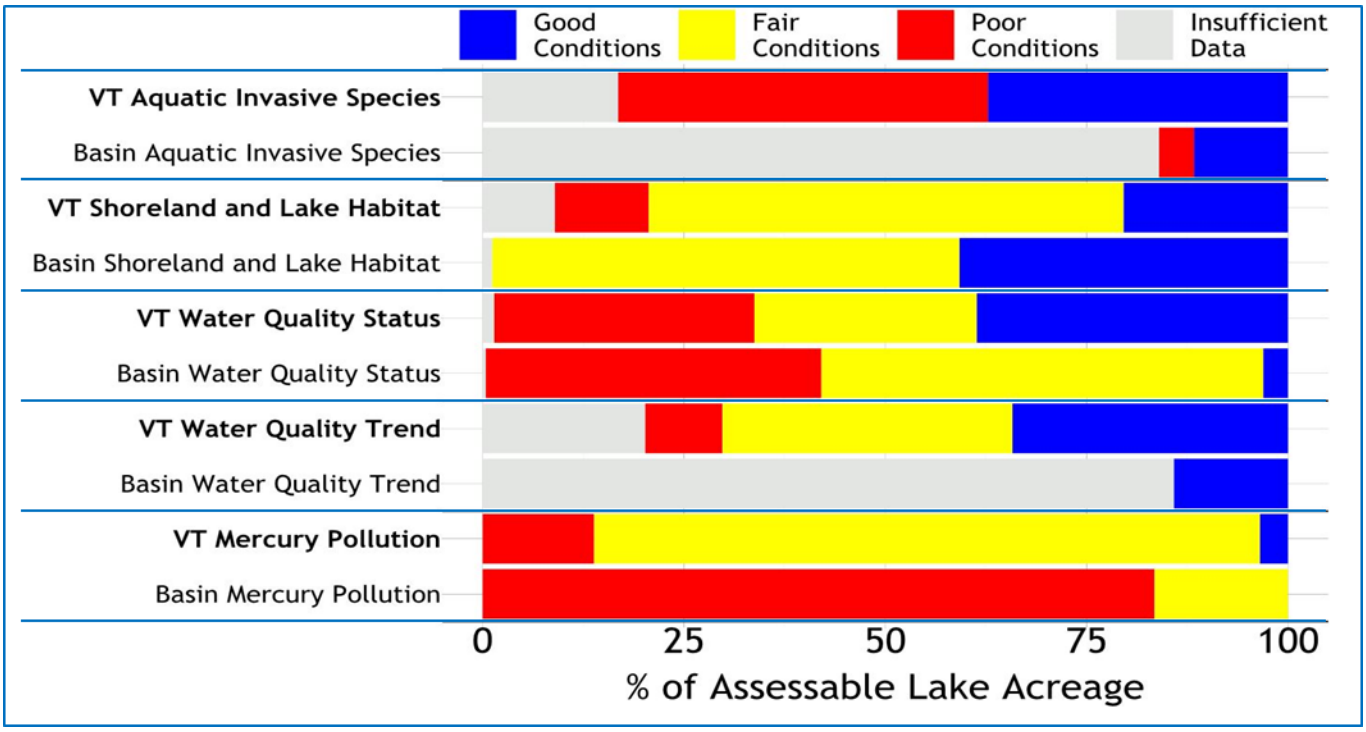

Figure 10. Use Conditions of Assessed Lakes

The greatest stressors to lakes in the Basin are acid and mercury deposition. Eleven lakes are impaired due to acid and four due to mercury. Basin 12 has more acid impaired lakes than any other basin in the state attributable to the prevailing weather pattern that carries mid-west air pollution through the region, proximity to those pollution sources and to the lack of buffering capacity of the bedrock geology.

Acid and Mercury Impaired Lakes		
Lake	**Acid**	**Mercury**
Adams Reservoir	X	
Grout Pond	X	X
Harriman Reservoir (Whitingham)	X	
Haystack Pond	X	
Howe Pond	X	
Lily Pond (Vernon)	X	
Little Pond (Woodford)	X	
Lost Pond (Glastenbury)	X	
Searsburg Reservoir		X
Sherman Reservoir		X
Somerset Reservoir	X	X
South Pond (Marlboro)	X	
Stamford Pond	X	

Table 1. Acid and Mercury Impaired Lakes

Condition of Wetlands

Wetlands are identified on the Vermont Wetlands Inventory Map however it is estimated that National Wetland Inventory maps, upon which Vermont Wetlands Inventory Maps are based, miss 82% of wetlands less than 3 acres in size and 68% of wetlands 3-20 acres in size.[7] Hence many wetlands in the Basin may not be mapped.

Protecting and monitoring wetlands is more effective when wetlands have been located on the landscape. Accurately mapping wetlands in Basin 12 is a priority to order to properly evaluate wetland contributions to stormwater and floodwater storage, erosion control, water quality, fish and wildlife habitat and more. Towns experiencing strong development pressure or with many high value wetlands, are particularly in need of accurate mapping which can be done using modern LIDAR imaging and field verification. Wilmington, Dover and Vernon are priority towns for wetland mapping.

More than 35% of the original wetlands in Vermont have already been lost. In recent years, residential, commercial and industrial development have been the primary causes of wetland loss. Identifying wetland restoration opportunities in the Basin is needed.

Few wetlands in Basin 12 or the state have been assessed for quality. Of those that have been assessed through the Vermont Rapid Assessment Methodology (VRAM) those in Basin 12 have ranked along the upper end of the scale, indicating higher quality and little disturbance (Figure 11).

A significant portion of Basin's wetlands are within the USFS Green Mountain National Forest affording them a high level of protection against disturbance. Others are protected on lands owned and conserved by Great River Hydro's easements with Vermont Land Trust (VLT). The lower elevation lands are subjected to possible flooding in the event of highwater releases from the hydroelectric dams along the Deerfield River system.

Outside of these areas, important wetlands in the Basin include the Vernon Black Gum Swamps, the floating bog in Lake Sadawga and Atherton Meadows wetland in Vermont's Atherton Meadows Wildlife Management Area. All three of these are recommended for assessment for consideration as Class 1.

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[7] https://www.uvm.edu/rsenr/sal/leslie/Morrissey_Sweeney.pdf

The Vernon Black Gum Swamps, Lily Pond and other wetlands in Vernon host a very high frequency of Rare, Threatened and Endangered (RTE) species and unusual species composition due to their southerly location in state. The area also has a higher than usual development pressure/potential due to its proximity to Massachusetts, the extent of undeveloped flat land, and the recent loss of income from the decommissioning of the Vermont Yankee Nuclear Power plant leading to interest in new development plans.

Many vernal pools are critical habitat for many native amphibians. Some have been identified and many more are awaiting field verification of their locations. Most towns have not had complete, ground truthed vernal pool surveys. Identifying their locations increases the likelihood of full protection under the Vermont Wetlands Rules.

Beavers are important wetland influencers. Allowing wetlands to naturally change in size and shape due to alterations by beavers is important to maintaining natural water systems and diverse aquatic habitat. Helping towns manage beavers and wetlands is an ongoing need. Large areas of undeveloped land, such as owned by Green Mountain National Forest, could be assisted in considering ways to fully support natural beaver activity in wetlands.

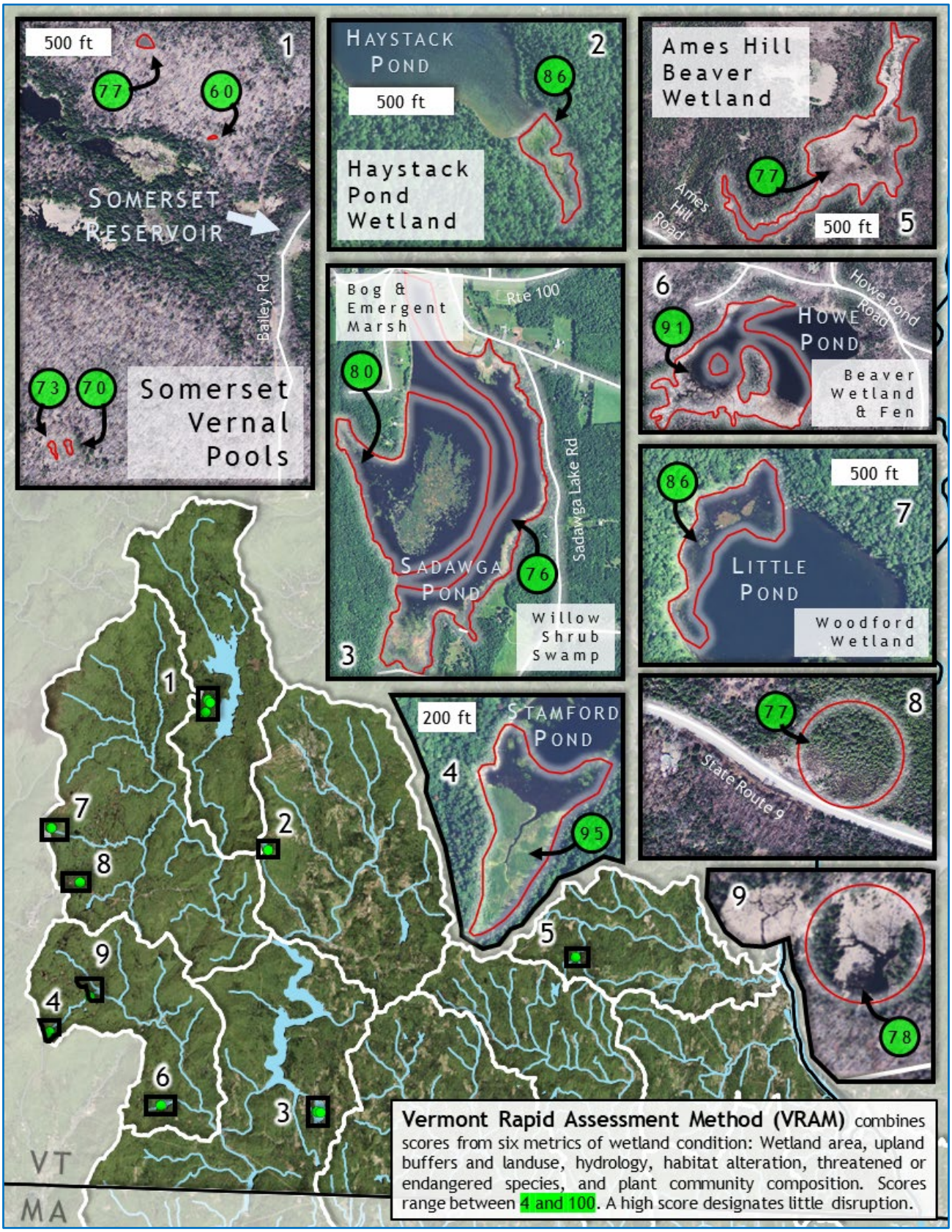

Figure 11. Condition of Assessed Wetlands

Condition of Fisheries

The Deerfield watershed and southern tributaries to the Connecticut River provide habitat for a variety of warm and cold-water fish species. The waterbodies in the Deerfield watershed include large reservoirs for hydropower generation, lakes and ponds which provide warmwater fisheries, small headwater streams providing cold-water habitat for trout, and large tributary streams. This diversity of habitat types promotes a range of fishing opportunities throughout the Basin.

One of the more profound characteristics of the Deerfield relates to the number of impoundments operated for hydropower. Somerset, Searsburg, Harriman, and Sherman are all part of a hydro power complex within the Deerfield. While these reservoirs interrupt natural stream processes, they also provide habitat for a variety of species and are popular recreational fisheries. Harriman and Somerset are the two largest reservoirs in the Basin.

Lakes and Ponds

The Basin also includes several other popular lakes and ponds including Lake Raponda, Lake Sadawga, South Pond, and Weatherhead Hollow where American eel, a Species of Greatest Conservation Need (SGCN) was observed in 2013.

Small Headwater Streams

Small headwater streams that provide habitat for native Brook Trout are found throughout the Basin. Streams with relatively high abundance include Bond Brook, Broad Brook, Cold Brook, Deerfield mainstem (i.e. Harriman bypass), Haystack Brook, Lamb Brook, Oak Brook, Central Park Brook, and West Branch Deerfield. It should be noted that trout abundances are highly variable and can be influenced by several factors, with stream temperatures being the most profound.

Large Tributary Streams

Large tributary streams include the North Branch Deerfield, East Branch Deerfield, Mainstem Deerfield, Whetstone Brook, Broad Brook and the Green River. Fish production downstream of Somerset and within the Harriman bypass, is presumed to be inhibited by the cold-water, low oxygen discharge from the dam. However, results for the region indicate that even in undeveloped watersheds, in the absence of a major dam, trout productivity is low to mid-range for the region.

Although these coldwater releases may result in sub-optimal conditions for trout growth immediately below the project, preliminary data indicate that the affected reach is relatively short. Moreover, deep water outlet structures can provide beneficial coldwater releases below hydroelectric projects which create temperature regimes suitable for year-round survival of trout[8]. Consistent coldwater releases can be particularly important in light of climate change predictions as these releases also extend and enhance coldwater habitats and fisheries further downstream. As such, broader trout fisheries benefits may be realized and outweigh localized impacts.

The North Branch Deerfield and tributaries are generally influenced by land use development including two ski resorts and agriculture. Currently the North Branch flows through a snow-making pond located at Mount Snow, which likely influences stream temperatures. Tributaries to the North Branch Deerfield such as Cold Brook are also influenced by snow-making due to two withdrawal sites, one located at the Hermitage and one located downstream of Mount Snow's snowmaking pond.

Tropical Storm Irene

Tropical storm Irene occurred in 2011 and resulted in the deposition of over six inches of rain in the central and south-eastern portion of Vermont. Post-flood activities required stream alteration to protect life and property and rebuild critical transportation infrastructure[9]. However, much of the in-stream work resulted in the widening, deepening and straightening of stream channels. In some cases, in-stream wood was removed, stream banks were bermed, and stream bed elevations were raised. As a result, aquatic habitats including a diversity of substrate types, depths, flows, and cover, necessary to support healthy fish populations, suffered severe negative impacts.

In 2012, VDFW staff conducted roadside assessments of instream habitat degradation throughout the central and southern portion of Vermont.[10] . An estimated 77 miles of streams were identified as being degraded from post-flood stream alteration activities. As such, the VDFW has been actively working to restore reaches to more natural conditions. For example, the Whetstone was recently restored to remove an over-abundance of bed armoring which resulted in subsurface flows. Efforts to continue

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[8] Walters, J.P., T.D. Fresques and S.D. Bryan. 1997. Comparison of creel returns from rainbow trout stocked at two sizes. North American Journal of Fisheries Management, 17:474-476.

[9] Lunderville, N. 2011. Irene recovery report. A stronger future. A report to the Governor of Vermont.
[10] Kirn, R. 2012. Impacts to Stream Habitat and Wild Trout Populations in Vermont . Following Tropical Storm Irene. Vermont Fish and Wildlife Department Annual Report, Project No.: F-36-R-14.

stream restoration in these reaches are paramount as it may take decades before these streams recover.

In sum, trout production can be influenced by many factors including food availability, water chemistry, temperature and available habitat. Trout production appears to be limited throughout the region due to natural causes such as water chemistry, stream temperatures, and in certain areas may be further impacted by flow alterations and post-Irene alterations within the system. Tributary streams provide greater trout abundances, and stocking supplements catchable sized trout to support a moderate recreational fishery. Efforts to improve aquatic passage, protect riparian corridors, re-evaluate the flow regime during the FERC relicensing process, and restoring Post-Irene reaches are management tools that could be applied to the Deerfield watershed, and tributaries of the Connecticut River.

All waters of Vermont are under a Vermont Department of Health Fish Consumption Advisory for exceeding the USEPA mercury limits in fish. Grout Pond, Somerset Reservoir, Harriman Reservoir, Sherman Reservoir, and Searsburg Reservoir fall under a Special Advisory with lower consumption limits of certain species due to their high acidity. Mercury is a chemical that becomes toxic to humans and other animals at high concentrations. As big fish eat smaller fish, the mercury concentrations increase in the fish tissues, and through this process of bioaccumulation, mercury levels become unsafe for human consumption of certain species of fish.

Management Recommendations:

1. Protect riparian corridors
2. Improve flood resiliency and restore post-Irene impacts.
3. Improve aquatic habitat and connectivity, including the strategic placement of wood in streams would also benefit native trout species in certain reaches.
4. Where flows are regulated, promote the natural flow regime
5. Help stop the spread of exotic species and pathogens
6. Protect water quality
7. Identify and designate B1 High Quality Fishing – wild salmonid streams quality

The complete *Deerfield Watershed and lower Connecticut Tribs (Basin 12) Fisheries Assessment* report provided by VDFW Fisheries Division can be found in Appendix D.

Chapter 2 Priority Surface Waters for Protection

All surface waters in Vermont are managed to support designated uses valued by the public at a level of Class B(2) or better (Table 2). These uses include swimming, boating, fishing, aquatic biota, aquatic habitat, aesthetics, drinking water source and irrigation. Several waters in the Basin are identified as being high quality, and these, as well as other unique waterbodies, are candidates for establishing alternate management objectives or augmented protections through one of the following processes.

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

Table 2. Criteria for Water Classes

Use	A1	B1	B2
Aquatic Biota	Excellent - Natural Condition	Very Good - minor change	Good - moderate change
Aquatic Habitat	Natural Condition	Very Good - minor change	Good - moderate change
Aesthetics	Natural Condition	Very Good	Good
Boating	Excellent - maximum extent without degradation	Very Good - maximum extent with no more than minor degradation	Good - meets hydrological criteria
Fishing	Salmonid population in Natural Condition	Salmonid population in Very Good Condition	Salmonid population in Good Condition
Public Water Supply	(A2) Uniformly excellent character, highly suitable	---	Suitable with treatment
Swimming	Excellent	---	Good

Class A(1) waters are waters in a natural condition that have significant ecological value. By Vermont statute[11] all surface waters above 2,500 feet of elevation are Class A(1). Below the 2,500-ft. elevation threshold, there are numerous surface waters which meet the biological criteria established for Class A(1), or exhibit characteristics consistent with Class A1. These waters are or can be designated as Class A(1).

[11] 10 V.S.A. § 1253

Class A(2) waters are waters of uniformly excellent character that, with filtration and disinfection, are suitable for use as a public water source.

Class B(1) waters are waters of which one or more uses are documented to be higher quality than Class B(2) criteria for waters.

Class B(2) waters are waters that are suitable for: swimming and other primary contact recreation; irrigation and agricultural uses; aquatic biota and habitat; good aesthetic value; boating, fishing, and other recreational uses; and, with filtration and disinfection, as a public water source. Class B(2) is the base (or default) classification to which all surface water uses, excepting those already designated as Class A(1), A(2), and/or B(1) are managed.

Figure 12 presents the Basin 12 protection priorities for lakes, rivers and wetlands.

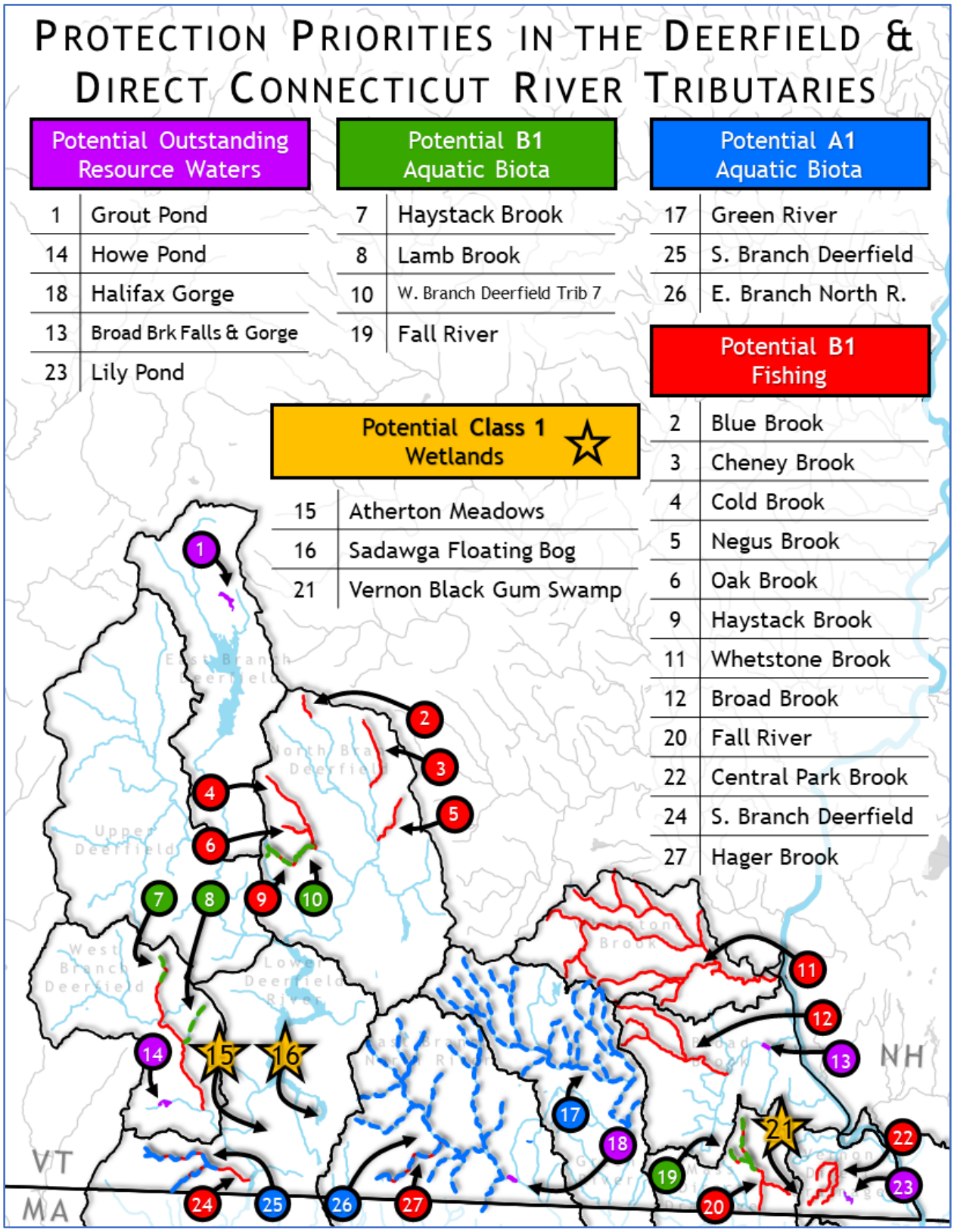


Figure 12. Protection Priorities

Reclassification of Waters

The waters presented in Table 3 meet or exceed the criteria for aquatic biota to the level listed.

Table 3.

Sub-watershed	Class	Use
Reclassification Proposed		
East Branch North River	A(1)	Aquatic Biota
Green River	A(1)*	Aquatic Biota
South Branch Deerfield River	A(1)	Aquatic Biota & Fish

* Due to its excellent condition the Green River is being recommended for A(1) reclassification. The Green River and its tributaries from the Vermont-Massachusetts state line to the Green River water supply intake 6.4 miles downstream in Massachusetts serves as a Massachusetts Class A - Public Drinking Water Supply for the town of Greenfield. In order to protect this resource, the Vermont portion of the river should be protected to the highest level possible.

The waters presented in Table 4 meet or exceed the criteria for the listed use to the level of B(1)for Aquatic Biota & Fishery

Table 4.

Sub-watershed	Class	Use
Reclassification Proposed		
Lamb Brook	B(1)	Aquatic Biota
West Branch Deerfield River - Trib 7	B(1)	Aquatic Biota
Fall River	B(1)	Aquatic Biota & Fishery
Haystack Brook	B(1)	Aquatic Biota & Fishery
Blue Brook	B(1)	Fishery
Broad Brook	B(1)	Fishery
Central Park Brook	B(1)	Fishery
Cheney Brook	B(1)	Fishery
Cold Brook	B(1)	Fishery
Hager Brook	B(1)	Fishery
Negus Brook	B(1)	Fishery
Oak Brook	B(1)	Fishery
South Branch Deerfield River	B(1)	Fishery
West Branch Deerfield River	B(1)	Fishery
Whetstone Brook	B(1)	Fishery

Outstanding Resource Waters (ORW) Designation

In 1987, the Vermont Legislature passed Act 67, "An Act Relating to Establishing a Comprehensive State Rivers Policy." A part of Act 67 provides protection to rivers and streams that have "exceptional natural, cultural, recreational or scenic values" through the designation of Outstanding Resource Waters (ORW). Depending on the values for which designation is sought, ORW designation may protect exceptional waters through the permits for stream alteration, dams, wastewater discharges, aquatic nuisance controls, solid waste disposal, Act 250 projects and other activities. ORWs can be designated by the Agency of Natural Resources through a public petition process. ORWs display outstanding qualities that are determined to deserve a higher level of protection. ORW designation may be based on any 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.

While there are presently no ORWs in Basin 12, several surface waters have been identified as prospective candidates for ORW, which are presented in Table 5. As part of the implementation of this tactical basin plan, the Agency, in cooperation with a petitioner, may evaluate the consistency of these surface waters with the features and values identified in prior ORW determinations. Surface waters that satisfy criteria for designation as ORW may be proposed for such designation through rulemaking.

Table 5. Proposed ORW Designation

Water	Location	Supporting Data	ORW Feature
Grout Pond	Stratton	WQ, scenic, RTE, Uncommon plant & animal	1, 5, 6, 8, 12
Howe Pond	Readsboro	Class A2, state forest land	1, 2, 5, 6, 8,
Lily Pond	Vernon	RTE, NC, uncommon plant & animal	5, 6, 8, 12
Broad Brook falls and gorge	Guilford	Scenic gorge and waterfalls, state lands river recreation access	7, 8, 12
Halifax Gorge	Halifax	1,500 ft spanning gorge, East Branch North River	7, 8, 12

Class 1 Wetlands Designation

The following wetlands are recommended for assessment for consideration of possible reclassification to Class 1.

Table 6.

Wetlands to Assess
Atherton Meadows (Whitingham)
Lake Sadawga floating bog (Whitingham)
Lily Pond (Vernon)
Vernon Black Gum Swamps (Vernon)

Identification of Existing Uses

Consistent with the federal Clean Water Act and the Vermont Water Quality Standards the Agency 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. An existing use is any designated use that has actually occurred on or after

November 28, 1975, in or on waters, whether or not the use is included in the standard for classification of the waters, and whether or not the use is presently occurring. Once identified, the level of water quality necessary to protect existing uses shall be maintained and protected regardless of the water's classification. The public is encouraged to recommend waters for existing uses for swimming, boating, fishing, drinking water, and ecological significance given that they provide evidence of such use.

The Agency stipulates to these broader existing uses:

- all lakes and ponds in the basin have existing uses of swimming, boating and fishing,
- fishing in streams and rivers is widespread and too numerous to document individually,
- small streams provide spawning and nursery areas, which contribute to fish stocks downstream.

Existing uses identified for the Basin to date should be viewed as only a partial accounting of known existing uses based upon limited information. The list does not change protection under the Clean Water Act or Vermont Water Quality Standards for waters not listed. The existing uses in the Basin for swimming, boating, fishing, and drinking water supply are found on the Deerfield Basin Plan webpage at: http://dec.vermont.gov/watershed/map/basin-planning/basin12 and in Appendix B.

Adams Reservoir,
Woodford State Park

Chapter 3 Priority Areas for Surface Water Restoration

A. Impaired Waters and Priority Surface Waters

The Vermont Surface Water Management Strategy (VSWMS) lays out the goals and objectives of VDEC's Watershed Management Division for addressing pollutants and stressors that can negatively affect the designated uses of Vermont surface waters. When waters do not fully support desired uses they are listed as **stressed, altered** or **impaired**.

Section 303(d) of the Federal Clean Water Act requires states to develop lists of impaired waters that include lakes, ponds, rivers and streams that do not meet Water Quality Standards. Five lists identify waters that do not meet water quality standards to some degree:

- Part A (303d list) – impaired waters requiring a TMDL;
- Part B – impaired waters with other required remediation measures in place;
- Part D – impaired waters with TMDLs in place;
- Part E – waters altered by aquatic invasive species;
- Part F – waters altered by flow modifications.

The sixth list

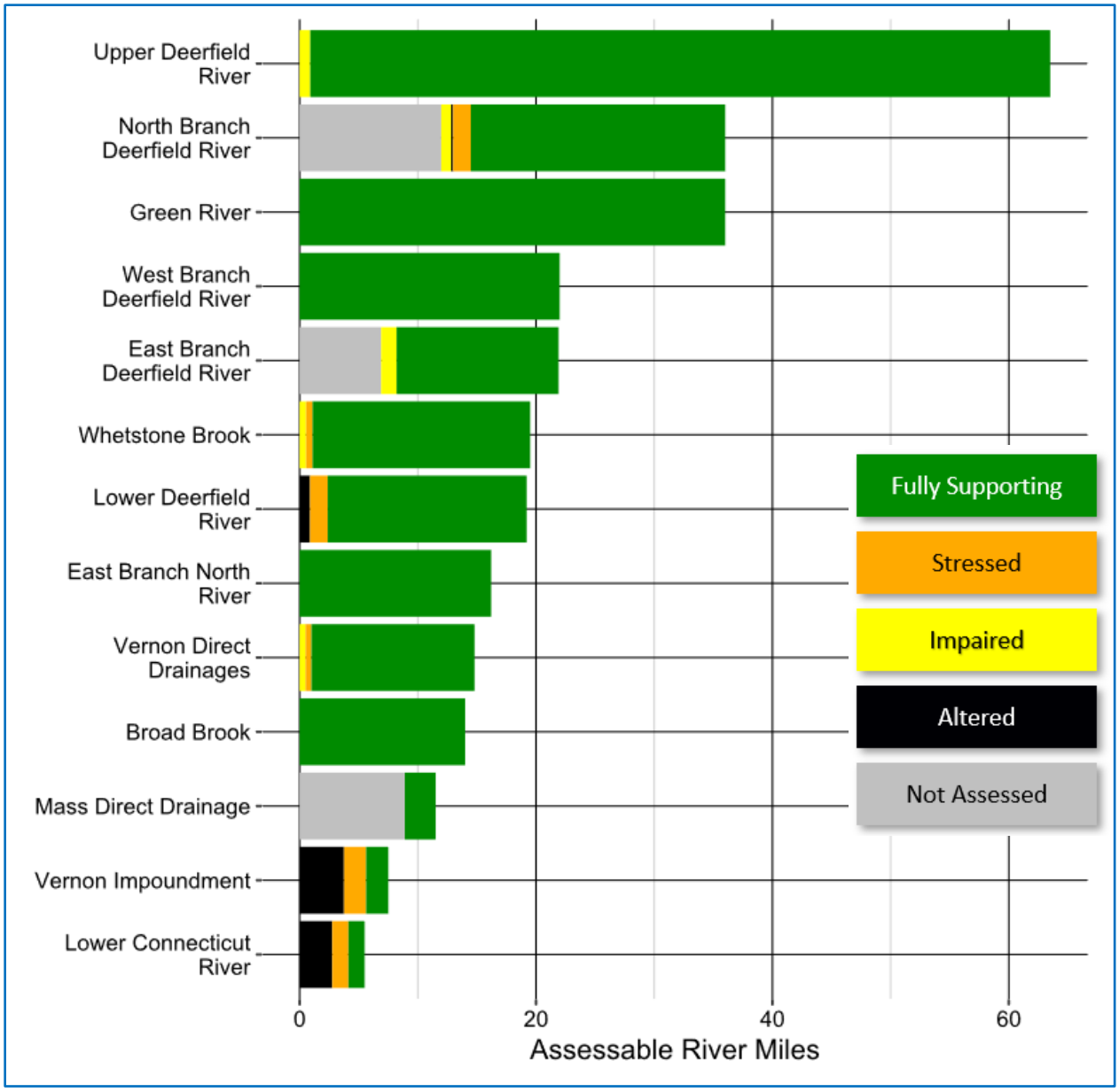
- Stressed Water – refers to waters that support uses but where water quality or habitat conditions have been disturbed and may require some attention to maintain or restore water quality.

These priority waters comprise the 303(d) List of Impaired Waters and List of Priority Surface Waters and can be viewed on the Vermont Environmental Atlas. For a more detailed description of monitoring results use the Integrated Watershed Information System (IWIS) online data portal. These lists also include preliminary information on responsible pollutants and/or physical alterations to aquatic and riparian habitat, the stressors and if known, the sources of the pollutant.

The results of monitoring and assessment data are documented in the Basin 12 Water Quality and Aquatic Habitat Updated Assessment Report and the Basin 13 - Lower Connecticut River Direct Drainage Assessment Report. The waterbodies identified on these lists are a focus for remediation efforts in this plan.

The majority of the Basin's waters fully support the desired uses as shown in Figure 13.

Figure 13. Use Support of Assessed Rivers



Impaired Waters and Priority Surface Waters

Figures 14 & 15 provide the location and list of Priority Waters.

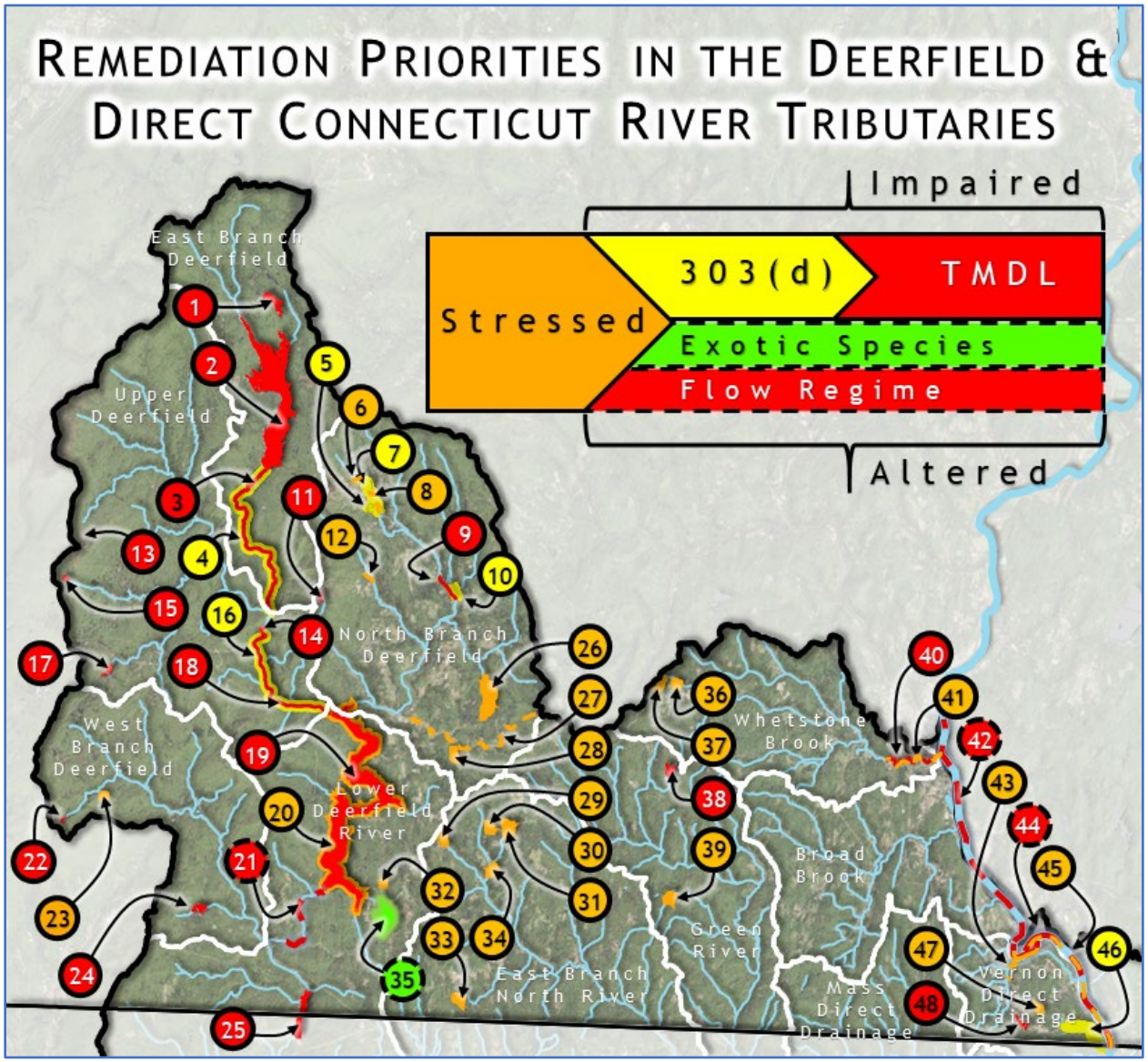


Figure 14. Remediation Priorities Map

Stressed

Map ID	Name	Pollutant/Problem	List
6	BASELODGE TRIBUTARY, FROM MOUTH UP 0.2 MILES	PHYSICAL ALTERATION,SEDIMENTATION	Stressed
8	NORTH BRANCH DEERFIELD RIVER, SNOW LAKE TO TANNERY BROOK RD	PHYSICAL ALTERATIONS, TEMP	Stressed
12	OAK BROOK, MOUTH TO HEADWATERS	ACID DEPOSITION	Stressed
20	HARRIMAN RESERVOIR (WHITHM)	ACID DEPOSITION	Stressed
23	MUD POND (WOODFD)	ACID DEPOSITION	Stressed
25	SOUTH BRANCH DEERFIELD RIVER, UP FROM SHERMAN RES	ACID DEPOSITION DEPOSITION	Stressed
26	LAKE RAPONDA	ACID DEPOSITION	Stressed
27	BEAVER BROOK	PHYSICAL ALTERATION, SEDIMENT	Stressed
28	SPRUCE POND (WILMTN)	ACID DEPOSITION	Stressed
29	RYDER POND	ACID DEPOSITION	Stressed
30	LAUREL POND	ACID DEPOSITION	Stressed
31	GATES POND	ACID DEPOSITION	Stressed
32	CLARA POND	ACID DEPOSITION	Stressed
33	SHIPPEE POND	ACID DEPOSITION	Stressed
34	JACKSONVILLE	ACID DEPOSITION	Stressed
36	MARLBORO-431;	ACID DEPOSITION	Stressed
37	HIDDEN POND	ACID DEPOSITION	Stressed
39	DEER PARK POND	ACID DEPOSITION	Stressed
41	WHETSTONE BROOK, BEND NW OF LIVING MEM PARK DOWN	SEDIMENTS, FLOW	Stressed
43	CENTRAL PARK BROOK	ACID DEPOSITION	Stressed
45	CT RIVER, BELOW VERNON DAM	TRITIUM	Stressed
47	VERNON HATCHERY;	ACID DEPOSITION	Stressed

303(d)

Map ID	Name	Pollutant/Problem	List
4	EAST BRANCH DEERFIELD RIVER, BELOW SOMERSET DAM, 5.2 MILES	ACID DEPOSITION	303(d)
5	IRON STREAM, TRIB TO JACKS BROOK (0.3 MILE)	IRON	303(d)
7	NO. BRANCH DEERFIELD RIVER, TANNERY BRK RD TO 0.2 MI ABOVE SNOW LAKE	STORMWATER, TEMPERATURE	303(d)
10	ELLIS BROOK, MOUTH TO RM 0.5	NUTRIENTS	303(d)
15	UPPER DEERFIELD RIVER, BELOW SEARSBURG DAM, 3.6 MILES	ACID DEPOSITION	303(d)
46	NEWTON BROOK, MOUTH TO RM 2.0	SEDIMENT, NUTRIENTS	303(d)

TMDL

Map ID	Name	Pollutant/Problem	List
1	GROUT POND (Stratton)	MERCURY, ACID DEPOSITION	TMDL
2	SOMERSET RESERVOIR (Somerset)	ACID DEPOSITION, MERCURY	TMDL
3	EAST BRANCH DEERFIELD RIVER, BELOW SOMERSET DAM	MERCURY	TMDL
9	NO. BRANCH, DEERFIELD RIVER, VICINITY OF WEST DOVER	E. COLI	TMDL
11	HAYSTACK POND (Wilmington)	ACID DEPOSITION	TMDL
13	LOST POND (Glastenbury)	ACID DEPOSITION	TMDL
14	SEARSBURG RESERVOIR (Searsburg)	MERCURY	TMDL
15	LITTLE POND (Woodford)	ACID DEPOSITION	TMDL
17	ADAMS RESERVOIR (Woodford)	ACID DEPOSITION	TMDL
18	UPPER DEERFIELD RIVER, BELOW SEARSBURG DAM	MERCURY	TMDL
19	HARRIMAN RESERVOIR (Whitingham)	MERCURY	TMDL
22	STAMFORD POND (Stamford)	ACID DEPOSITION	TMDL
24	HOWE POND (Readsboro)	ACID DEPOSITION	TMDL
26	SHERMAN RESERVOIR (Whitingham)	MERCURY	TMDL
38	SOUTH POND (Marlboro)	ACID DEPOSITION	TMDL
40	WHETSTONE BROOK - BRATTLEBORO	E. COLI	TMDL
48	LILY POND (Vernon)	ACID DEPOSITION	TMDL

Exotic Species / Flow Regime

Map ID	Name	Pollutant/Problem	List
35	SADAWGA POND	LOCALLY ABUNDANT EWM GROWTH.	Exotics
21	LOWER DEERFIELD RIVER BELOW HARRIMAN RESERVOIR (3.5 MILES)	HYPOLIMNETIC WATER RELEASE	FLOW
42	CT RIVER, ABOVE VERNON DAM	WATER LEVEL FLUCTUATION AT DAM	FLOW
44	CT RIVER, BELOW VERNON DAM (5.5 MILES)	FLUCTUATING FLOWS BY HYDROPOWER	FLOW
21	LOWER DEERFIELD RIVER BELOW HARRIMAN RESERVOIR (3.5 MILES)	HYPOLIMNETIC WATER RELEASE	FLOW

Figure 15. Remediation Priorities List

The goals of the Tactical Basin Plan include addressing the stressors or pollutants degrading the listed waters through geographically specific actions listed in the implementation table in Chapter 5 and the Watershed Projects Database. The types of actions prescribed are based on the stressor specific practices outlined in the Vermont Surface Water Management Strategy. Additional monitoring and assessment needs are outlined in Table 18 in Chapter 5.

An additional goal is to reduce nitrogen loading from the Basin contributes to elevated nitrogen levels in Long Island Sound and that results in a dissolved oxygen impairment. The types of actions prescribed are based on the stressor specific practices outlined in the Vermont Surface Water Management Strategy. See the section below on the Long Island TMDL.

B. Basin Specific Total Maximum Daily Loads (TMDLs)

A TMDL or Total Maximum Daily Load is the calculated maximum amount of a pollutant that a waterbody can receive and still meet Vermont Water Quality Standards. In a broader sense, a TMDL is a plan that identifies the pollutant reductions a waterbody needs to meet Vermont's Water Quality Standards and develops a means to implement those reductions. TMDLs can be calculated for reducing water pollution from specific point source discharges or for an entire watershed to determine the location and amount of needed pollution reductions.

Under Section 303(d) of the Federal Clean Water Act, all states are required to develop lists of impaired waters. The list includes impaired lakes, ponds, rivers and streams that do not meet Water Quality Standards. For Vermont, impairment is substantiated by chemical, physical or biological data collected through monitoring and these waters are noted on the state's 303(d) list of Impaired Waters. The Federal Clean Water Act requires TMDLs to be developed for waters on the list; the list provides a schedule indicative of TMDL completion priority.

Pursuant to 40 C.F.R. §130.7(b), the State may use a Water Quality Remediation Plan (WQRP) in lieu of a TMDL for an impaired water when the State determines that the pollution control requirements of the WQRP are stringent enough to meet State Water Quality Standards within a reasonable period of time.

Table 7 lists the TMDLs completed thus far in the Basin:

Table 7. TMDLs

Sub-watershed	Date	Coverage
TMDLs		
Vermont Statewide TMDL for Bacteria-Impaired Waters	2011	
North Branch-Deerfield	2011	
Whetstone Brook	2011	
TMDL for 30 Acid Impaired Lakes	2003	
TMDL for 7 Acid Impaired Lakes	2004	
TMDL for 2 Acid Impaired Lakes	2012	
Vermont - Mercury	2007	Statewide
Long Island Sound Dissolved Oxygen TMDL	2000	Multi-state
Vermont Enhanced Implementation Plan	2013	
Northeast Regional Mercury Total Maximum Daily Load	2007	Multi-state
Mount Snow Resort Water Quality Remediation Plan	2011	Mt Snow Resort
Mount Snow Carinthia Iron Stream Remediation Plan	2015	Mt Snow Resort

Long Island Sound Dissolved Oxygen TMDL

The Long Island Sound Dissolved Oxygen TMDL, released in 2000, is designed to address low dissolved oxygen or hypoxia in Long Island Sound bottom waters (Figure 16). 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 oxygen-breathing organisms use up the available oxygen in the lower water column and in the bottom sediments, gradually reducing the dissolved oxygen concentration to unhealthy levels.[12]

[12] A Total Maximum Daily Load Analysis to Achieve Water Quality Standards for Dissolved Oxygen in Long Island Sound

In 2013 a Vermont-specific section was added to the LIS-TMDL to address four goals:

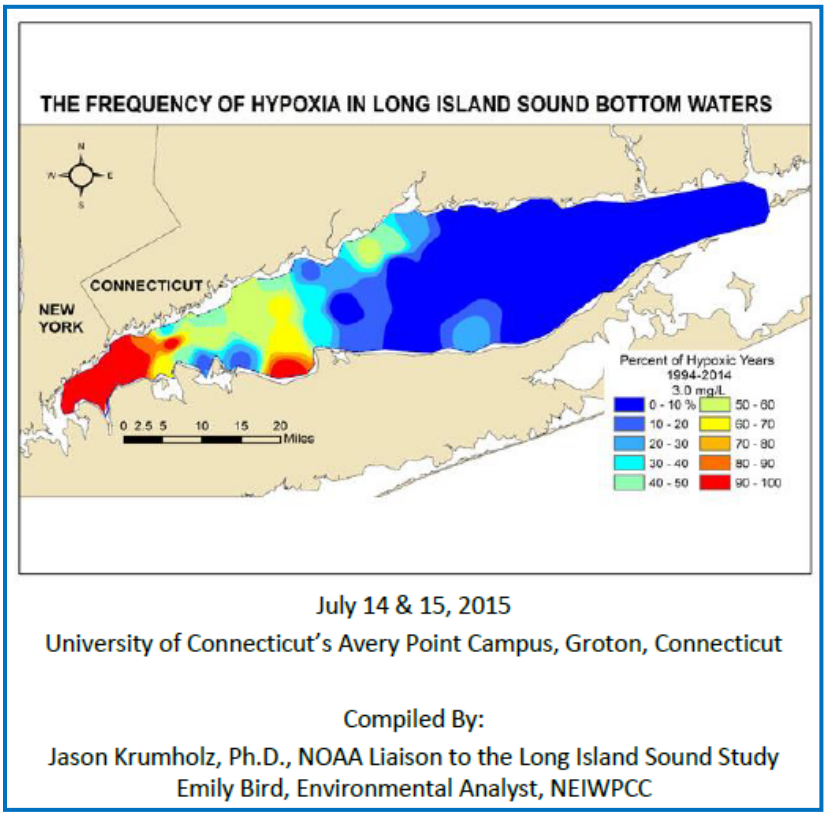


Figure 16. Frequency of Hypoxia in Long Island Sound[13]

- identify the Vermont sources of nitrogen as they are currently understood, across broad land use sectors, such as developed, agricultural and forested;
- identify the current 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 time period of 1990;
- 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
- 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% NPS nitrogen reduction and if these actions are sufficient to maintain that control into the future. [14]

A USGS report found nitrogen loading of 1,750 pounds per square mile per year in the Connecticut River watershed near the confluence of the Saxtons River is coming from sources in Vermont and New Hampshire. This rate of loading is lower than that

[13] Proceedings of the 2015 Long Island Sound Water Quality Workshop
[14] Vermont Enhanced Implementation Plan for the Long Island Sound TMDL

recorded at the MA/CT state line near Thompsonville Connecticut, at 2230 pounds per square mile per year.[15]

Loading of nitrogen in the Connecticut River watershed has also been modeled through the Spatially Referenced Regressions on Watershed Attributes (SPARROW) model by the New England Interstate Water Pollution Control Commission and USGS. The findings were presented in a 2004 publication by Richard Moore. This modeling included estimated loading from municipal discharges, agricultural, and developed lands, as well as with atmospheric deposition along with additional calculations for watershed and in stream nitrogen loss. This model estimated Vermont nitrogen export to LIS to be about 4,367 metric tons or 24% of the total load to the Sound. Data collected at the Massachusetts state line indicate that 41 percent of the nitrogen load entering Long Island Sound originated upstream from Vermont and New Hampshire. SPARROW results also indicate that, of the nitrogen load in the Connecticut River leaving New Hampshire and Vermont, 11 percent is from municipal wastewater-treatment facilities and other point sources; 6 percent is from developed land; 20 percent is from agricultural lands; and the remaining 63 percent is from atmospheric deposition. [16]

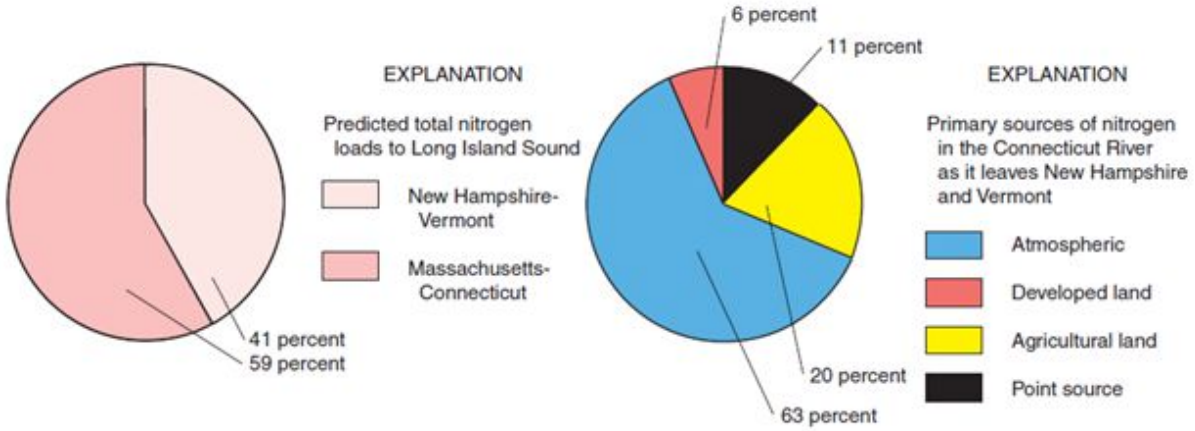


Figure 17. Example from the Connecticut River Basin of total maximum daily load applications of the results from the New England SPARROW model for total nitrogen.[17]

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[15] Assessment of Total Nitrogen in the Upper Connecticut River Basin in New Hampshire, Vermont, and Massachusetts, December 2002–September 2005
[16] Estimation of Total Nitrogen and Phosphorus in New England Streams Using Spatially Referenced Regression Models
[17] Ibid.

In 2017, EPA embarked on its Nitrogen Reduction Strategy to investigate and better define control actions to reduce nitrogen in the Long Island Sound. Information on the most current developments and strategies can be found in EPA's Long Island Sound Study, a summary is provided below:

> *EPA is implementing a strategy to aggressively continue progress on nitrogen reductions, in parallel with the States' continued implementation of the 2000 Total Maximum Daily Load (TMDL) and achieve water quality standards throughout Long Island Sound and its embayments and near shore coastal waters. The strategy recognizes that more work must be done to reduce nitrogen levels, further improve dissolved oxygen (DO) conditions, and address other nutrient-related impacts in Long Island Sound. The nitrogen reduction strategy complements the 2000 TMDL in important ways. Foremost, while the 2000 TMDL is premised on achieving water quality standards for DO in the open waters of LIS, the EPA strategy expands the focus to include other nutrient-related adverse impacts to water quality, such as loss of eelgrass, that affect many of LIS's embayments and near shore coastal waters.*

The sources of nitrogen to be addressed in Vermont include wastewater discharges, agricultural lands, developed lands and forest practices. Overarching strategies and the steps Vermont is taking to implement these by enacting Act 64 in 2015 include:

- *Continue implementation of nitrogen reductions from wastewater treatment plants (WWTPs), including capping WWTP nitrogen loads, monitoring nitrogen discharged from WWTPs, and the completion of nitrogen removal optimization studies at WWTPs in the VT portion of the LIS watershed.* The development of targets for nitrogen reduction is underway. Discharge permits are being reviewed and updated as part of the permit renewal process.
- *Control non-point source discharges from agricultural lands through implementation of Required Agricultural Practices (RAP) and Best Management Practices (BMP) to decrease sediment and nutrient runoff.* RAPs have been updated and implemented to include increased requirements for small farm certification, increased buffer zones, livestock exclusion, additional nutrient management, and tile drainage. Additional requirements include inspections of small certified farms; requirements for training farm owners or operators regarding prevention of discharges to waters; mitigation of stormwater runoff; land application of manure or nutrients; nutrient management planning; and certification of custom applicators land-applying manure or nutrients.
- *Continue implementation of state stormwater permits covering construction, roads, direct and indirect discharges.* Activities that require an ANR stormwater permit,

have been expanded to include: construction of one acre or more of impervious surface; discharge from industrial facilities; municipal separate storm sewer systems; earth disturbance of one or more acres; expansion of existing impervious surface by more than 5,000 square feet if the resulting impervious area is more than one acre; runoff from municipal and state roads; and retrofitting of old impervious surfaces.

  - *Note:*
    - The 1-acre construction threshold will be reduced to ½-acre in 2022;
    - An additional road permit is the Statewide Transportation Separate Storm Sewer System General Permit specific to the State (AOT) highway system and non-road developed lands.

- *Decrease discharges from forestry practices through continued implementation of AMPs, outreach and the use of portable skidder bridges.* VDFPR has revised the Acceptable Management Practices for Maintaining Water Quality on Logging Jobs (AMPs).

The Long Island Sound Watershed Regional Conservation Partnership Program (LISW-RCPP) was created in 2015 across six states to coordinate the development and implementation of a comprehensive working lands program with foci on: 1) nutrient management and soil health, 2) protection of non-industrial forest habitat, biodiversity, and drinking water sources, and 3) stem erosion and improve resiliency on working lands through riparian restoration.

In partnership with the Vermont Association of Conservation Districts (VACD), UVM Extension, the Connecticut River Conservancy, The Nature Conservancy and federal, state and local organizations in NH, MA, CT, NY and RI ten million dollars is being invested in the adoption of best management practices on private working lands, providing both technical and financial assistance.[18] Additionally the Long Island Sound Futures Fund is available throughout the Connecticut River watershed for Nitrogen removal projects.[19]

[18] LISW-RCPP website at: http://www.lisw-rcpp.com/home.html
[19] Long Island Sound Futures Fund: https://www.nfwf.org/lisff/Pages/home.aspx

Water Quality Remediation Plans

As mentioned above, Water Quality Remediation Plans (WQRP) are used in lieu of TMDLs where the source, cause and extent of a problem is identifiable. Two WQRPs are in place to address water quality issues from Mount Snow resort development. These lay out actions to be implemented to remediate the water quality impacts.

Mount Snow WQRP actions:

- Removal of Snow Lake and restoration of the North Branch Deerfield River stream channel, thus reducing thermal loading and restoring the natural hydrologic and sediment transport regime
- Implementation of the iron seep prevention and control plans
  Remediation of undersized, improperly sited, or degraded culverts to restore the hydrologic regime
- Implementation of on-mountain BMPs for waterbars, work roads, storage areas, and other practices to help control runoff
- Expand upon prior watershed assessments to identify point sources of sediment loading and confirm existing water quality stressors identified in the 2006 Stream Geomorphic Assessment (SGA)for the purpose of identifying remediation projects
- Transfer of the existing salt and sand storage area adjacent to existing parking lots to a covered facility at the proposed maintenance building to minimize potential runoff
- Adherence to VTDEC construction stormwater permit requirements and the USFS Special Use Permit (on USFS lands) soil stabilization and revegetation requirements to minimize the effects of excessive sediment washoff associated with areas of earth disturbance

C. Targeted Waters for Restoration

While numerous waterbodies are identified as needing remediation in Figures 14 & 15. For this Basin Plan the sub-watersheds in Table 8 are being prioritized for focused restoration based on their current conditions. These waters have on-going water quality problems, or their water quality or habitat conditions are threatened by current land use practices. Strategies for these waters are included in the Summary of Implementation Actions, (Table 17) and the Watershed Projects Database.

Table 8. Restoration Priorities

Sub-watershed	Restoration Focus	Land Use Sector
North Branch Deerfield River	Address bacteria TMDL, stormwater TMDL and altered flows	Land Development, Snow Making, Agriculture, Wastewater
Cold Brook	Address development and stormwater runoff & altered flows	Land Development, Snow Making
Whetstone Brook	Address bacteria TMDL and stormwater runoff	Land Development, Roads
Broad Brook	Improve important wildlife connectivity to CTR & NH at the landscape scale	Natural Resources
Newton Brook	Address nutrients & sediment from agricultural inputs	Agriculture
Lake Raponda	Work with community to assess lake conditions and implement restoration projects	Land Development, Roads, Natural Resources
Kettle Pond	Work to address stormwater inputs degrading the pond	Land Development

A Word About Hydro

The generation of hydroelectric power plays a significant role in Basin 12. Great River Hydro, LLC (GRH) purchased the power infrastructure on the Deerfield River in Vermont and lower Connecticut Rivers in 2017. Public Sector Pension Fund owns the Northfield Mountain pump storage facility across the border in Massachusetts. These hydroelectric facilities are in service and have flow alteration impacts on Basin 12 rivers and lakes. One other hydroelectric facility, the Harrisville Mill dam, is located on the Green River in Halifax.

Together the GRH dams are capable of producing 103 megawatts of electricity. The dams operate on a store and peak system. Water is held back until power is needed by the electric grid at which time water is released and power generated. This practice interrupts natural flows and sediment transport throughout the river systems. As a result, the Connecticut River and the Deerfield River below Harriman Dam are listed as

impaired for altered flows impacting aquatic life support. Further assessment of the reservoirs is needed to determine if they should be listed as flow altered or stressed.

Table 9. Hydroelectric Facilities in Basin 12

Sites	Generating Capacity (MW)	Type
Deerfield River at Somerset Dam - VT	0	Storage, no hydropower generation
Deerfield River at Harriman - Readsboro, VT	41	Peaking, seasonal storage
Deerfield River at Searsburg - VT	5	Peaking, daily storage
Deerfield River at #5-Monroe Bridge - MA	14	Peaking, daily storage
Deerfield River at Sherman Dam - Rowe, MA	6	Peaking, weekly storage
Connecticut River at Vernon Dam - VT	37	Peaking, daily storage
Northfield Mountain Pumped Storage Station - MA	1168	Peaking, pumped storage

Glory Hole at Harriman Dam

Vernon Dam and Fish Ladder

Chapter 4 Strategies to Address Pollution by Land Use Sector

Tactical basin plans address water quality by land use sector as summarized in the following sections. These sectors are consistent with the VDEC CWIP Clean Water Investment Report. A source sector is a land use activity that can contribute pollutants to the environment. Sectors effecting water quality addressed in this plan are:

A. Agriculture

About 4.6 percent of the Basin is in agricultural land use. Agriculture can both positively and adversely affect water quality. Well managed agricultural land can allow for infiltration of precipitation, improve soil health and remove nutrients through sediment attenuation on floodplains and plant uptake. However, nutrients, pathogens, and sediments can adversely affect water quality when waste storage facilities or erosion control methods fail, or when heavy rains and floods inundate fields and wash manure, fertilizer and sediment from fields and farmstead areas into waterways.

This section integrates basin specific information on agricultural water resource impairments, regulatory programs, Best Management Practice (BMP) implementation, funding sources, outreach efforts, and partnerships to inform strategies to address agricultural water resource impairments. The tactical basin planning approach engages local, regional, and federal partners in the development of strategies needed to accelerate agriculture-related BMPs in order to meet the state's clean water goals nutrient reductions to support the Long Island Sound Nitrogen TMDL. This section is organized around the Vermont Agency of Agriculture, Food, and Markets (VAAFM) regulatory programs including the Required Agricultural Practices (RAPs), the Large Farm Operation Program (LFO), the Medium Farm Operation Program (MFO) the Certified Small Farm Operations Program (CSFO) and the available agricultural assistance and outreach programs and local coordination efforts.

Agricultural activity in the Basin is concentrated in the valleys of the Connecticut River, the North Branch of the Deerfield, the East Branch of the North River and along the Whetstone and Broad Brooks.

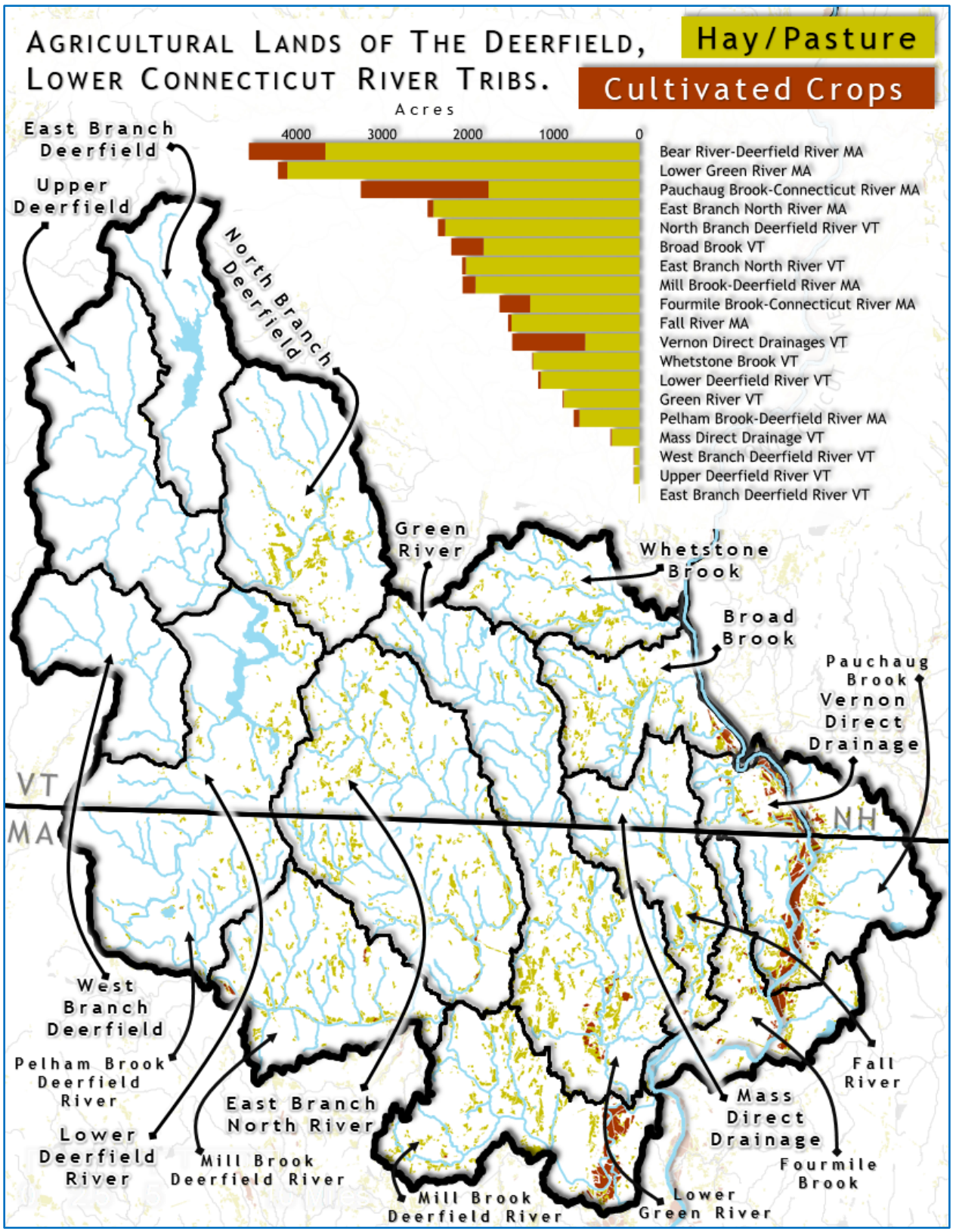

Figure 18. Agricultural Land Cover

Land cover analysis shows that between 2001 and 2016 there has been a small increase in the percent of land in the Basin used for annual crop production and a smaller decrease in the percent used for hay or pasture.

There are 17 registered farms in the Basin made up of one MFO, six CSFOs and ten SFO. There are no permitted LFOs in the Basin. VAAFM and the Natural Resources Conservation Service (NRCS) fund programs that assist farmers with implementing field and farmstead BMPs to improve water quality. Many farms in the Basin are implementing field BMPs. The most popular field BMP through state and federal assistance programs is cover cropping which has been implemented on over 870 acres of cropland in the Basin since 2012. Other field BMPs that have been implemented through state and federal cost share programs since 2012 in the Basin include conservation crop rotation (225 acres); corn-to-hay conversion (81 acres); prescribed grazing (100 acres); brush management (188 acres); early successional habitat development/management (113 acres).

From 2012-2018 VAAFM invested $69,829 in farmstead BMPs which has been matched by farmers' investment of $72,703 totaling $142,532 in improvements. Implemented farmstead BMPs were primarily related to barnyard management and heavy use are protection. USDA NRCS also works with farmers on farmstead BMP implementation and funding adding to the overall investment in the Basin's farms.

Runoff from agricultural lands has been identified as a contributor to water quality issues in two of the waters in the Basin. These are nutrient loading concerns in Newton Brook in Vernon and Ellis Brook in Dover. Agricultural runoff also contributes nitrogen from the watershed to the impairment of Long Island Sound causing critically low dissolved oxygen levels.

Priority areas for agricultural work include:

- Newton Brook
- Ellis Brook
- Whetstone Brook
- Connecticut River
- North Branch Deerfield River

The foci for all of these are buffers and farmstead improvements.

Agricultural Regulatory Programs

The VAAFMs RAPs, formerly the Accepted Agricultural Practices, and existing MFO and LFO permit programs set baseline farm management practices to ensure environmental stewardship. Medium and Large Farm Operational Permits (L/M FO) have been in place for over 10 years, while the Required Agricultural Practices (RAPs) were established in 2006 and revised in 2016 and 2018 to support the necessary nutrient load reductions to address the TMDLs in the state including the Long Island Sound TMDL. These revisions are expected to result in a significant increase in conservation practice implementation in the future by requiring Nutrient Management Plans (NMPs), increasing vegetative buffers, reducing maximum soil erosion rates by half on small farms, and the creation of a small farm certification program along with many other practices.

Large (LFO) and Medium (MFO) Farm Operation Programs

The VAAFMs permit programs set baseline farm management practices to ensure environmental stewardship. Medium and Large Farm Operational Permits (L/M FO) have been in place for over 10 years, while the Required Agricultural Practices (RAPs) were established in 2006 and revised in 2016 and 2018 to support the necessary nutrient load reductions to address the TMDLs in the state including the Long Island Sound TMDL. These revisions are expected to result in a significant increase in conservation practice implementation in the future by requiring nutrient management plans, increasing vegetative buffers, reducing soil erosion rates by half on small farms and creating a small farm certification program along with many other practices.

The VAAFM LFO Program requires large sized farms with more than 700 mature dairy cows (or the equivalent in other livestock types) to operate under an individual permit. The MFO Program requires farms with between 200 and 700 mature dairy cows (or equivalent) to operate under a general permit. Both permit program requirements exceed those of the technical components of the Federal Clean Water Act and aim to reduce the amount of phosphorus and other nutrients entering Vermont's waterways. In the Basin, there are no permitted LFOs and only one permitted MFO. VAAFM inspects all MFOs every three years. Inspections include assessments of farm Nutrient Management Plans (NMPs), production area assessments of all facilities associated with the permitted operation, and cropland management assessments in accordance with Vermont's Water Quality Standards and RAP's.

Certified Small (CSFO) and Small Farm Operations (SFO) Programs

VAAFM's Certified Small Farm Operations (CSFO) program supports farmers to ensure their clear understanding of the RAPs, while helping assess, plan, and implement any conservation and management practices necessary to meet water quality goals.

VAAFM estimates that there are 6 CSFO in the Basin. CSFOs are required to annually self-certify their operations and will be inspected at least once every 7 years. Inspections are just getting underway and are currently focused on increasing education and outreach about regulations and financial and technical assistance programs.

VAAFM estimates 10 small farms in the Basin will fall within RAP jurisdiction but may not need to certify. Outreach will need to continue to the remaining farms or locations to help landowners understand where they fall within the RAP farm size categories and to help them understand the RAP requirements.

Priority watersheds for inspection in this Basin include

- Newton Brook,
- Whetstone Brook
- Lower Connecticut River valley

Agricultural Assistance and Outreach Programs

In addition to work completed to meet regulatory requirements, farm operators have begun and will continue to voluntarily adopt field and farmstead BMPs based on the increased availability of technical and financial assistance throughout the Basin. VAAFM and NRCS both fund several programs that support farmers with developing nutrient management plans, implementing practices, or purchasing equipment to improve water quality. State funding programs are listed on the VAAFM grants website[20] and more information about NRCS programs.[21]

Many farmers implement conservation practices without financial assistance. In 2019, VAAFM launched the Multi-Partner Agricultural Conservation Practice Tracking and Planning Geospatial Database ("Partner Database") to improve planning and tracking of NRCS, VAAFM, and no cost share agricultural field and farmstead BMP implementation across the state.

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[20] https://agriculture.vermont.gov/grants
[21] https://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/?&cid=stelprdb1048817

Figure 19 represents field BMPs implemented each year from 2012 to 2018 through state and federal assistance programs. This graph depicts only practices funded though the AAFM and NRCS programs. Practices that are continued by the farmer outside of these programs are not included. The most popular field BMP is cover cropping at 870 acres, followed by crop rotation at 225 acres. The graph shows an increase in the acreage of cover crops over this time period.

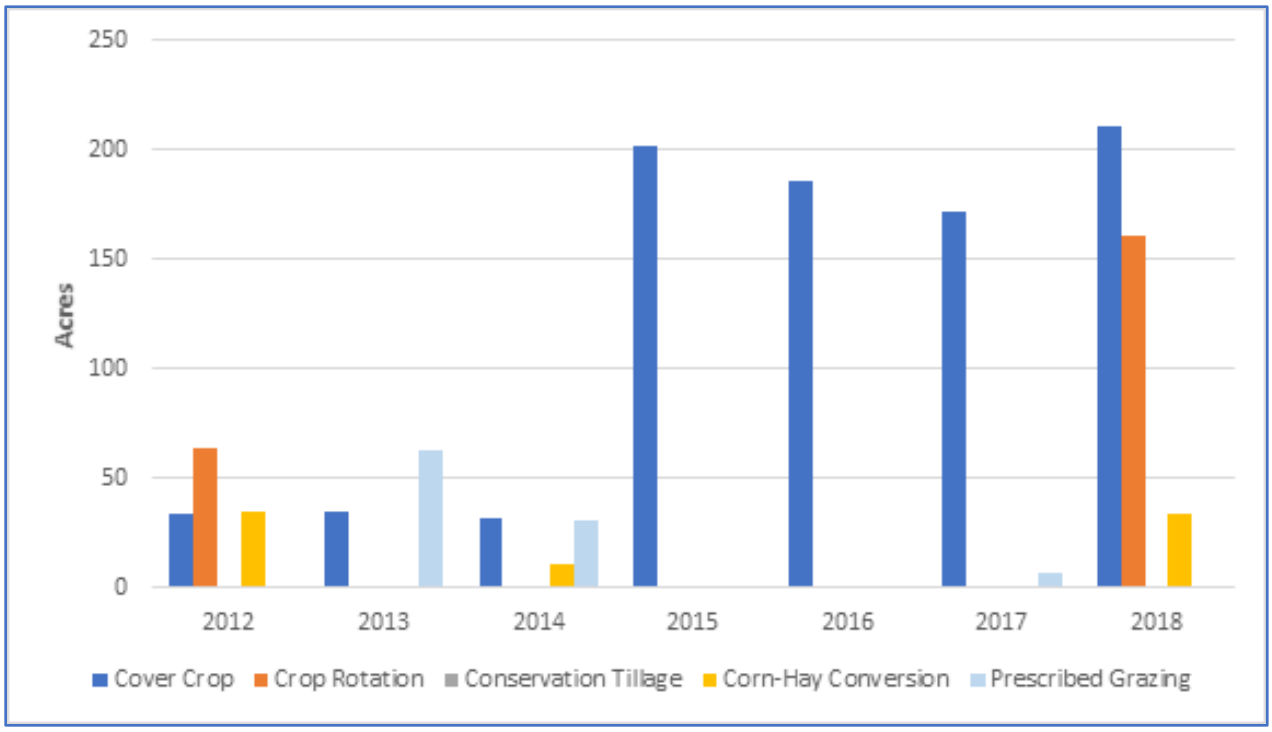


Figure 19. Acreage of NRCS and VAAFM Funded Field BMPs Implemented by Year

Clean Water Goals for Agriculture

In order to coordinate agricultural water quality improvement efforts identified through the basin planning process, several watershed and farm-focused organizations have been actively engaging their communities for several years. These include: the BCCD, WCNRCD, the Connecticut River Watershed Farmers Alliance (CRWFA), AAFM, UVM Extension, and USDA/NRCS.

Through discussions with the agricultural community and conversations between farm-focused partners in the region, the following drivers of local water quality problems have been identified:

- Agriculture runoff
- Nutrient loading (in local waters and as per the LIS-TMDL).
- Lack of riparian buffers

- General water quality and human health issues (e.g. *E. coli,* cyanobacteria)
- Streambank erosion

These issues were defined and ranked according to both the surface water monitoring data and the public concern expressed at forums and meetings. . Sustained coordination with these groups is an important strategy in this plan to effectively target agricultural BMP implementation and improve water quality conditions. Other areas of focus for this group are:

- Hosting annual workshops on:
  - the RAP revisions,
  - improving soil health,
  - implementing conservation field practices and
  - wetland designations
- Establishing local (municipal) goals and objectives to protect
  - water quality
  - wetlands
  - floodplains
- Educational workshops directed to horse, beef, and small animal operations.
- Outreach to promote buffer planting practices and opportunities.
- Farmer support in developing and implementing NMPs
- Regional equipment sharing programs to increase the implementation of effective cover cropping programs.
- Water quality monitoring and research effort to understand nitrogen source areas in all the Connecticut River watersheds.
- Outreach and targeted project implementation among partners.
- Work with NRCS and VAAFM to address funding distribution inequity in the Basin. (Figure 20).

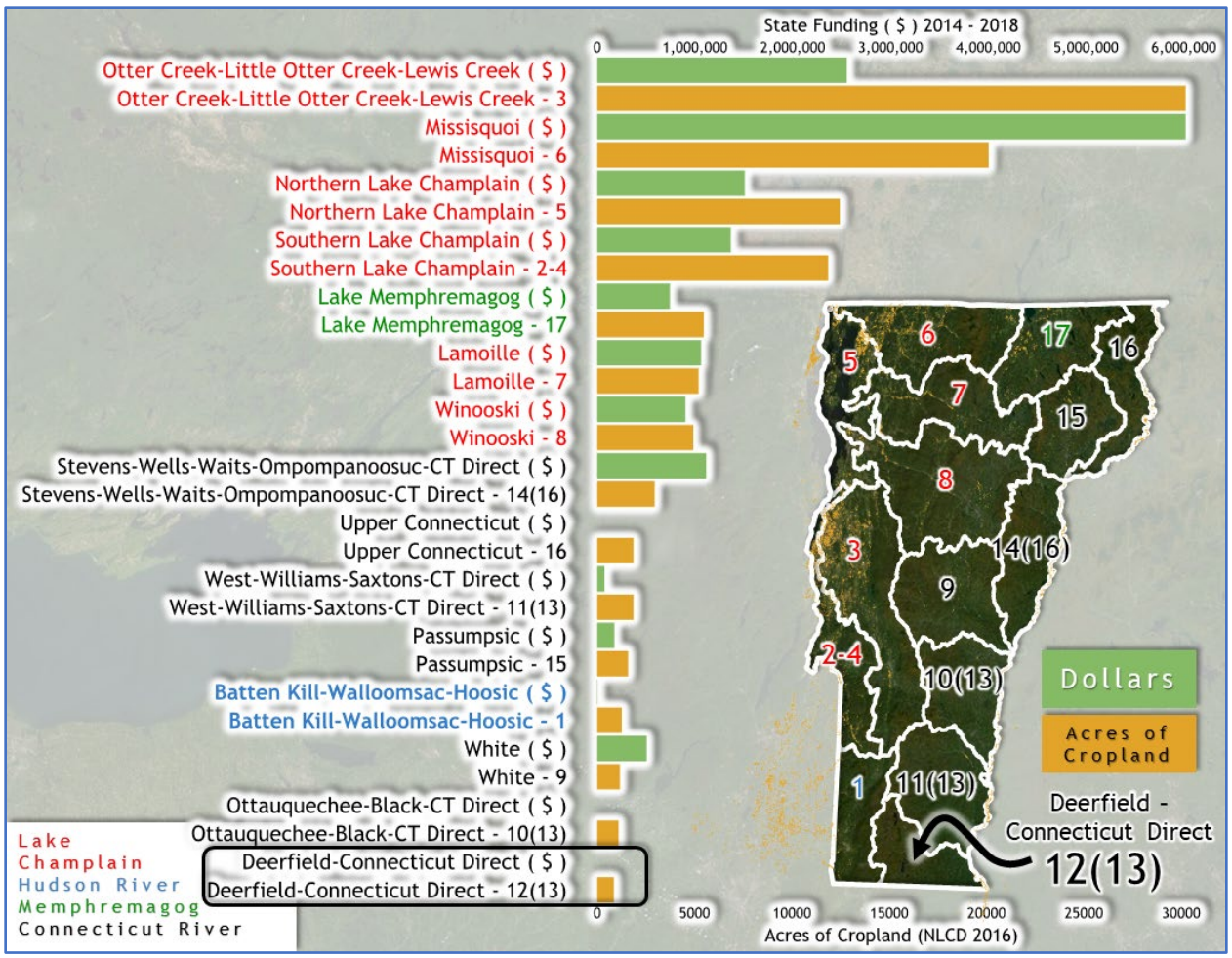


Figure 20. State Agricultural Funding Since 2004

B. Developed Lands -- Stormwater

Stormwater runoff is a contributor to many of the water quality issues in the Basin. However, the only impairment listed due to stormwater is a segment of the North Branch Deerfield River from just above Snow Lake down to Tannery Road. The cause of this impairment is due to stormwater runoff, stream channel modifications, land development and construction related erosion. The Base lodge tributary at Mount Snow is stressed for runoff from land development which has been noted as causing erosion resulting in a high sand bedload. Stormwater is a key concern in the North Branch Deerfield River and Cold Brook in Dover and Wilmington.

Stormwater runoff across the Basin also contributes sediment and nitrogen which is a concern in relation to Long Island Sound and is impacting the Whetstone Brook and the Kettle Pond watershed in Brattleboro.

This section integrates basin specific information on stormwater-related water resource impairments, regulatory programs, stormwater master plans (SWMPs), Illicit Discharge Detection and Elimination (IDDE) studies, existing implementation efforts, and partnerships to inform strategies to address stormwater-related water resource impairments. The tactical basin planning approach engages local, regional, and federal partners needed to accelerate stormwater-related practice implementation in the development of these strategies to meet the state's clean water goals. Stormwater mapping work, IDDE studies and SWMP are the primary drivers for voluntary implementation efforts in the Basin.

Stormwater Mapping and IDDE - DEC has assisted municipalities not subject to the regulatory stormwater rules by mapping drainage systems and performing illicit discharge detection and elimination (IDDE) studies. The goal of IDDE is to improve water quality by identifying and eliminating contaminated, non-stormwater discharges entering stormwater drainage systems and discharging to surface waters. This work has been completed for most major urbanized areas in the state and is underway in Basin 12. Data is compiled in Town Stormwater Mapping and Stormwater Master Planning Reports[22].

[22] https://dec.vermont.gov/watershed/cwi/manage/idde

Operational three-acre impervious surface permit program

The Stormwater Program will issue a general permit in 2019 for stormwater from so-called "three-acre sites" which are existing sites with three or more acres of impervious surface that lack a stormwater permit based on the 2002 Vermont Stormwater Management Manual. For the Connecticut River watershed including the Deerfield River Basin, parcels will need to apply for permit coverage by 2033. For the North Branch of the Deerfield stormwater impaired sub-watershed and other waters with stormwater impairments, this permit will be required before 2023. Since this date is well beyond the timeframe for this plan, voluntary stormwater efforts though stormwater master planning are likely to be the primary drivers for stormwater implementation efforts for this planning cycle.

Stormwater Master Planning and Outreach

One stormwater master plan (SWMP) has been completed for Crosby Brook in Brattleboro. SWMPs are recommended for the remainder of Brattleboro and for the towns of Dover and Wilmington and where development around Mount Snow and Hermitage Resorts has caused increased sedimentation and stormwater runoff.

Clean Water Goals for Stormwater

- Develop and implement SWMPs for Brattleboro, Dover, Wilmington and Hermitage Resorts
- Implement treatment recommendations in the town Stormwater Reports and WQRPs
- Decrease stormwater discharges to Kettle Pond
- Address gully erosion due to stormwater discharge points

C. Developed Lands -- Roads

Reducing road runoff and erosion is critical to meeting the state's clean water goals. Municipal roads runoff is a major source of sediment and nutrients in the Basin that contributes to water quality issues. Road runoff also contributes a small portion of the nitrogen loading to the Connecticut River watershed which is a concern for the Long Island Sound TMDL.

This section integrates basin specific information on transportation-related water resource impairments, road erosion inventories (REIs), road practice implementation, regulatory programs, and existing partnerships to inform strategies to address transportation-related water resource impairments. The tactical basin planning approach engages local, regional, and federal partners needed to accelerate transportation-related practice implementation in the development of these strategies in order to meet the state's clean water goals. The section is organized around the regulatory programs including the Municipal Roads General Permit (MRGP), the Transportation Separate Storm Sewer System Permit (TS4), and the Municipal Separate Storm Sewer System Permit (MS4) as these regulatory programs are the driving factor in road water quality implementation efforts in the Basin.

The Municipal Roads General Permit (MRGP) released in 2018, along with the Transportation Separate Storm Sewer System Permit (TS4), and the Municipal Separate Storm Sewer System Permit (MS4) are the driving regulatory programs in road water quality implementation efforts in the Basin. There are no MS4 towns in the Basin. The TS4 program covers all stormwater discharges from state-owned or controlled impervious surfaces and is implemented by AOT.

The MRGP is a state-wide permit, for all Vermont cities and towns. It is intended to achieve significant reductions in stormwater-related erosion from municipal roads, both paved and unpaved. The permit requires each municipality to conduct a Road Erosion Inventory (REI) of hydrologically-connected roads, those in close proximity to water resources, to determine if town roads meet MRGP road standards. Additional information regarding the MRGP and tools available to assist municipalities can be found at this link and maps of hydrologically-connected roads can be found on the ANR Atlas under the Stormwater layer. Un-organized towns and gores, such as Glastonbury and Somerset, are exempt from the MRGP.

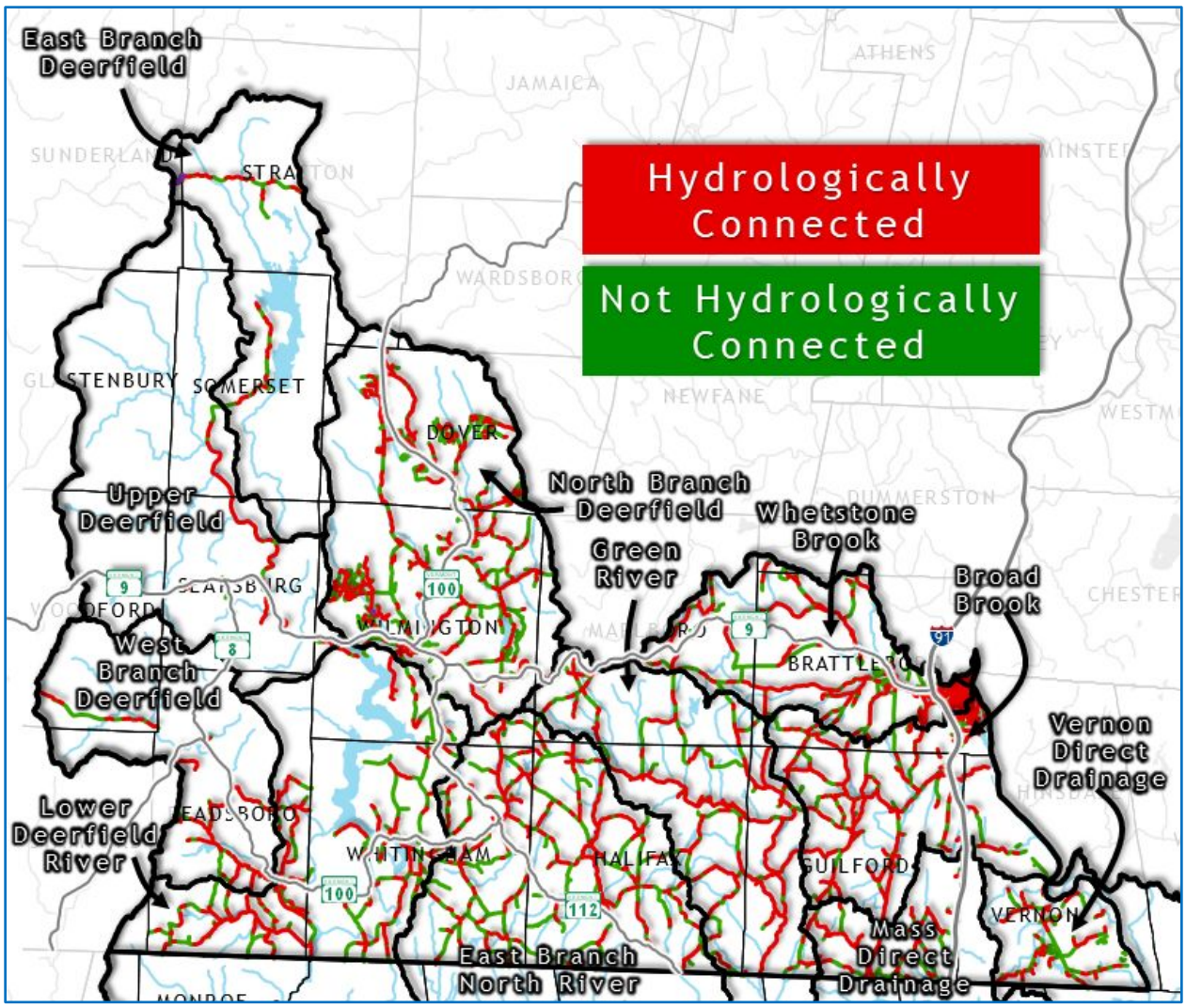


Figure 21. Hydrologically Connected Road Segments

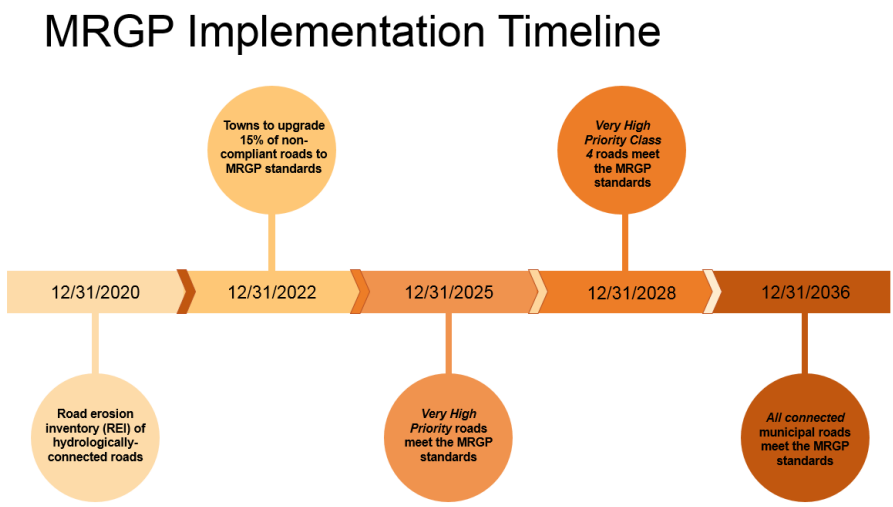


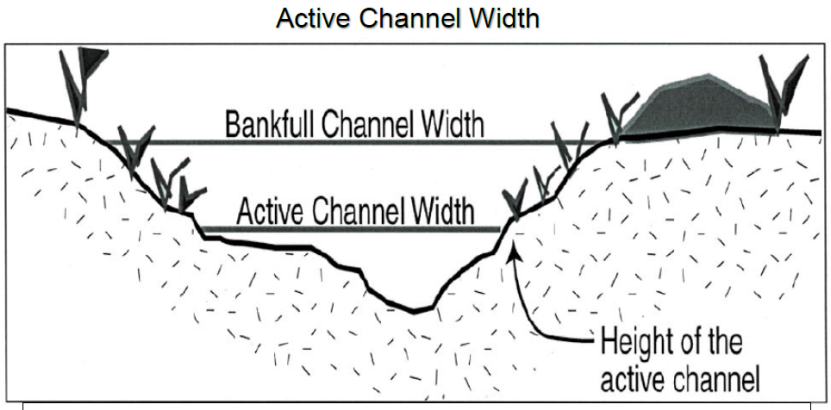
Figure 22.

REIs are due to be completed by December 31, 2020. DEC has developed a computer application to assist municipalities in undertaking REIs.

MRGP road standards include road crowning,

stabilizing drainage ditches, removing grader berms, lowering road shoulders, upgrading drainage culverts, rock lining catch basin outfalls, disconnecting drainage from waterways and other practices. The MRGP standards implemented over a period of time, will bring all hydrologically connected municipal roads up to the new standard by December 31, 2036. DEC requires towns to bring *Very High Priority* road segments[23] up to the new standards before December 31, 2025 for all road types, except Class 4 roads which are required to meet standards by December 31, 2028. *Very High Priority* road segments are those that score Does Not Meet MRGP standards and are located on slopes greater than 10%. The MRGP requires that all towns bring at least 15% of non-compliant road segments up to MRGP standards before December of 2022. REI results by town can be found in the MRGP Implementation Table.

In addition to the MRGP, **Vermont Road and Bridge Standards** are required for municipalities under Act 64. Towns can voluntarily adopt the Vermont Road and Bridge Standards. These standards are administered by AOT, and go above and beyond MRGP standards. For example, municipalities may adopt MRGP standards for non-hydrologically-connected roads. Additional standards include adopting the Active Channel Width for intermittent stream culvert replacements. The Active Channel Width (Figure 23) is described as the channel scour width and is approximately 75% of the bankfull channel width, which is generally required for perennial stream channel bridge and culvert replacements. Towns adopting the Vermont Road and Bridge



Active Channel Width means the limits of the streambed scour formed by prevailing stream discharges, measured perpendicular to streamflow. The active channel is narrower than the bankfull width (approximately 75%) and is defined by the break in bank slope and typically extends to the edge of permanent vegetation.

Culvert sizing for crossings on intermittent streams: Determine the Active Channel Width by field measurements, ***the culvert size should meet or exceed the Active Channel Width***. To obtain the measurements go to the crossing location and obtain several upstream Active Channel Width measurements in riffle (fast moving water) narrower channel locations. The selected channel width should be a representative average of the field measurements. In the absence of field measurements, the drainage areas in the table can be used.

Figure 23. Active Channel Width

[23] Hydrologically-connected paved and gravel road segments with drainage ditches scoring "Does Not Meet" on the REI, on slopes greater than 10 %, are considered Very High Priority Road Segments.

Standards, may be entitled to higher cost share rates in federally-declared flood event reimbursements.

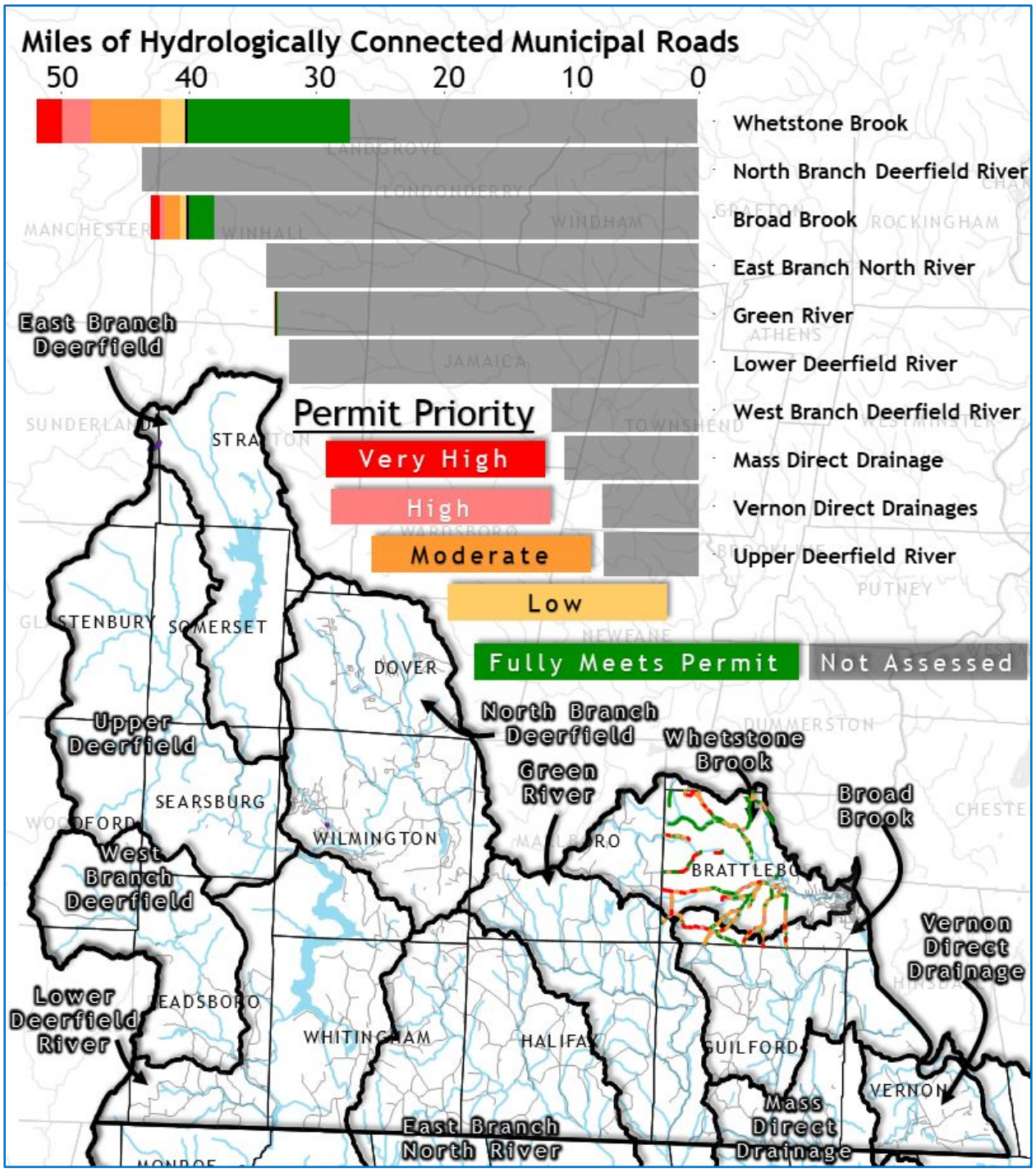


Figure 24. High Risk Road Segments

Table 10.

MRGP Segment Priority Counts

Municipality	Total Road Miles[1]	Hydrologically Connected Segment Count[1]	Inventoried Segments	Meets Standards			REI Status
				Fully	Partially	Does Not	
Brattleboro	93	1076[1]	490	244	149	88	underway
Dover	61	474	0	250	121	103	COMPLETE
Dummerston	66	6[1]	1	1			COMPLETE, Report pending
Glastonbury[2]	Exempt	0					EXEMPT
Guilford	76	806	0				planned 2020
Halifax	70	535	0				COMPLETE
Marlboro	56	197	0				planned 2020
Readsboro	43	438	0				2019 field season
Searsburg	6	72	0				2019 field season
Somerset[2]	Exempt	71					EXEMPT
Stratton	28	34[1]	0				COMPLETE
Sunderland[1]	31	6[1]	6	4	2	0	COMPLETE
Vernon	25	164	0				field work compete 2018, report pending
Whitingham	64	396	0				not scheduled
Jacksonville Village	-	37	0				---
Wilmington	74	555	0				field work compete 2018, report pending
Woodford	9	24[1]	0				not scheduled

[1] portion of town in Basin 12
[2] unorganized towns are exempt from MRGP

VTrans Better Roads and the ANR's Municipal Roads Grants-in-Aid program both sponsored by the Clean Water Fund, support the development of municipal REIs and project implementation. In addition to completing a REI, numerous towns in the Basin have taken advantage of these grant programs and technical assistance to address erosion along hydrologically-connected roads. Of the 16 municipalities that are mostly or entirely located in the Basin, 9 enrolled in Grants-in-Aid (GIA) in FY 2018, and in FY 2019, 9 enrolled in this program to receive financial support for addressing hydrologically connected roads. The GIA program requires that non-MRGP compliant hydrologically-connected roads be brought up to MRGP standards, as a condition of grant completion. Road improvements funded through the Clean Water Fund are summarized in the Vermont Clean Water Initiative Annual Investment Report. The BMPs used to address water quality concerns on unpaved roads are among the most cost-effective actions to reduce nutrient and sediment pollution.

From 2014 and 2019 the Clean Water Program has provided funding of $458,738 to towns to complete REI and implement corrective projects.

Table 11. Better Roads Grant Funding

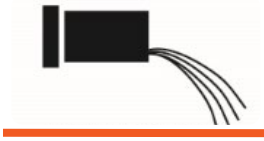
Better Roads Grants Funded		
2014 - 2019		
Town	**Funding Awarded**	**# Projects**
Brattleboro	4,000	1
Dover	8,000	1
Dummerston	58,795	3
Glastenbury	0	0
Guilford	60,000	2
Halifax	37,600	3
Marlboro	24,206	4
Readsboro	18,000	2
Searsburg	0	0
Somerset	13,801	1
Stamford	17,355	2
Stratton	8,000	1
Sunderland	51,630	4
Vernon	23,040	2
Wardsboro	0	0
Whitingham	0	0
Wilmington	134,311	6
Woodford	0	0
TOTALS	**$458,738**	**32**

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

The 2017 TS4 General Permit is a stormwater permit for all AOT owned or controlled infrastructure. The permit requires AOT to reduce the discharge of pollutants from the TS4 to the maximum extent practicable (MEP) through compliance with the six minimum control measure requirements. This includes state roads, garages, park and rides, welcome centers, airports, and sand and gravel operations. The PCPs will require inventories of all regulated surfaces, establishment of baseline phosphorus loading per lake segment, and a prioritized schedule for implementation of BMPs to achieve the lake segment percent phosphorus reductions.

Clean Water Goals for Roads

- Complete REIs for all towns and uploaded to the database in the Basin to meet this MRGP requirement. Guilford, Marlboro (planned 2020), Whitingham, Woodford (not scheduled)
- Implement priority practices in target watersheds and MRGP projects across the watershed where these will result in the biggest water quality benefits
- Increase municipal participation in Better Roads & Grant-In-Aid funding
- Conduct outreach on private roads and driveway BMPs
- Provide technical assistance to towns on project development and prioritization for WQ benefit
- Implement projects to address Class 4 road & legal trail erosion addressing Very High Priority non-MRGP compliant Class 4 roads, those on slopes greater than 10%, first
- Priority watersheds for implementation:
    - Whetstone Brook, Green River, East Branch North River



D. Wastewater

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 before discharge into a receiving water.

An overarching consideration for the issuance of wastewater discharge permits in the Deerfield River planning basin is the Long Island Sound TMDL for nitrogen. This multi-state TMDL has been promulgated with interim waste load and nonpoint source nitrogen load allocations. At issuance of this Plan, all facilities are operating under permits developed under a nitrogen permitting strategy whereby all Vermont WWTFs ultimately discharging to the Connecticut River must, collectively, discharge no more than 1,727 lbs. TN/day. Each individual facility has a unique Total Nitrogen (TN) loading limit. In addition to the nitrogen loading limit, WWTFs are required to develop optimization plans for maximizing nitrogen removal and regularly monitor for nitrogen compounds.

In an effort to be better informed about potential nutrient impacts, the WSMD, with assistance from certain municipalities, is conducting an extensive sampling effort to

document the current loading conditions to determine the "reasonable potential" that WWTFs have, to cause or contribute to downstream water quality impairment. Results of these investigations are recorded as part of permit issuance documentation. Municipal wastewater discharge permits in the Basin are shown in Table 12.

Table 12. Municipal Wastewater Discharge Permits

Facility (permit ID)	Permit effective date	Planned permit re-issuance year	Permitted flow (MGD)	IWC* 7Q10 /LMM	Current Percent of Design Flow (2017)	Treatment type	# of CSOs	Receiving water
Brattleboro (3-1242)	2016	2021	3	0.004 / 0.001	44%	RBC	0	CT River
Cold Brook FD 1 (3-1296)	2017	2019	.028 (direct discharge flow)	0.047 / 0.005	Have not reached capacity that necessitates a direct discharge. In 2018, the facility processed 4.7 MGD at the Haystack treatment system and 7.1 MGD at the Golf Course system.	Aerated lagoons and indirect spray disposal fields	0	Indirect - Rose and Haystack Brooks Direct – North Branch of the Deerfield
NorthStar Nuclear Decommissioning Company LLC (formerly Entergy Nuclear VT Yankee) (3-1199)	Original effective date: 2017 (transfer of ownership in 2019)	2022	4.3	XX	84%	*None*	0	CT River
Long Falls Paperboard, LLC (formerly FiberMark) (3-1136)	2012	Expired 2017	2	0.003 / 0.001	62%	Primary clarification/ aerated stabilization	0	CT River
Readsboro (3-1215)	2015	2020	0.075	0.004 / 0.002	47%	Aerated lagoons	0	Deerfield River
Whitingham (3-1229)	2013	2019	0.012	NA[1]	62%	RBC	0	Harriman Reservoir
Whitingham-Jacksonville (3-1230)	2014	2019	0.05	0.120 / 0.032	37%	RBC	0	East Branch North River
Wilmington (3-1281)	2018	2023	0.135	0.166 / 0.024	59%	RBC and aerated lagoons	0	North Branch Deerfield River

** Instream Waste Concentration – or the proportion of river flow at lowest base (7Q10) and low median monthly (LMM) flow attributable to discharge, for the facility design flow. Note that the IWC is specific to the flow of receiving water.*

[1] Facility discharges to a reservoir; dilution statistics for stream not applicable.

Six municipal wastewater treatment facilities and two industrial facilities process more than 6.6 billion gallons of wastewater per year. All WWTF undergo periodic inspections of facility operations, effluent data collections and laboratory testing procedures to verify compliance with permit conditions.

Wastewater treatment facility improvement projects decrease nutrient pollution (e.g., phosphorus and nitrogen) from municipal wastewater systems through treatment upgrades, combined sewer overflow (CSO) abatement, and refurbishment of aging infrastructure. The recent upgrade of the North Branch Fire District #1 facility in Dover was supported by a state/federal/municipal partnership investment of $4,419,902.

Facility Specific Information

Brattleboro

The Town of Brattleboro owns and operates the Brattleboro Wastewater Treatment Facility. Brattleboro is one of the largest direct-dischargers to the Connecticut River.

The facility recently underwent a major refurbishment which consisted of a headworks, two primary clarifiers, a moving bed bio-reactor (MBBR), four trains of rotating biological contactors (RBCs), two secondary clarifiers, and a chlorine contact chamber. Solids are processed using the 2PAD Anaerobic Digestion System, a thermophilic and mesophilic system.

Overall, the refurbishment has improved the Facility's treatment capacity. The 2PAD Digestion System has allowed the facility to accept additional septage, high-strength industrial wastewater, and dairy processing wastewater from nearby homes and businesses. In addition, in response to the Long Island Sound TMDL, the new MBBR was added to provide tertiary treatment for Total Nitrogen removal via nitrification and denitrification. In 2017, the Facility removed an annual average of 6% of the daily influent TN loading. In addition to nitrogen removal, the MBBR can be used to provide supplemental treatment of Biochemical Oxygen Demand (BOD).

Cold Brook FD 1

The Cold Brook facility is permitted for two indirect spray disposal fields and a single direct discharge. The two spray disposal fields are in the watersheds of Rose Brook and Haystack Brook. When and if the spray fields exceed their maximum application, effluent may be discharged directly to the North Branch Deerfield River.

Wastewater treatment consists of two separate aerated lagoon WWTFs, one at the Hermitage Golf Club and one at Haystack Mountain. The facilities are interconnected, and wastewater can be diverted from Haystack to the Golf Course WWTF if indirect discharge flows at Haystack reach capacity.

NorthStar Nuclear Decommissioning Company LLC (Entergy Nuclear VT Yankee)

In 2018 the VT Yankee Nuclear power plant was sold to the NorthStar Decommissioning Company to finalize the decommission and ultimate closure of the plant. The plant has been shut-down since 2014 and as of August 2018, all spent nuclear fuel has been removed from the facility's spent fuel pool and dry-casked,

thereby ceasing any spent-fuel-pool related thermal loading to the wastewater discharge.

Currently, as NorthStar works to finalize the plant's decommissioning, periodic intake and discharge associated with on-site equipment cooling and fire protection will continue to occur in accordance with the Discharge Permit. During this decommissioning period wastewater discharge flows are anticipated to be approximately 36 gallons per day, drastically lower than their permitted flow of 4.3 million gallons per day.

Long Falls Paperboard (formerly FiberMark)

The wastewater treatment system consists of primary clarification followed by an 8.3 million-gallon aerated stabilization basin. The treated effluent is discharged via a diffuser into the Connecticut River. The most recent reasonable potential review for the current authorization to discharge established a more restrictive effluent limitation for turbidity, based upon a review of facility monitoring data.

Readsboro

The Town of Readsboro owns and operates the Readsboro WWTF which consists of two aerated lagoons, chlorination for disinfection and dechlorination before being discharged to the Deerfield River. In 2017, the Facility removed an annual average of 44% of the daily influent TN loading.

Whitingham

The Whitingham WWTF is a secondary wastewater treatment facility. The Facility's sister-plant is Whitingham-Jacksonville. The treatment system consists of three septic tanks in series followed by two aerated flow equalization tanks, an RBC unit, a secondary clarifier and two ultraviolet light disinfection units. In 2017, the Facility removed an annual average of 30% of the daily influent TN loading. The municipality is currently in the process of performing an engineering evaluation on the two WWTFs to determine the need for maintenance, refurbishment, or upgrades. Discharges go to the Deerfield River.

Whitingham-Jacksonville

The Jacksonville WWTF is Whitingham's sister plant, which has an identical treatment train, including secondary treatment facility consisting of two parallel trains of septic tanks, followed by two parallel trains of aerated flow equalization tanks, an RBC unit, a secondary clarifier and two ultraviolet disinfection units. In 2017, the Facility removed

an annual average of 10% of the daily influent TN loading. The municipality is currently in the process of performing an engineering evaluation on the two WWTFs to determine the need for maintenance, refurbishment, or upgrades. Discharges go to the East Branch North River.

Wilmington

The Wilmington WWTF utilizes a rotating belt filter, two parallel RBCs, and aerated lagoons to provide secondary treatment to wastewater. The rotating belt filter is an innovative treatment technology that provides screening and primary treatment to influent wastewater. Solids are composted to Class-A biosolids using an in-vessel composting process and delivered free to Town residents. Since the Discharge Permit was recently issued in 2018, there is currently not enough data to calculate a removal efficiency of TN. The Facility will be collecting influent and effluent TN data moving forward. Discharges go to the North Branch Deerfield River.

Clean Water Goals for Wastewater

- Reduce the nitrogen load from municipal wastewater discharges which are predicted to account for 9% of Vermont's total discharge to the Connecticut River.[24]
- Conduct planning and feasibility studies for small communities without wastewater systems
- Upgrade wastewater facilities for nitrogen reduction
- Increase funding of the State Revolving Fund programs to meet statewide wastewater control needs, including Long Island Sound nitrogen control needs
- Encourage communities to invest in protection of future water supply source waters

[24] Estimation of Total Nitrogen and Phosphorus in New England Streams Using Spatially Referenced Regression Models, USGS 2004

E. Natural Resources Restoration

Restoration of "natural infrastructure" functions helps prevent and abate nutrient and sediment pollution. Natural infrastructure includes floodplains, river channels, lakeshores, wetlands, and forest lands. Additional benefits of restoration and protection of natural infrastructure include:

- Improved flood resiliency and flood hazard mitigation for public health and safety
- Improved habitat function
- Support of outdoor recreation opportunities and economy
- Implementation of TMDL requirements

a) River Stability and Connectivity

Stream Geomorphic Assessments (SGA) study the physical conditions of rivers and the interrelationships of flowing water and sediment within varying landscapes. SGAs incorporate watershed-wide information from maps, aerial photographs, existing studies, and field data into a detailed characterization of riparian and instream habitat, erosion, and flood hazards for use in watershed planning. The overall goal of the VDEC Rivers Program is "managing toward, protecting, and restoring the fluvial geomorphic equilibrium condition of Vermont rivers by resolving conflicts between human investments and river dynamics in the most economically and ecologically sustainable manner," done through

- fluvial erosion hazard mitigation;
- sediment and nutrient load reduction; and
- aquatic and riparian habitat protection and restoration. [25]

Stream Geomorphic Assessments completed in the Basin are shown in Table 15. **River Corridor Plans** (RCP) compile SGA data into a report informing the basin planning process on potential implementation projects to mitigate both natural and

[25] VANR River Corridor Planning Guide

anthropogenic geomorphic problems which are listed in the Watershed Project Database.

Table 15. Stream Geomorphic Assessments Completed

Sub-watershed	Date	Coverage
Stream Geomorphic Assessments		
North Branch of the Deerfield River Corridor Plan	2013	Phase 1, 2 & Corridor Plan
Green River Corridor Plan	2014	Phase 1, 2 & Corridor Plan
East Branch North River Corridor Plan	2017	Phase 1, 2 & Corridor Plan
Whetstone Brook Watershed Corridor Plan	2008	Phase 1, 2 Only

Geomorphic conditions of assessed waters are shown in Figure 25.

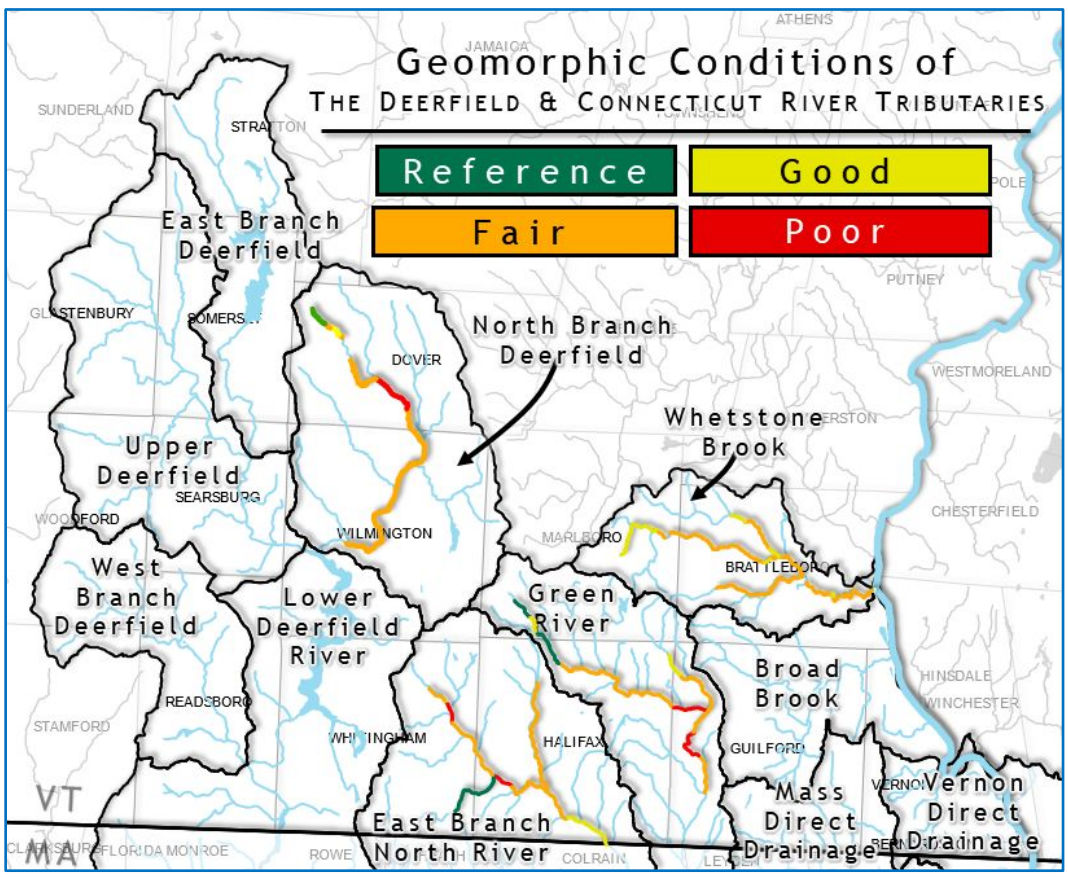


Figure 25. Geomorphic Conditions of Assessed Waters

There are 54 known dams in the Basin and likely many more that have not been documented. Each known dam is categorized by the status of its use or condition. For a complete listing of known dams see Appendix C.

Table 16. Dam Status

Dam Status	# of Dams
Breached / Partially Breached	7
In Service	39
Not in Service	2
Removed	4
Deleted	1
Unknown	1

Dams are also rated by how much damage would be done downstream if the structure were to fail. These ratings are High, Significant and Low.

Of the 43 dams with this rating, 12 are High Hazard. These dams should be reviewed for possible removal and to ensure that Emergency Action Plans are in place.

Clean Water Goals for Rivers

- Work toward equilibrium
- Increase floodplain access
- Remove unneeded dams
- Remove Snow Lake dam at Mt Snow
- Protect floodplains and river corridors from conversion & development
- Focus on protection of alluvial fan areas
- Focus restoration work on reaches with High to Extreme Sensitivity ratings
- Restoration of Birge Street parcel, Brattleboro

b) Lakeshore Restoration

Healthy shoreland conditions help protect the functions and values of lakes, such as water quality; aquatic habitat; fishing; swimming; boating; bird-watching; property values; and many others. Recent Vermont lake science from the National Lake Assessment study shows that Vermont ranked lowest in the northeast ecoregion and in the nation for degraded shallow water habitat. Vermont's degraded conditions for aquatic habitat is directly related to shoreland clearing and conversion of natural shores to lawns.

Shoreland Best Management Practices help achieve the healthy shoreland conditions needed to protect the lake and improve water quality and habitat conditions. Lake Wise Assessments identify and work to address runoff, erosion and habitat degradation through BMP implementation. Some of the practices encouraged are shoreland vegetated buffers, infiltration steps, waterbars and rain gardens.

Lily Pond – Vernon

Lily Pond is a natural on-stream pond on Newton Brook. The pond is the only Outwash Plain Pondshore natural community in Vermont and hosts over a dozen species of rare aquatic plants. Downstream of the pond Newton Brook is impaired for nutrients and sediment due to agricultural impacts. The steep eastern shore has a 50-foot riparian buffer yet the levels of Total Phosphorus in the pond are high. Protection of this rare community is a priority.

Kettle Pond – Brattleboro

This tiny pond in the Wilson-Woods development is a true natural kettle pond created by a retreating glacier. It has no inlet or outlet stream and rises and falls with precipitation and snow melt. When it was sampled in 2015 Kettle Pond had the highest conductivity measured in a pond in Vermont, and extremely high phosphorus and chloride levels. Stormwater runoff from the neighborhood, the high school and the town garage lot flow to the pond. Stormwater treatment of these areas is needed.

Sadawga Lake – Whitingham

Sadawga Lake's interesting natural history make it an important lake for protection. The floating bog hosts numerous rare plants, however invasive Eurasian water milfoil and curly-leaf pondweed are pervasive, and control should be undertaken.

Jacksonville Pond – Whitingham

Shallow, averaging only 8 feet deep, and with extensive wetlands and agriculture upstream, Jacksonville pond has rising Total Phosphorus levels that need to be assessed.

Lake Raponda – Wilmington

Roads surround about 75% of Lake Raponda causing runoff and contributing large amounts of sediment to the pond and feeder streams. The town and lake association have begun addressing these issues and work will be continuing to improve conditions looking toward gaining future protections for the pond.

Clean Water Goals for Lakeshores

- Conduct LakeWise Action Plan Assessments
- Establish a Lake Wise Leader to communicate with shoreland neighbors what lake-friendly practices and shoreland management looks like along the shore, and to serve as the point person for communicating with the staff of the Lake Wise Program. Establish volunteer Lay Monitoring and Volunteer Invasive Patroller Programs;
- Conduct septic systems and maintenance outreach to shoreland owners through Septic Socials;
- Restore living shorelands along lakes
- Protect Lily Pond
- Encourage landowners to form lake associations and join the Federation of Vermont Lakes and Ponds (FOVLAP)

c) Wetland Restoration

Wetland restoration is the process of returning a degraded wetland to an approximation of its pre-disturbance condition. The United States has lost over half of its wetlands since European colonization in the early 1600s, and Vermont has lost as much as 35 percent. While conservation and protection of wetlands are critical for preventing continued loss of our remaining intact wetlands, wetland restoration is essential for rehabilitating those that have already been degraded or lost.

The large amount of active agricultural land along the Connecticut River originally hosted numerous wetlands that have over many decades, been converted to agricultural and other uses. The Connecticut River and its lower tributaries including Newton Brook in Vernon, could benefit from wetland assessment and restoration to improve water quality and habitat conditions.

Clean Water Goals for Wetland Restoration

- Assess areas of prior converted wetland and hydric soils for restoration
- Implement wetland restoration as sites and opportunities are identified

d) Forestland Restoration

Forests are the best form of land use for sustaining water quality and quantity. Studies clearly show that the amount of forestland within a watershed is an indicator of water quality and healthy aquatic ecosystems. In urban areas, trees and forests are part of what is referred to as the community's "green infrastructure" and help reduce stormwater runoff. In rural areas, forests protect municipal water supplies, mitigate the impacts of flooding, replenish groundwater aquifers, and provide recreation and critical fish and wildlife habitat, as well as a variety of wood products.[26]

Basin 12 is the second most forested, and the least developed Basin in Vermont. Forested land covers 82% of the Basin. This affords significant protection to the Basin's waters.

Forestry operations can directly impact water quality by affecting how water flows through an area. In particular, constructing roads, trails, and log landings can reduce soil permeability, increase soil erosion, and divert and concentrate water flow, leading to a channeling effect. Concentrated water flow can also erode banks and put undue pressure on bridges and culverts.[27]

The most recent Vermont Forest Resource Harvest Summary[28] from 2016 documents that Windham County, which covers most of Basin 12, had the highest volume of sawlogs and veneer trees harvested in the state at 20,412 million board feet.

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[26] VDFPR, Forest Water Quality
[27] VDFPR, Forest Water Quality
[28] Vermont Forest Resource Harvest Summary - 2016

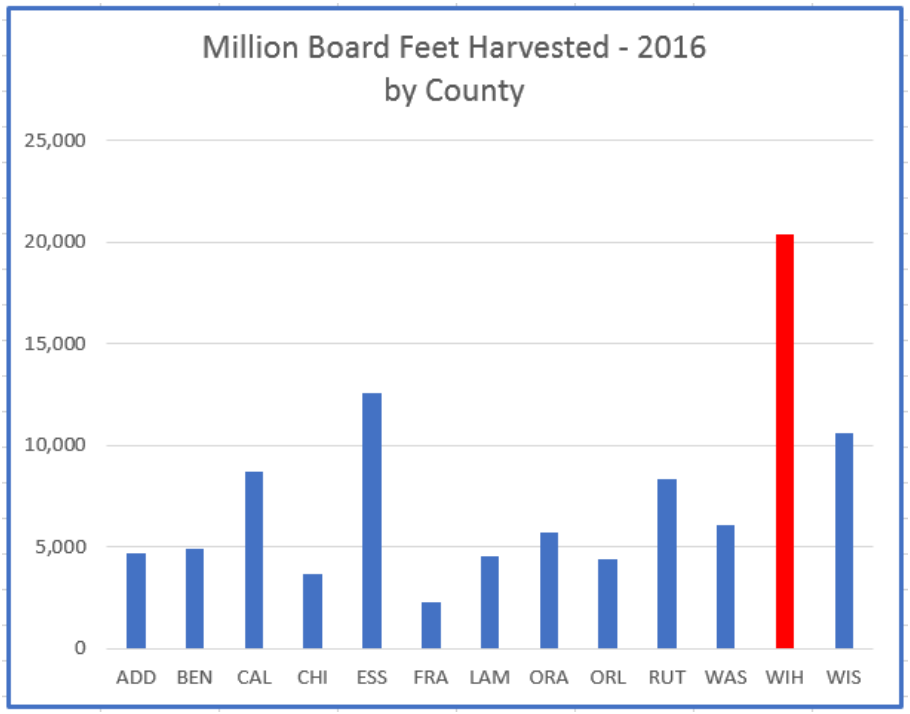

Figure 26. Windham County Harvest Summary

Proper Forestry Operations require careful adherence to the Acceptable Management Practices (AMPs) for Maintaining Water Quality on Logging Jobs in Vermont. The AMP rules, which were initially adopted in 1987, and updated in 2018, are preventative measures that help control soil erosion and protect water quality. Proper implementation of the AMPs will help absorb and disperse runoff, retain soil nutrients, filter sediment and prevent fluctuations in water temperature, minimizing the effects of logging on the natural hydrologic functions of forests. In addition to updating the rules, a new version of the AMP Manual was created in 2019. This new manual has detailed information on each of the 26 practices to protect water quality, as well as a section on planning the harvest, and a section on the wetland rules and how to protect wetlands during harvesting. The new manual can be found both in print form as a field manual, or on the FPR website in pdf form[29].

Clean Water Goals for Forest Restoration

- Decrease discharges from forestry operations through continued implementation of AMPs, outreach and training, and the use of portable skidder bridges
- Prevent stream erosion and improve resiliency on working lands through riparian restoration; logging road restoration; and stream crossing improvements which include installing properly sized structures or structure removal.

[29] https://fpr.vermont.gov/forest/managing-your-woodlands/acceptable-management-practices

- Protect forest habitat, biodiversity, and drinking water sources

e) Climate Change Adaptation for Wildlife

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 species responding to climate change pressure.

Habitat protection for these species will be critical to their long-term survival. The VDFW's 2015 Wildlife Action Plan includes these species as priorities for conservation:

Fowlers Toad (*Bufo fowleri*) was listed as Endangered in 2015. It is a Species of Greatest Conservation Need in Fluvial Habitat. The Fowler's Toad is very rare and has been found only in the southern Connecticut River Valley. It prefers naturally disturbed shorelines.[30]

Spotted Turtle (*Clemmys guttata*) found in limited locations in Windham, Bennington and Addison counties has a state natural heritage rank of S1[31] (very rare). The Spotted Turtle has been designated a Species of Greatest Conservation Need (high priority).[32]

North American Racer (*Coluber constrictor*) currently found only along the southern Connecticut River, has a state natural heritage rank of S1 (rare). The North American Racer is threatened in Vermont and has been designated a Species of Greatest Conservation Need (high priority).[33]

Eastern Box Turtle (*Terrapene carolina*) in Vermont are generally assumed to be released pets, however a cluster of reports from the southern Connecticut River Valley suggest the possibility of a native population.[34]

American Shad (*Alosa sapidissima*) in Vermont, is restricted to the Connecticut River from the Massachusetts line upstream to at least Bellows Falls dam. In 2019 over 314,000 shad migrated past the Holyoke Dam in Massachusetts and over 11,000 passed the Vernon Dam into Vermont.

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[30] The Vermont Reptile and Amphibian Atlas
[31] A system that ranks how common or rare a species is in Vermont. Species are ranked on a scale of S1 through S5 in which S1 and S2 are considered rare, S3 is considered uncommon, and S4 and S5 are common.
[32] Ibid.
[33] Ibid.
[34] 2015 Wildlife Action Plan

American Eel (*Anguilla rostrata*) – Connecticut River population – 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.[35]

Clean Water Goals for Climate Change Adaptation[36]

- Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN
- 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
- Conserve known habitat through fee simple purchase, development rights or easements, management agreements, and education of private landowners and managers regarding appropriate management
- Continue to document species distribution in Connecticut River Valley with targeted searches of potential sites, and sites where previously reported.
- Map species habitat including connectivity of patches
- Work to maintain connectivity with populations to the south in Massachusetts.
- Consider reintroduction or augmentation from closest healthy source
- Maintaining and enhancing extant populations is always a priority and should be continued
- Monitor species distribution and relative abundance of populations

[35] Ibid
[36] Ibid

Summary of Implementation Actions

Strategies	Priority Areas	Town	Partners	Funding
AGRICULTURAL LANDS				
Increase outreach and technical assistance through workshops and trainings for farmers, ag contractors and technical service providers on the new RAPs, improving soil health, implementing conservation field practices			UVM Ext., NRCDs, AAFM, NRCS	
Implement livestock exclusion practices	Newton Brook	Vernon	NRCDs, AAFM, NRCS	
Increase farm buffer establishment along surface waterways and upland wetlands	North Branch Deerfield, Newton Brook, Whetstone Brook, Connecticut River	Wilmington, Vernon, Brattleboro	NRCDs, AAFM, NRCS	
Support small farm NMP development and implementation through courses and trainings for farmers, manure applicators and technical service providers			UVM Ext., NRCDs, AAFM, NRCS	
Establish long-term funding for agricultural buffer projects			VDEC, NRCDs, AAFM, NRCS	
Increase the use of cover crops			UVM Ext., NRCDs, AAFM, NRCS	
Develop and host educational workshops directed to horse, beef, and small animal operations			UVM Ext., NRCDs, AAFM, NRCS	
Identify areas where water quality will most benefit from farm inspections and assistance	North Branch Deerfield, Newton Brook, Whetstone Brook		NRCDs, AAFM, NRCS	
Increase regional equity of State and Federal agricultural funding distribution			AAFM, NRCS	
Acquire RCE on lands located on alluvial fans			VLT, VRC, UVLT	

Strategies	Priority Areas	Town	Partners	Funding
DEVELOPED LANDS / STORMWATER				
Conduct stormwater master planning to identify and prioritize actions	North Branch Deerfield, Cold Brook, Whetstone Brook	Brattleboro, Dover, Mount Snow, Hermitage	RPCs, NRCDs, municipalities, ski resorts	
Implement priority project identified in these plans		Brattleboro, Dover, Mount Snow, Hermitage	North Branch Deerfield ski resorts	
Identify and mitigate sources of bacteria causing impairment	North Branch Deerfield, Whetstone Brook	Dover, Wilmington, Brattleboro	VDEC, municipalities	
Address stormwater runoff entering Kettle Pond		Brattleboro	WCNRCD, municipality	
Address stormwater runoff entering Whetstone Brook	Whetstone Brook	Brattleboro	WCNRCD, municipality	
Address stormwater runoff discharges from ski area development impairing water quality	North Branch Deerfield, Cold Brook	Dover, Wilmington	Municipalities, ski resorts	
Implement required actions to mitigate impairments addessed in the Mt Snow WQRPs	North Branch Deerfield, Baselodge trib,utary	Mt Snow Resort	Mt Snow Resort	
Conduct outreach to landowners scheduled to fall under the 3-acre stomwater rule			RPCs, NRCDs, VDEC	
DEVELOPED LANDS / ROADS				
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 (MRGP)			RPCs, NRCDs, municipalities	BR, GIA
Complete REIs in remaining towns		Dover, Guilford, Marlboro, Whitingham Woodford	RPCs, municipalities	BR
Assist towns with support and training on data collection methods and uploading data into MRGP database			RPCs, VDEC	
Increase municipal participation in BR & GIA funding: assist in project prioritization and project proposal development			RPCs, NRCDs, municipalities, VDEC	
Implement projects to address Class 4 road & legal trail erosion			NRCDs, municipalities	Work Crew Block Grant
Conduct outreach on BMPs for private roads and driveways			RPCs, NRCDs	
Replace geomorphologically incompatible culverts and bridges			VTrans, municipalities	Structures
WASTEWATER				
Reduce the nitrogen load from municipal wastewater discharges to address the LIS-TMDL			Municipalities	CWSRF
Conduct wastewater planning and feasibility studies for small communities without municipal systems			VDEC	CWSRF

Strategies	Priority Areas	Town	Partners	Funding
NATURAL RESOURCE RESTORATION: Rivers, Lakes, Wetlands & Forests				
RIVERS: Work toward stream equilibrium and flood resilience				
Increase the number of river and floodplain restoration projects to re-establish connections to floodplains	reaches with High to Extreme Sensitivity ratings		NRCDs, RPCs	
Increase River Corridor Easements which incorporate channel management, riparian buffer provisions and flood resiliency	Green River, East Branch North River		VRC, VLT, TNC	
Increase buffer plantings	Newton Brook, Whetstone Brook		NRCDs, watershed assoc's	
Remove dams, esp. High Hazard dams			CRC, RPCs, dam owners	
Protect floodplains and river corridors from conversion & development			VRC, VLT, TNC	
Increase buffer plantings			NRCDs, watershed assoc's	
Restore floodplain of Birge Street parcel	Whetstone Brook	Brattleboro	NRCDs, watershed assoc's	
SHORELANDS: protect and restore				
Promote & Implement the Lake Wise Program to encourage lake-friendly shoreline property maintenance	All Lakes & ponds		lakeshore owners, lake assoc's	
Establish Lay Lake Monitoring on appropriate lakes and ponds	Sadawga, Grout, Howe, Lily		lakeshore owners, lake assoc's	
Work to control riparian and aquatic invasive plants	All Lakes & ponds		lakeshore owners, lake assoc's	
Work to protect Lily Pond			lakeshore owners, VANR, municipality	
WETLANDS: protect and restore				
Restore degraded wetlands for habitat and water quality improvement		Vernon	AAFM, VDEC, NRCDs, watershed assocs	
Assess areas of prior converted wetland and hydric soils for restoration			AAFM, VDEC, NRCDs, watershed assocs	
Implement wetland restoration as sites and opportunities are identified			AAFM, VDEC, NRCDs, watershed assocs	
Assess wetlands for potential reclassification	see Table 6	Towns experiencing strong development pressure	VDEC - Wetlands	
Map unmapped wetlands		Wilmington, Dover and Vernon	VDEC - Wetlands, RPCs	

Strategies	Priority Areas	Town	Partners	Funding
FISHERY: protect and restore				
Implement strategic wood addition projects on:			TU, VDFW, USFS	
• East Branch of the Deerfield below Somerset Dam				
• Deerfield mainstem above Rake Branch				
• Rake Branch				
• Deer Cabin, Deer Lick, Blind and Glastonbury				
• Heather Brook and within Vose Brook				
Repair and maintain fish ladder at Green River Crib Dam			Community org	
FOREST MANAGEMENT: abate soil erosion				
Protect headwater streams and sensitive upland surface waters			DFPR, USFS, VLT	
Conduct outreach on AMPs and forest BMPs			DFPR, NRCDs	
Better manage forest road runoff through adherence to AMPs and site restoration			DFPR, landowners	
Continue and expand the Portable Skidder Bridge Program			NRCDs	
CLIMATE CHANGE ADAPTATION: mitigate potential impacts of climate change on species survival				
Support efforts, such as state, federal, regional and international Climate Change Action Plans to reduce greenhouse gas emissions in the Northeast and climate change risks to SGCN	Connecticut River valley		ANR, RPCs, NRCDs, USFWS	
Conserve known habitat of SGCN through fee simple purchase, development rights or easements, management agreements, and education of private landowners and managers regarding appropriate management	Connecticut River valley		ANR, RPCs, NRCDs, USFWS	
Work to maintain connectivity with populations to the south in Massachusetts	Connecticut River valley		ANR, RPCs, NRCDs, USFWS	
HAZARD MITIGATION & FLOOD RESILIENCY				
Increase outreach and training for municipalities on ERAF and river corridor protections			VDEC-Rivers, RPCs	WQ Planning
Increase funding for technical assistance and incentives for municipalities to enhance flood resiliency			VEM, VDEC-Rivers	
Remove sewer lines from hazardous locations including streambeds	Whetstone Brook	Brattleboro	Municipalities, VDEC - FED	CWSRF
Buy-out properties that are highly vulnerable to flooding from willing sellers	Green River, East Branch North River, Whetstone Brook		VEM, FEMA, RPCs	FEMA, HMP, PDHMP
Assess dams for structural integrity: prioritize High and Significant Hazard dams for removal or repair			VDEC - FED	FEMA, HMP, PDHMP
Create & implement Emergency Action Plans for all High and Significant Hazard dams			RPCs, VDEC - FED	
Implement infrastructure project at Jacksonville Municipal Center	East Branch North River	Jacksonville village	RPCs, VDEC, municipality	FEMA, HMP, PDHMP

Strategies	Priority Areas	Town	Partners	Funding
FLOW ALTERATION: Restore natural flows				
Work with dam operators to mitigate flow variations and work toward run-of-river management	Connecticut River, Deerfield River		Great River Hydro	
SURFACE WATER PROTECTION: Restoration and Reclassification				
Monitor and assess waters with no or outdated data	see Table 18		VDEC	
Work with partners to submit applications for reclassification	see Tables 3 & 4		RPCs, NRCDs, municipalities	
Evaluate waters for ORW designation	see Table 5		VDEC	
Evaluate waters for Class 1 Wetland designation	see Table 6		VDEC - Wetlands	

Monitoring Priorities Table

Table 18. identifies monitoring priorities for the Basin across several monitoring programs to achieve State monitoring goals. As described in the "What is a Tactical Basin Plan" section – the planning process is broken down into a 5-year planning cycle and the Deerfield River Basin is up for targeted monitoring in 2021. However, several monitoring programs monitor water quality in the Basin on an ongoing basis. Monitoring programs include:

- Monitoring and Assessment Program (BASS):
    - biological monitoring of macroinvertebrate and fish communities,
    - targeted chemistry sampling around WWTF or other pollution concerns,
    - LaRosa volunteer water quality monitoring program
    - Acid Lakes Long Term Monitoring program
- River Management Program (RMP):
    - geomorphic assessments that evaluate geomorphic and habitat conditions
- Lakes and Ponds Management and Protection Program:
    - spring phosphorus monitoring lake monitoring
    - lay lake monitoring programs which evaluate nutrient conditions and trends
    - shoreland condition
    - depth/bathymetric lake assessments
    - surveys for aquatic invasive species
- Wetlands Program:
    - wetlands assessments
- Vermont Department of Fish and Wildlife (VDFW):
    - fish assessments which are used to understand fish populations
    - temperature monitoring

Monitoring goals across all programs are aimed to:

1) identify and confirm water quality conditions that support reclassification of surface waters to a higher level;

2) understand water quality conditions where these are unknown such as streams or lakes that have not been sampled or assessed or where assessments may be out of date;

3) understand water quality conditions where there is a known water quality problem – to evaluate if the problem has gotten worse or to evaluate the effectiveness of restoration efforts;

4) understand pollution source areas that may be contributing to water quality issues such as nitrogen loading regarding LIS;

5) evaluate water quality changes over time – as supported by sentinel monitoring network on rivers and streams or targeted studies to evaluate water quality improvements with the implementation of best management practices.

Table 18 is an initial list of water quality monitoring priorities to guide monitoring over the next 5 years. This list has more sites than there is capacity to sample so will need to be further prioritized based on information needed to answer the most pressing questions in the Basin.

Table 18. Basin priorities for monitoring and assessment

- see Acronyms list on page 91

Waterbody	Assessment Need	Priority	Location (River Mile)	Partner(s)	Monitoring Action
Rivers & Streams					
Deerfield River	Old data	Moderate	44.4	BASS*	Data update
	Old data	Low	51.3	BASS	Data update
	Old data	Low	51.8	BASS	Data update
	Old data	Low	52.4	BASS	Data update
	Old data	Moderate	65.6	BASS	Data update
	Old data	Low	66.3	BASS	Data update
	Support A(1)	High	67.5	BASS / USFS / GRH	Potential A(1)
	Old data	Low	73.1	BASS / USFS / GRH	Maintain A(1)
	Old data	Low	74.9	BASS / USFS / GRH	Maintain A(1)
	No data, need headwater data	Low	above 74.9	BASS / USFS / GRH	Maintain A(1)
Bond Brook	Wind station	Moderate	1.7	BASS / USFS / GRH	Permit tracking
Boyd Brook	no data	Low		BASS / USFS / GRH	Establish Baseline
Castle Brook	pH only	Low	0.2	BASS / USFS	Maintain A(1)
South Pond Brook	no data	Low		BASS / USFS	Maintain A(1)
Rake Branch	pH only	Moderate		BASS / USFS	Data update
Redfield Brook	no data	Low	0.7	BASS / USFS	Establish Baseline
Mill Pond Brook	no data	Low		BASS / USFS	Establish Baseline
Little Pond Brook	chem only	Low		BASS / USFS	Data update
Red Mill Brook	Reclassification	Moderate		BASS / USFS	Establish Baseline
Dunbar Brook (VT/MA)	no data	Low		BASS	Establish Baseline
Graves Brook	no data	Low		BASS / GRH	Establish Baseline
Heather Brook	no data	Low		BASS / USFS	Establish Baseline
Medbury Brook	Wind station	Low	0.4	BASS / USFS / GRH	Monitor acid stress
Number Nine Brook	no data	Low		BASS / GRH	Establish Baseline

Waterbody	Assessment Need	Priority	Location (River Mile)	Partner(s)	Monitoring Action
Pine Brook	no data	Low		BASS / USFS / GRH	Establish Baseline
Tobey Brook	no data	Low		BASS / GRH	Establish Baseline
Vose Brook	no data	Low		BASS / USFS / GRH	Establish Baseline
Wheeler Brook (MA)	no data	Low		BASS	Establish Baseline
Wilder Brook	single sample	Low	0.8	BASS / USFS / GRH	Data update
Glastenbury River					
	old fish data	Low	0.4	BASS / USFS	Maintain A(1)
Blind Brook	pH only	Low	0.3	BASS / USFS	Maintain A(1)
Deer Lick Brook	pH only	Low	0.1	BASS / USFS	Maintain A(1)
Deer Cabin Brook	old data	Low	0.1	BASS / USFS	Maintain A(1)
East Branch Deerfield River					
	Reclassification	High	0.1	BASS / USFS / GRH	Potential A(1)
	Reclassification	High	5.3	BASS / USFS / GRH	Potential A(1)
Black Brook	pH only	Low	2.2	BASS / USFS / GRH	Data update
West Branch Deerfield River					
	Reclassification	High	0.1	BASS / USFS	Potential A(1)
	Reclassification	High	1.8		Potential A(1)
	Reclassification	High	5.9		Potential A(1)
	Reclassification	High	8.5		Potential A(1)
Reservoir Brook	no data	Low		BASS / USFS	Maintain A(1)
Yaw Pond Brook	pH only	Low	0.4	BASS / USFS	Data update
Howe Pond Brook	chem only	Low		BASS / USFS	Data update
Lamb Brook	Reclassification	Low	0.1	BASS / USFS / permittee	Data update
Lamb Brook	Reclassification	Low	0.7		Potential A(1)
South Branch Deerfield River					
	Reclassification	High	1.3	BASS / USFS / GRH	Potential A(1)
Beaver Brook	no data	Low		BASS	Establish Baseline
Windsor Pond trib	no data	Low		BASS	Establish Baseline

Waterbody	Assessment Need	Priority	Location (River Mile)	Partner(s)	Monitoring Action
North Branch Deerfield River					
	Evaluate WQ issue	High	5.8	BASS	Determine source
	Evaluate WQ issue	High	6.5	BASS	Determine source
	Old data	High	7	BASS	Data update
	Evaluate WQ issue	High	11	BASS / Mt Snow	Permit tracking
	Evaluate WQ issue	High	12.1	BASS / USFS / Mt Snow	Permit tracking
	Reclassification	High	12.6	BASS / USFS / Mt Snow	Potential A(1) / Permit tracking
Baselodge Trib	old data	High	0.1	BASS / Mt Snow	Permit tracking
Beaver Brook	E. coli tracking	High	1	BASS / GRH	Locate source
Bill Brook	no data	Low		BASS	Establish Baseline
Hall Brook	no data	Low		BASS	Establish Baseline
Meadow Brook	no data	Low		BASS	Establish Baseline
Binney Brook	Evaluate WQ issue	Moderate	0.1	BASS / USFS	Determine source
Rose Brook	Evaluate WQ issue	Moderate	0.9	BASS / USFS / GRH	Determine source
Blue Brook	Reclassification	Moderate	0.7	BASS	Potential future B(1)
Cold Brook	Reclassification	High		BASS / USFS	Potential B(1) / Permit tracking
Oak Brook		High		BASS / Hermitage	Permit tracking
Haystack Brook	Reclassification	High		BASS / USFS / Hermitage	Potential B(1) / Permit tracking
Ellis Brook	Evaluate WQ issue	Moderate		BASS / USFS	Determine source
Negus Brook	old data	Low		BASS / USFS	Data update
Cheney Brook	old data	Low		BASS / USFS	Data update

Waterbody	Assessment Need	Priority	Location (River Mile)	Partner(s)	Monitoring Action
Tannery Brook (named by DEC)	no data	Low		BASS	Establish Baseline
Iron Stream	old data	High	0.3	BASS / Mt Snow	Evaluate iron / data update
Jacks Brook	old data	Low		BASS / Mt Snow	Data update
Green River					
	Reclassification / Sentinel Stream	High	16.6	BASS	Potential A(1)
	Reclassification	High	19.9	BASS	Potential A(1)
Borden Brook (VT/MA)	no data	Low		BASS	Establish Baseline
Deer Park Pond Brook (unnamed)	no data	Low		BASS	Establish Baseline
Harrisville Brook	no data	Low		BASS	Establish Baseline
Hinesburg Brook	no data	Low		BASS	Establish Baseline
Pond Brook	Reclassification	Moderate		BASS	Potential A(1), need fish
Roaring Brook	no data	Low		BASS	Establish Baseline
Thorne Brook (VT/MA)	no data	Low		BASS	Establish Baseline
Trib. #6	old data / Reclassification	Moderate	1.7	BASS	Potential A(1) / data update
North River (MA)					
East Branch North River	Reclassification	High	11.7	BASS	Potential A(1)
Branch Brook	no data	Low		BASS	Establish Baseline
Sperry Brook	no data	Low		BASS	Establish Baseline
Butler Brook – unnamed trib (Gates Pond outlet)	no data	Low		BASS	Establish Baseline
Fowler Brook	no data	Low		BASS	Establish Baseline
Hager Brook	no data	Low		BASS	Establish Baseline

Waterbody	Assessment Need	Priority	Location (River Mile)	Partner(s)	Monitoring Action
Pearsons Road Brook – unnamed trib	no data	Low		BASS	Establish Baseline
Pease Brook	no data	Low		BASS	Establish Baseline
Randall Brook	no data	Low		BASS	Establish Baseline
Ryder Pond Brook – unnamed trib	no data	Low		BASS	Establish Baseline
Sprague Brook	no data	Low		BASS	Establish Baseline
West Branch Brook (MA)	no data	Low		BASS	Establish Baseline
Brown Brook	no data	Low		BASS	Establish Baseline
Burton Brook	no data	Low		BASS	Establish Baseline
Cyrus Brook	no data	Low		BASS	Establish Baseline
Connecticut River & Direct Streams					
Connecticut River	no data	Moderate		BASS	Establish Baseline
Reach 04 – West River confluence to Vernon Dam	EPA NRSA site	Moderate		BASS	TMDL tracking
Reach 05 – Vernon Dam to MA line	no data	Moderate		BASS	Establish Baseline
Broad Brook					
	old data	High	0.9	BASS	Data update
Guilford Ctr Road - unnamed trib	no data	Low		BASS	Establish Baseline
Lee Road - unnamed trib	no data	Low		BASS	Establish Baseline
South Branch - unnamed trib (Rte 5)	no data	Low		BASS	Establish Baseline
Weatherhead Hollow Road - unnamed trib	no data	Low		BASS	Establish Baseline
Fall River	Reclassification	Moderate	15.2	BASS	Potential A(1)
West Brook	no data	Low		BASS	Establish Baseline
Roaring Brook	no data	Low		BASS	Establish Baseline
Keets Brook	no data	Low		BASS	Establish Baseline

Waterbody	Assessment Need	Priority	Location (River Mile)	Partner(s)	Monitoring Action
	Packer Corners Rd - unnamed trib	no data	Low		BASS
Newton Brook					
	Evaluate nutrient trend	High	0.6	BASS	Track impairment
	Evaluate nutrient trend	High	0.2	BASS	Track impairment
Whetstone Brook					
	Evaluate bacteria	High	1.1	BASS	Track impairment
	Evaluate bacteria	High	2.4	BASS	Track impairment
	Reclassification	High	10.7	BASS	Potential A(1)
Ames Hill Brook	no data	Moderate		BASS	Establish Baseline
Halladay Brook	no data	Low		BASS	Establish Baseline
Pleasant Valley Reservoir trib	no data	Low		BASS	Establish Baseline
Lakes & Ponds					
Deerfield River					
Adams Reservoir – Woodford	Evaluate nutrient trend	Moderate		Lakes Program, BASS/LTM	Track impairment
Grout Pond – Stratton	Evaluate nutrient trend	High		Lakes Program, BASS/LTM	Establish LMP, Track impairment
Harriman Reservoir – Wilmington, Whitingham	Shoreland assessment / water level fluctuation	High		Lakes Program	Establish LMP
Haystack Pond – Wilmington	Shoreland assessment	High		Lakes Program, BASS/LTM	Establish LMP
North Pond – Whitingham	Establish data to determine nutrient trend	Moderate		Lakes Program	Establish LMP

Waterbody	Assessment Need	Priority	Location (River Mile)	Partner(s)	Monitoring Action
Howe Pond – Readsboro	establish LMP	Moderate	A2-water supply	Lakes Program, BASS/LTM	Establish LMP, Track impairment
Little Pond – Woodford	Establish data to determine nutrient trend	Low		Lakes Program, BASS/LTM	Establish LMP, Track impairment
Mud Pond – Stamford, Woodford	Evaluate nutrient trend / shoreland assessment	Low		Lakes Program	Track trends
Lake Raponda – Wilmington	Monitor nutrient trend	High		Lakes Program	Track trends
Sadawga Lake – Whitingham	Establish LMP to track trends	High		Lakes Program	Establish LMP
Searsburg Reservoir - Searsburg	Establish data to determine nutrient trend / water level fluctuation	Low		Lakes Program	Establish LMP
Sherman Reservoir – Whitingham	Establish data to determine nutrient trend	Low		Lakes Program	Establish LMP
Snow Lake – Dover	Monitor discharges during removal	Low		Lakes Program	Remove pond
Somerset Reservoir – Stratton, Somerset	Shoreland assessment / water level fluctuation	Low		Lakes Program	Establish LMP
Spruce Lake - Wilmington	Establish data to determine nutrient trend	Low		Lakes Program	Establish LMP
Stamford Pond – Stamford	Evaluate nutrient trend	Low		Lakes Program, BASS/LTM	Establish LMP, Track impairment

Waterbody	Assessment Need	Priority	Location (River Mile)	Partner(s)	Monitoring Action
Yaw Pond – Woodford, Readsboro	no data	Low		Lakes Program	Establish Baseline
Green River					
Deer Park Pond – Halifax	Monitor nutrient trend	High		Lakes Program	Establish LMP
South Pond – Marlboro	Monitor nutrient trend	High		Lakes Program	Track impairment
East Branch North River					
Gates Pond – Whitingham	no LMP	Moderate		Lakes Program	Establish LMP
Jacksonville Pond – Whitingham	Evaluate nutrient trend	High		Lakes Program	Establish LMP
Laurel Pond – Whitingham	Establish data to determine nutrient trend	Low		Lakes Program	Establish LMP
Ryder Pond – Whitingham	Establish data to determine nutrient trend	Low		Lakes Program	Establish LMP
Shippee Pond – Whitingham	Establish data to determine nutrient trend	High		Lakes Program	Establish LMP
Connecticut River Direct					
Keets Brook					
Sweet Pond – Guilford	Monitor refill / shoreland assessment	High		Lakes Program	Monitor refilling of pond for sediment movement
Weatherhead Hollow Pond – Guilford	Evaluate nutrient trend	High		Lakes Program	Track trends
Newton Brook					
Lily Pond – Vernon	Protection	High		Lakes Program	Track impairment

Waterbody	Assessment Need	Priority	Location (River Mile)	Partner(s)	Monitoring Action
Vernon Hatchery Pond – Vernon	Establish data to determine nutrient trend	Low		Lakes Program	Track trends
Whetstone Brook					
Hidden Lake – Marlboro	Monitor nutrient trend	Moderate		Lakes Program	Track trends
Kettle Pond – Brattleboro	Evaluate nutrient trend / hi conductivity	High		Lakes Program	address stormwater inputs
Pleasant Valley Reservoir – Brattleboro	Evaluate nutrient trend / shoreland assessment	Low		Lakes Program	Track trends

Wetlands					
Atherton Meadow – Whitingham	Reclassification	High		Wetlands Program	Potential Class 1
Beaver Meadow – Readsboro	Reclassification	Low		Wetlands Program	Establish Baseline
Shep Meadow Pond – Somerset	Reclassification	Low		Wetlands Program	Establish Baseline
Lake Sadawga floating bog – Whitingham	Reclassification	Low		Wetlands Program	Establish Baseline
Lily Pond – Vernon	Reclassification	High		Wetlands Program	Establish Baseline

Acronyms

2PAD - 2-phase anaerobic digestion

7Q10 - proportion of river flow at lowest base

AAFM – Agency of Agriculture, Food & Markets

AIS GIA – Aquatic Invasive Species Grant-in-Aid

ANR – Vermont Agency of Natural Resources

BASS = Biomonitoring and Assessment Program

BCCD – Bennington County Conservation District

BG – Block Grant

BR – Better Roads Grant

CRC – Connecticut River Conservancy

CSO – combined sewer overflow

CWIP – Clean Water Initiative Program

CWSRF – Clean Water State Revolving Fund

DU – Ducks Unlimited

ERP – Ecosystem Restoration Program

FED – Vermont Facilities Engineering Division

FEMA - Federal Emergency Management Agency

GIA – Road Grant-in-Aid

GRH - Great River Hydro, LLC

HMP – Hazard Mitigation Program

HMP – Hazard Mitigation Program

PDHMP – Pre-Disaster Hazard Mitigation Program

IWC - Instream Waste Concentration

LMM - low median monthly

LMP – Lay Monitoring Program

LTM – Long-term Monitoring Program

MBBR - moving bed bio-reactor

MGD – million gallons per day

MRGP - Municipal Roads General Permit

MS4 – Municipal Separate Storm Sewer System

NRCD – Natural Resources Conservation District

NRCS – USDA Natural Resources Conservation Service

RBC – rotating biological contactors

RPC – Regional Planning Commission

TNC _ The Nature Conservancy

TU – Trout Unlimited

USFS – US Forest Service

UVLT – Upper Valley Land Trust

UVM Ext. – UVM Extension Service

VACCD – VT Agency of Commence and Community Development

VDFW – Vermont Department of Fish & Wildlife

VFPR - Vermont Department of Forests, Parks & Recreation

VDEC - Vermont Department of Environmental Conservation

VEM – Vermont Emergency Management

VHCB – Vermont Housing & Conservation Board

VLT – Vermont Land Trust

VRAM – VT Rapid Assessment Methodology

VRC – Vermont River Conservancy

WCNRCD – Windham County NRCD

WID - Watershed Investment Program of VDEC

WMA – Wildlife Management Area

WQRP - Water Quality Remediation Plan

WRC – Windham Regional Commission

Glossary

10 V.S.A., Chapter 47 - Title 10 of the Vermont Statutes Annotated, Chapter 47, Water Pollution Control, which is Vermont's basic water pollution control legislation.

Accepted Agricultural Practices (AAP) - land management practices adopted by the Secretary of Agriculture, Food and Markets in accordance with applicable State law.

Acceptable Management Practices (AMP) - methods to control and disperse water collecting on logging roads, skid trails, and log landings to minimize erosion and prevent sediment and temperature changes in streams.

Aquatic biota - all organisms that, as part of their natural life cycle, live in or on waters.

Basin - one of fifteen planning units in Vermont. Some basins include only one major watershed after which it is named such as the Lamoille River Basin. Other Basins include two or major watersheds such as the Poultney/Mettawee Basin.

Best Management Practices (BMP) - a practice or combination of practices that may be necessary, in addition to any applicable Accepted Agricultural or Silvicultural Practices, to prevent or reduce pollution from nonpoint source pollution to a level consistent with State regulations and statutes. Regulatory authorities and practitioners generally establish these methods as the best manner of operation. BMPs may not be established for all land use sectors but are often listed by professional associations and regulatory agencies as the best manner of operation for a particular industry practice.

Biological integrity - the ability of a body of water to support and maintain a community of organisms that has the expected species composition, diversity, and functional organization comparable to that of the water in its natural condition.

Classification - a method of designating the waters of the State into categories with more or less stringent standards above a minimum standard as described in the Vermont Water Quality Standards.

Designated use - any value or use, whether presently occurring or not, that is specified in the management objectives for each class of water as set forth in §§ 3-02 (A), 3-03(A), and 3-04(A) of the Vermont Water Quality Standards.

Existing use - a use that has actually occurred on or after November 28, 1975, in or on waters, whether or not the use is included in the standard for classification of the waters, and whether or not the use is presently occurring

Fluvial geomorphology - a science that seeks to explain the physical interrelationships of flowing water and sediment in varying landforms

Impaired water - a water that has documentation and data to show a violation of one or more criteria in the Vermont Water Quality Standards for the water's class or management type.

Mesotrophic – An intermediate level of nutrient availability and biological productivity in an aquatic ecosystem.

Natural Community - An interacting assemblage of organisms, their physical environment, and the natural processes that affect them.

Natural condition - the condition representing chemical, physical, and biological characteristics that occur naturally with only minimal effects from human influences.

Nonpoint source pollution - pollution that reaches waters in a diffuse manner from any source other than a point source including, but not limited to, overland runoff from construction sites, or as a result of agricultural or silvicultural activities.

pH - a measure of the hydrogen ion concentration in water on an inverse logarithmic scale ranging from 0 to 14. A pH under 7 indicates more hydrogen ions and therefore more acidic solutions. A pH greater than 7 indicates a more alkaline solution. A pH of 7.0 is considered neutral, neither acidic nor alkaline.

Point source - any discernible, confined and discrete conveyance including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which either a pollutant or waste is or may be discharged.

Production Area - means those areas of a farm where animals, agricultural inputs, or raw agricultural products are confined, housed, stored, or prepared whether within or without structures, including barnyards, raw materials storage areas, heavy use areas, fertilizer and pesticide storage areas, and waste storage and containment areas. Production areas include egg washing or egg processing facilities, milkhouses, raw agricultural commodity preparation or storage, or any area used in the storage, handling, treatment, or disposal of mortalities.

Riparian vegetation - the native or natural vegetation growing adjacent to lakes, rivers, or streams.

River Corridor - the land area adjacent to a river that is required to accommodate the dimensions, slope, planform, and buffer of the naturally stable channel and that is necessary for the natural maintenance or natural restoration of a dynamic equilibrium condition, as that term is defined in 10 V.S.A. §1422, and for minimization of fluvial erosion hazards, as delineated by the Agency in accordance with the VANR River Corridor Protection Guide.

Sedimentation - the sinking of soil, sand, silt, algae, and other particles and their deposition frequently on the bottom of rivers, streams, lakes, ponds, or wetlands.

Thermal modification - the change in water temperature

Turbidity - the capacity of materials suspended in water to scatter light usually measured in Nephelometric Turbidity Unit (NTU). Highly turbid waters appear dark and "muddy."

Waste Management System -a planned system in which all necessary components are installed for managing liquid and solid waste, including runoff from concentrated waste areas and silage leachate, in a manner that does not degrade air, soil, or water resources. Such systems are planned to preclude discharge of pollutants to surface or ground water and to recycle waste through soil and plants to the fullest extent practicable.

Water Quality Standards - the minimum or maximum limits specified for certain water quality parameters at specific locations for the purpose of managing waters to support their designated uses. In Vermont, Water Quality Standards include both Water Classification Orders and the Regulations Governing Water Classification and Control of Quality.

Waters - all rivers, streams, creeks, brooks, reservoirs, ponds, lakes, springs and all bodies of surface waters, artificial or natural, which are contained within, flow through or border upon the State or any portion of it.

Watershed - all the land within which water drains to a common waterbody (river, stream, lake pond or wetland).

Wetlands - are places where land and water meet which may be inundated or saturated by water for a few weeks of the year to shallow water year-round. Vermont's wetlands are defined as those areas of the state that are inundated by surface or ground water with a frequency sufficient to support plants and animals that depend on saturated or seasonally saturated soil conditions for growth and reproduction. These areas are

commonly known as ponds, bogs, fens, marshes, wet meadows, shrub swamps, and wooded swamps.

Water quality remediation plan means a plan, other than a TMDL, designed to bring an impaired water body into compliance with applicable water quality standards in accordance with 40 C.F.R. § 130.7(b)(1)(ii) and (iii).

Appendices

Appendix A. 2014 Report Card

The 2014 Tactical Basin Plan laid out 63 Objectives each containing between one and seven Action items to be addressed. Of the 63 Objectives, 36 have been fully or partially implemented.

The implementation status of 2014 Actions are documented as:

- Completed – the Action has been implemented
- Deleted – the Action has been withdrawn from consideration
- In progress – the Action underway
- Not Started – the Action has not begun
- On-going – the Action is taking place and will continue to be carried out

Additional projects and actions that were identified after the publication of the 2014 plan have also been undertaken and many have been completed. These are listed at the end of the Report Card table below.

In developing the implementation projects for the 2019 Plan some of the 2014 projects will be carried forward for future implementation while others are no longer relevant to the current clean water priorities of the Agency of Natural Resources.

Action	Partners	Funding	Implementation Location	Status
Objective 1: Complete on-the-ground shoreline assessments of the lakes and ponds in the Basin.				
1) Reference WRC shoreline maps	Lakes & Ponds	ANR	All un-assessed lakes	In Progress
2) Assess and ground-truth	N/A			
Objective 2: Monitor and assess the temperature issues created by the cold water discharges from Somerset, Searsburg and Harriman dams and warm lake water in the reservoirs.				
1) Monitor above and below each discharge & reservoir	USFS	USFS, ANR	Deerfield River & East Branch Deerfield	In Progress
2) Assess fisheries above and below each discharge & reservoir	USFS	USFS, ANR/VDEC & VFWD	Deerfield River & East Branch Deerfield	On-going
Objective 3: Monitor waterbodies with no or little data.				
1) Monitor	VDEC – Lakes & Ponds	ANR	Binney Brook	Completed
	VDEC - WSMD		Beaver Brook	Completed
			Black Brook	Completed
			Blue Brook	Completed
			So. Branch Deerfield	Completed
			Ellis Brook	Completed
			Fall River	Completed
			Keets Brook	Not Started
			Connecticut River	Not Started
Objective 4: Monitor and assess Ellis Brook to determine cause of degradation to ALS and fisheries as listed in 303(d) Part C – Waters in Need of Further Assessment.				
Biomonitoring & chemical assessment	VDEC – BASS lab	ANR	Ellis Brook Stations 0.5 – > 2.6	Completed
Objective 5: Monitor, assess and implement clean-up of tritium contamination in the Connecticut River as Listed in Part C.				
1) Monitor tritium levels in groundwater discharges to the CT River and in the river itself	Entergy-VT Yankee, VDOH, VDEC	private	CT River, Vernon	Not Started

Action	Partners	Funding	Implementation Location	Status
2) Remove and mitigate tritium contamination	Entergy-VT Yankee	private		Not Started
Objective 6: Monitor the impacts of the Deerfield Wind Projects on the surrounding Class A waters to ensure there is no future degradation of water quality.				
Biomonitoring & chemical assessment	VDEC – BASS lab	Deerfield Wind, LLC, ANR	All surrounding Class A brooks	On-going
Objective 7: Survey, assess and document biodiversity in areas of the Basin with insufficient data to reference in BioFinder.				
Conduct surveys	VDFW, conservation commissions	ANR	Wilmington, Whitingham, Halifax, Brattleboro, Guilford	In Progress
Objective 8: Conduct geomorphic assessment & corridor planning on the East Branch of the North River.				
1) Conduct SGA	WCNRCD, WRC, DRWA	ERP, DREF	Mainstem, Branch Brook, Gates Pond Brook	Completed
2) Compile corridor plan				Completed
Objective 9: Expand volunteer monitoring on the major lakes in the Basin.				
1) Lay lake monitoring program	VDEC – Lakes & Ponds, watershed associations	ANR, WG	Gates, Grout, Harriman, Howe, Jacksonville, Lily, Sadawga, Searsburg, Sherman, Shippee, Somerset, Weatherhead Hollow	On-going

Action	Partners	Funding	Implementation Location	Status
2) VIP monitoring program		ANR, WG, ANS Grant-in Aid	Gates, Grout, Harriman, Howe, Jacksonville, Lily, Raponda, Sadawga, Searsburg, Sherman, Shippee, Somerset, Weatherhead Hollow	On-going
Objective 10: Locate, field-verify and document vernal pools in the Basin to fully protect wetlands.				
1) Continue project funding for & mapping of vernal pools	conservation commissions, watershed associations VCE, Arrowwood Env.	Legislature, ANR, WG	Full basin	Not Started
2) Identify groups of vernal pools that are particularly significant or likely to maintain hydrology and habitat connectivity and thus species presence in the face of climate change	VDEC – Wetlands	ANR	Full basin	Not Started
3) Identify areas to prioritize vernal pool protection and possible consideration for Class One wetland complex	VDEC – Wetlands	ANR	Full basin	Not Started
Objective 11: Assess high elevation wetlands in northern Deerfield watershed in relation to spring feeding by bears and use as wildlife travel corridors and provide data for BioFinder and RTE.				
Conduct wetland assessments	VDEC – Wetlands,	ANR	Dover, Wilmington, Searsburg, Somerset	In Progress
Conduct bear surveys	VFWD	ANR	Same	In Progress
Objective 12: Survey the Deerfield watershed and document waterfalls, cascades and gorges.*				
Conduct survey and map sites	DRWA, WRC	WG, 604(b), DREF	Deerfield watershed	Not Started

Action	Partners	Funding	Implementation Location	Status
Objective 13: Assess wetland complexes upstream of Wilmington for improved flood storage capacity.				
Map and model current and potential storage capacity	VDEC- Rivers Program & Wetlands	ANR	Wilmington	Not Started
Objective 14: Conduct AEM assessments on the North Branch Deerfield upstream of Wilmington.				
Assess agricultural operations for environmental BMPs	WCNRCD, VACD, AAFM	VWG, ERP, AAFM	North Branch Deerfield	????
Objective 15: Incorporate river corridors and flood resiliency strategies into local and regional development plans and zoning.				
Focus on areas of highest risk identified in River Corridor plans	RPC's, Town Planning and Conservation Commissions, VLCT	MPG	Basin-wide	In Progress
			Focus Towns: Brattleboro, Wilmington, Dover, Vernon	
Objective 16: Remove dams that are no longer serving a useful purpose.				
1) The Coop dam on Whetstone Brook	VDFW, VT Dam Task Force, USFWS	AR/NOAA, ERP, USFWS-EBTJV	42.850948, -72.557962	Not Started
2) Cold Brook dam in Dover	VDFW, VT Dam Task Force, USFWS	AR/NOAA, ERP, USFWS-EBTJV		Completed
3) Prioritize dams in *Poor* condition for removal potential	VDFW, VT Dam Task Force, USFWS	AR/NOAA, ERP, USFWS-EBTJV		In Progress
Objective 17: Identify, document and protect the natural communities (NC) and RTE species in significant wetlands, including Ryder Pond, prior to dam removals.				
1) Survey and document NC and RTE in the Ryder Pond wetlands	VDEC – Wetlands, VDFW – NHP		Ryder Pond	Deleted

Action	Partners	Funding	Implementation Location	Status
2) Survey and document NC and RTE in wetlands above dam any proposed removal project	VDEC – Wetlands, VDFW – NHP			
Objective 18: Complete a wetland restoration following a dam removal.				
1) Conduct training for staff and partners on dam removal and wetland restoration	Institute for Wetland & Environmental Education & Research, NRCS, VDEC - Wetlands	ERP, PFW, WRP/DU, USFWS, WG		In Progress
2) Complete the removal of the Ryder Pond dam	Ryder Pond Landowners Association	Ryder Pond Landowners Association	Ryder Pond	Deleted
			42.812828,-72.843178	
3) Restore the functions of the remaining wetland	WRP/DU			
Objective 19: Use the WRC *Undeveloped Shorelands Maps*, to prioritize areas for protection on lakes, ponds, river and streams.				
1) Prioritize most threatened sites	WRC, Watershed Assoc.	ANR, 604(b)	Basin-wide	Not Started
2) Seek funding for purchase and easements	WRC, Municipalities, VRC	ERP,	Basin-wide	Not Started
Objective 20: Implement stormwater control projects to reduce flows and sediment wherever possible. Focus area priority: outfalls to the North Branch Deerfield and its tributaries.				
1) Conduct stormwater survey and IDDE investigations	VDEC - Stormwater	ERP	Dover, Wilmington, Whitingham, Readsboro	In Progress
2) Develop and implement stormwater control projects	VDEC, Municipalities, Ski Resorts	ERP, private	Dover, Wilmington	On-going

Action	Partners	Funding	Implementation Location	Status
Objective 21: Encourage and implement green infrastructure practices.				
1) Encourage use of green stormwater infrastructure.	VDEC	VDEC	Basin-wide	On-going
2) Promote local regulatory approaches to encourage GSI and LID	VDEC	ERP, VAPDA	Basin-wide	On-going
3) Promote local incentives to support GIS and LID.	VDEC	ERP, VAPDA		Not Started
Objective 22: Monitor and document impacts of TS Irene.				
1) Document erosion damage & mass failures	VGS, WRC, BCRC, SGA Consultants	604(b)	Basin-wide	Completed
2) Document infrastructure problems and concerns	WRC, BCRC, VTrans, SGA Consultants	604(b)	Basin-wide	On-going
3) Develop remediation projects where appropriate	WRC, BCRC, SGA Consultants	604(b), BBR	Basin-wide	In Progress
4) Update delineated SGA and FEH corridors where river has migrated outside of boundary	VDEC – Rivers Program	ANR	Where applicable	Not Started
Objective 23: Better manage lakeshore and water quality issues on lakes and ponds in the Basin.				
1) Promote and initiate the Lake Wise program	VDEC – Lakes & Ponds, Lake Assoc.		Lake Raponda, Sadawga Lake, Lily Pond, Hidden Lake	On-going
2) Coordinate with LID staff on lakeshores and retrofitting systems	VDEC – Lakes & Ponds & Stormwater, Lake Assoc.	ERP, BBR		In Progress
3) Establish conservation programs for lakeshores	VDEC – Lakes & Ponds, WRC, BCRC, VRC	VRC, VHCB, ERP	Lake Raponda, Sadawga Lake, Shippee Pond, Lily Pond, Hidden Lake	Not Started

Action	Partners	Funding	Implementation Location	Status
4) Conduct invasives evaluation and protection programs on the lakes	VDEC – Lakes & Ponds, Lake Assoc.		Lake Raponda, Sadawga Lake, Shippee Pond, Lily Pond, Hidden Lake, Grout Pond, Jacksonville Pond, Weatherhead Hollow Pond, South Pond	On-going
5) Expand Lay Monitoring program to more Basin lakes	VDEC – Lakes & Ponds, Lake Assoc.		All but Lake Raponda	In Progress
6) Establish a monitoring and control program on Sadawga Lake to reduce the levels of Eurasian watermilfoil.	LSA	ANS Grant-in Aid	Sadawga Lake	Not Started
7) Work with lakes subject to annual drawdown to eliminate these impacts	VDEC – Lakes & Ponds, Lake Assoc.		Where applicable	On-going
Objective 24: Encourage and support smart growth development and compact village centers and downtowns to slow forest fragmentation.				
1) Promote ACCD programs.	VDEC	VDEC	Basin-wide, focus areas: resort development, Brattleboro, Wilmington, Dover	On-going
2) Identify high-priority landscapes for conservation efforts.	ANR			On-going
Objective 25: Dovetail continued post-closure monitoring programs of landfills with working on fixes for known water quality impacts following the end of the required monitoring in 2013.				
1) Maintain water monitoring programs	VDEC - WMD	SWAG - CPP	Municipal landfills in Brattleboro, Dover, Halifax, Searsburg, Wilmington	Not Started
2) Develop and implement clean-up projects at impacted locations	VDEC - WMD	SWAG - CPP		Not Started

Action	Partners	Funding	Implementation Location	Status
Objective 26: Reduce sand and sediment inputs from gravel roads throughout the Basin.				
1) Provide more training and education for road agents on preventing erosion	Local Roads, Municipal DPW's, RPCs	Local Roads	Basin-wide	On-going
2) Conduct BBR capital budget inventories for road-related erosion, AOP impediments, and river-road conflicts with an emphasis on flood resiliency	Focus towns, Better Backroads technician, VDEC	BBR, ERP	Brattleboro, Dover, Guilford, Halifax, Whitingham, Wilmington	In Progress
3) Seek funding for regionally shared equipment for sand sweeping, catch basin sump cleaning and reduced use of sand & salt with possible conversion to brine	Focus towns, Better Backroads technician, VDEC	BBR, 319, VTrans	Brattleboro, Dover, Guilford, Halifax, Whitingham, Wilmington	Not Started
3) Relocate or cover town sand pile storage area	VDEC, Guilford DPW	319	Guilford, Broad Brook	In Progress
4) Conduct an assessment of water quality impairments associated with Class IV town roads using the model developed for the White River Basin.	VDEC, Towns, WRC, VDFPR, Better Backroads	ERP, BBR	Basin-wide	In Progress
5) Reduce the amount of sediment and other pollutants associated with Class IV town roads.	Towns, WRC , Better Backroads, VDEC, VDFPR , VYCC	ERP, DREF, VYCC, Hazard Mitigation Grant Program	Basin-wide	On-going
Objective 27: Work to improve fisheries and fish habitat throughout the Basin.				
1) Implement habitat improvement projects on Whetstone, Broad, Newton and Crosby Brooks	VDFW, TU, CRWC	WG, ERP	Whetstone, Broad, Newton, Crosby Brooks	Not Started

Action	Partners	Funding	Implementation Location	Status
Objective 28: Reduce non-point source pollutants from farming operations by implementing BMPs on farms.				
1) Conduct AEM assessments and AOI visits to all livestock farms in focus area	WCNRCD, AAFM	AAFM, WG, ERP	Deerfield watershed: North Branch, lower Deerfield & North River, Hinesburg Brook	?????
			CTR watershed: CTR mainstem, Newton, Whetstone, Broad, Crosby Brooks	
2) Coordinate referrals of potential program staff	WCNRCD, BCCD, VACD, AAFM, NRCS			Not Started
3) Implement BMP's on prioritized critical source areas	WCNRCD, BCCD, VACD, AAFM, NRCS	EQIP, CREP, AAFM, PFW, WHIP, WRP/DU, 319		Not Started
Objective 29: Reduce non-point source pollutants from farming operations by sharing machinery regionally.				
1) Survey interest of area farmers	WCNRCD	WG	Basin-wide	Not Started
2) Seek funding for regionally shared equipment for manure incorporation, pasture inter-seeding & ag plastic recycling	WCNRCD, BCCD, VACD, AAFM, NRCS	AAFM, ERP, EQIP, FSA, NRCS, 319		Not Started
3) Coordinate rental / reservation program for sharing equipment	WCNRCD, BCCD			Not Started

Action	Partners	Funding	Implementation Location	Status
Objective 30: Reduce non-point source pollution associated with logging operations by implementing AMPs and by promoting the use of portable skidder bridges.				
1) Continue the AMP Monitoring Program administered by DFPR	VDFPR, DEC Compliance and Enforcement Division, Vermont Forest Products Association	State General Funds	Basin-wide	On-going
2) Support the Portable Skidder Bridge Rental Program	Windham & Bennington County NRCD, VDFPR	ERP	Basin-wide	On-going
Objective 31: Monitor for invasive tree pests (i.e. hemlock wooly adelgid and emerald ash borer) that could impact forest health and sustainability, and support community preparedness planning.				
1) Support the Forest Pest First Detector Program.	VDFPR, UVM Extension	State General Funds	Basin-wide	On-going
2) Support municipalities to prepare for invasive tree pests.	VDFPR, UVM Extension		Basin-wide	On-going
Objective 32: Improve planning and management of the urban tree canopy.				
1) Promote the planning and management of urban tree canopy to municipalities.	VDFP, UVM Extension	VDFPR, USFS	Urban areas: Focus: Brattleboro	On-going
2) Promote the benefits of trees and forests for water quality.	VDFPR, UVM Extension	VDFPR, USFS	Basin-wide	On-going
3) Encourage participation in the Stewardship of the Urban Landscape - Tree Stewards course	VDFPR, UVM Extension	VDFPR, USFS	Basin-wide	On-going
Objective 33: Protect the current high quality waters in the Deerfield watershed through reclassification and ORW designations.				
1) Submit Class A reclassification proposals for all waters identified in Table 3	VDEC – MAPP			Completed & On-going

Action	Partners	Funding	Implementation Location	Status
2) Submit ORW designation proposals for all waters identified in Table 5	VDEC – MAPP			Not Started
4) Submit Class 1 reclassification proposals for the wetland if it meets the standards	VDEC – Wetlands, watershed groups, MAPP, VDFW, VDFPR			In Progress
Objective 34: Work with the TransCanada to address river impacts related to temperature on the Deerfield River listed in Part F.				
1) Summarize and present data	VDEC, USFS, TransCanada	TransCanada	Below the Harriman Reservoir	Not Started
2) Develop & implement mitigation strategies	VDEC, TransCanada, USFS	TransCanada	Below the Somerset Reservoir (from fisheries)	In Progress
Objective 35: Work with VDFPR, VDFW, the Town of Vernon and local partners to evaluate Atherton Meadows pond and wetland and Vernon's black gum wetlands for potential Class 1. reclassification.				
1) Conduct evaluations	DEC Wetlands, VDFPR, VDFW, the Town of Vernon, local partners			Not Started
2) Develop and implement management goals	VDEC – MAPP, DEC Wetlands, VDFPR, VDFW, the Town of Vernon, local partners			Not Started

Action	Partners	Funding	Implementation Location	Status
3) Seek reclassification if criteria are met	DEC Wetlands, VDFPR, VDFW, the Town of Vernon, local partners			Not Started
Objective 36: Develop and implement the WQRP for Mount Snow resort to address stormwater impairment and altered flows as listed in Parts A & F.				
1) Review Master Plan and Framework and develop remediation plan & projects	Mt Snow Resort, Act250, VDEC	Private		???????
2) Work with resort to implement projects	Mt Snow Resort, Act250, VDEC	Private	North Branch Deerfield & tribs	
3) Disconnect Snow Lake from the North Branch Deerfield and restore stream channel	Mt Snow Resort	private	Snow Lake	Not Started
4) North Branch	Mt Snow Resort, Dover	Private, BBR	North Branch	
5) Iron Stream trib.	Mt Snow Resort	Private	Iron Stream trib.	
Objective 37: Work with the Mount Snow resort, the towns of Dover & Wilmington and the community to address high *E. coli* levels causing impairments to the North Branch of the Deerfield River.				
Implement bacteria mitigation practices identified in the TMDL	Mt Snow Resort, Towns of Dover & Wilmington	SWAG – CPP, CWSRF	Impaired reach of No. Branch	Not Started
Objective 38: Implement recommendations of the LIS-TMDL to reduce point source nitrogen (N) loads by 25%.				
1) Identify sources and implement reduction practices	Municipal WWTFs, industrial N dischargers	CWSRF	See Section 2.6	Not Started

Action	Partners	Funding	Implementation Location	Status
Objective 39: Implement recommendations of the LIS-TMDL to reduce non-point source nitrogen loads by 10%.				
1) Educate ag producers on N reduction practices	AAFM, NRCS, NRCDs, ag producers		Basin-wide	On-going
2) Implement appropriate practices including:	AAFM, NRCS, NRCDs, ag producers	EQIP, AAFM, VACD, CREP	Basin-wide	On-going
• Increased soil testing &				
Nutrient Management Planning				
• Timed fertilizer application				
• Needs based N application rates				
• Use of cover crops & perennial grasses				
• Extended rotation periods				
• Install wood chip filter beds/trenches to treat drainage water				
• Increased riparian buffers				
Objective 40: Work with the TransCanada, through the FERC relicensing process, to address river impairments related to flow issues on the Connecticut River listed in Part F -Waters Altered by Flow Regulation.				
1) Above and below the Vernon Dam	TransCanada, FERC, USFWS, NHFG, TNC, CRWC, others	TransCanada	CT River, above and below the Vernon Dam	On-going thru FERC relicensing process
2) Below the Bellows Falls Dam	Same	TransCanada	CT River, below the Bellows Falls Dam	
Objective 41: Preserve existing and create more floodplain along the Connecticut River.				
1) Assess current floodplain quantity & capacity	TNC	WG		Not Started
2) Seek RCE opportunities	CRWC, CRJC	ERP		
3) Seek floodplain reconnection and restoration opportunities	TNC, CRWC, CRJC	ERP		

Action	Partners	Funding	Implementation Location	Status
Objective 42: Protect the land and habitat along the Connecticut River to enhance survival of the high concentration of RTE species.				
1) Focus efforts in Vernon & Brattleboro	USFWS – Conte Refuge, VRC	USFWS, PFW, CREP, WHIP	Vernon & Brattleboro	Not Started
2) Control the spread of invasive species that degrade native floodplain and riparian habitat	USFWS – Conte Refuge, VRC	USFWS, PFW, CREP, WHIP		On-going
Objective 43: Control aquatic invasive species in the Connecticut River.				
1) Water chestnut in Vernon Dam impoundment	SeVWA, CRJC-LRS, USFWS – Conte Refuge	ANS Grant-in Aid	Vernon 42.779779,-72.508396	On-going
2) Focus species: Eurasian watermilfoil, curly leaf pondweed, Japanese knotweed, European Naiad		ANS Grant-in Aid	all boat access points	On-going
Objective 44: Conduct a Stream Geomorphic Assessment of the East Branch North River.				
1) Include Branch and Hager Brooks	WCNRCD, WRC	ERP		Complete
2) Partner with Massachusetts to assess the lower river	DRWA, RPCs	ERP, DREF		Complete
Objective 45: Protect the Halifax Gorge.				
1) Pursue ORW designation			42.743262, -72.735191	Not Started
2) Consider a public access easement	VRC	ERP		Not Started
Objective 46: Complete the Stream Geomorphic Assessment of the Green River.				
1) Implement priority projects in the Corridor Plan	WCNRCD, WRC	ERP, DREF	TBD	Complete
2) Partner with Massachusetts to assess the lower river	DRWA, RPCs	ERP, DREF		Not Started
Objective 47: Work to prevent the further spread of Japanese knotweed in the watershed.				
1) Continue pulling workshops and outreach.	Conservation Commissions, WCNRCD	ANS Grant-in Aid, WG, WHIP		On-going
Objective 48: Investigate if the Green River could be considered for “Wild & Scenic” status.				
1) Review resources & requirements for W&S	FGR, DRWA	WG, DREF		Not Started

Action	Partners	Funding	Implementation Location	Status
2) Pursue if appropriate	FGR, DRWA	WG, DREF		
Objective 49: Formalize public access sites in appropriate areas.				
Locate & pursue current access points without formal agreements	VRC, DRWA, VDFPR, VFWD	ERP, DREF,		On-going
Objective 50: Consider removing the dam on Pond Brook off Jelly Mill Rd, Guilford north of Gallup Pitch Rd.				
1) Contact landowner	VDTF			In progress
2) Pursue removal if appropriate	VDTF	AR/NOAA	approx. 42.764859, -72.669357	
Objective 51: Protect and enhance wildlife crossing access across I-91.				
1) Assess AOP and terrestrial crossing opportunities in this very important RTE corridor	VTrans, VDFW, Conservation Commissions	WG, Enhancement, Structures, USFWS AOP		Not Started
2) Implement crossing improvement opportunities	VTrans, VDFW, Conservation Commissions	Enhancement, Structures, USFWS AOP		
Objective 52: Work with DFPR on the water quality and habitat aspects of the re-filling or wetland restoration of Sweet Pond.				
Coordinate with VDFPR	VDEC – MAPP & Wetlands, VDFW	ANR	Sweet Pond	
Objective 53: Reduce sediment impacts to Crosby Brook.				
1) Enlarge the capacity of the C&S stormwater pond	C&S, VDEC-Stormwater	private	42.892878, -72.550964	Not Started
2) Address the mass failure on Black Mountain Rd.	WCNRCD, VDEC-Rivers	ERP	42.885587, -72.565995	Not Started
3) Address erosion on Black Mountain Rd.	Town of Brattleboro	BBR		Complete

Action	Partners	Funding	Implementation Location	Status
4) Implement priority projects from the Corridor Plan	WCNRCD, WRC, Towns of Brattleboro & Dummerston	ERP, WG		On-going
5) Implement priority projects from Putney Road Restoration Study Project	AOT, Town of Brattleboro	Enhancement, ERP, WG, Windham Fdn	Ryan Road to Landmark Hill Driver	On-going
6) Address erosion on gravel roads	Towns of Brattleboro & Dummerston	BBR, ERP		On-going
Objective 55: Replace or retrofit structures prioritized in the Crosby Brook Corridor Plan.				
1) Ryan Road	Town of Dummerston	BBR, ERP	42.899759, -72.551597	Not Started
2) Middle Road (upper)	Town of Dummerston	BBR, ERP		
3) Black Mountain Road	Town of Brattleboro	BBR, ERP	42.88317, -72.563421	
4) Dickinson Road	Town of Brattleboro	BBR, ERP	42.888716, -72.569686	
Objective 56: Encourage Low Impact Development (LID) by offering development density incentives for those projects which result in reduced footprints of impervious cover.				
Implement zoning bylaws allowing greater residential densities with the implementation of LID techniques.	RPCs, Towns, WSMD – Stormwater, VLCT	604(b)		Not Started
Objective 57: Implement recommendations of the Whetstone Brook Bacteria TMDL to control high levels of bacteria.				
1) Pursue and address failing or malfunctioning onsite septic systems	Town DPW, SeVWA, property owners	WG, ERP, CWSRF	Watershed-wide	Not Started

Action	Partners	Funding	Implementation Location	Status
2) Pursue and address leaking sanitary sewer pipes	Town DPW	CWSRF	Brattleboro	Not Started
a) Begin testing for sanitary sewer leaks in the downtown area				
3) Pursue and address stormwater runoff from developed areas	Town DPW, SeVWA, property owners	ERP, WG	Brattleboro, West Brattleboro	On-going
4) Pursue and address illicit discharges	Town DPW	CWSRF, ERP	Brattleboro, West Brattleboro	On-going
5) Expand citizen education about the negative impacts of stormwater, with a focus on the importance of picking up after one's pet.	SeVWA, WCNRCD	WG	Watershed-wide	On-going
6) Support programs that assist with the replacement or upgrading of failed onsite septic systems or expansion of the municipal wastewater system to reach more residences.	Town DPW	CWSRF	Watershed-wide	Not Started
Objective 58: Protect remaining floodplain and flood capacity in the Whetstone Brook watershed.				
1) Develop appropriate regulations to protect lands within the identified floodplain.	RPC's, Town Conservation and Planning Commissions	604(b), MPG	Brattleboro, esp. West Brattleboro, Marlboro	On-going
2) Encourage landowners to install buffers, and other tools that protect shoreland and/or riparian areas.	WCNRCD, NRCS, AAFM	T4S, CREP, WHIP, AAFM, ERP	Watershed-wide	On-going

Action	Partners	Funding	Implementation Location	Status
3) Seek to enhance buffers through a combination of buffer plantings, land conservation, and incentive programs.	WCNRCD, NRCS, AAFM	T4S, CREP, WHIP, AAFM, ERP	Watershed-wide	On-going
Objective 59: Remove Tri-Park trailers in Mountain Home Park that are under agreement to be removed from the floodway.				
1) Coordinate development of Tri-Park Master Plan to relocate homes	VDEC – RMP, Town Planning Services Dept., Tri-Park Cooperative, ACCD	CDBG, MPG	Mountain Home Park	On-going
a) Priority sites: Winding Hill Rd., Brookwood Dr., and Village Dr.				
b) include relocation schedule & funding sources				
2) Obtain planning grants to fund Master Plan development	Town Planning Services Dept., ACCD	CDBG, MPG		In progress
3) Remove 51 trailers from the floodplain		HMGP		Not Started
4) Remove the berm and other structure that limit floodplain access		ERP		Not Started
Objective 60: Implement Better Backroads projects along the brook.				
1) Focus areas include: Hamilton Rd., Bonnyvale Rd., Guilford Rd. & Sunset Lake Rd.	Town DPWs	BBR		On-going
Objective 61: Reduce sand and sediment inputs to Broad Brook.				
1) Work with Town to improve sand pile storage	Town DPW	Enhancement	Guilford	Not Started
2) Work with Town to reduce gravel road runoff	Town DPW	BBR		On-going
3) Complete a Road Inventory and Capital Budget Plan	Town DPW	BBR		On-going
Objective 62: Develop an implementation plan to address the sediment impairment in Newton Brook.				
1) Coordinate plan development	VDEC, AAFM, NRCDs	ANR, AAFM, WG, ERP		Not Started

Action	Partners	Funding	Implementation Location	Status
2) Implement plan strategies	VDEC, AAFM, NRCDs, NRCS	319, EQIP, CREP, ERP		
3) Seek to enhance buffers through a combination of buffer plantings, land conservation, and incentive programs	WCNRCD, NRCS, AAFM	T4S, EQIP, CREP, WHIP, AAFM, ERP		
4) Implement Better Backroads projects	Municipalities	BBR		

Projects identified and completed after the publication of the 2014 plan:

- Reclassification to Class A(1)
    - Deerfield River and tributaries above confluence with East Branch
    - West Branch Deerfield and tributaries
    - All waters in GMNF Wilderness Areas below 2500 feet
- Deerfield Resilient Communities bi-state group formed and meeting
- RiverSmart – Deerfield River resiliency report and recommendations published by UMass - Amherst
- Deerfield Headwater Stream Management multi-agency project organized and focused on restoration of the North River
- 2015 Deerfield River Enhancement Fund awarded to the Southern Vermont Nature Museum for creation of a Deerfield River watershed museum display
- Long Island Sound -Regional Conservation Partnership Program created by 5 states providing funding for the Connecticut River watershed
- CEI Crosby Brook stormwater master plan completed
- Kettle Pond in Brattleboro monitored for the first time
- EPA Design for Resilience in Brattleboro's Whetstone Brook Corridor
- Making a Visible Difference initiative in Brattleboro focusing on flood resiliency
- Green River clean-up and restoration project (Guilford) involving removal of storm damaged/abandoned house and out-buildings, site clean-up, River Corridor Easement (RCE), site and river restoration, buffer planting
- FEMA buy-out, site restoration & RCE on property on Whetstone Brook (Brattleboro)

- Birge Street parcel (Brattleboro), purchase of floodplain parcel, completion of EPA Phase 1 ESA
- CT River Farmers Watershed Alliance created
- Green River Watershed Alliance:
    - organization created
    - outreach and education project – watershed identity workshops and walks, watershed bus tour, Rivers and Roads forums
- VTrans Methods and Tools for Transportation Resilience Planning project to develop and apply new methods that integrate river science with transportation planning, engineering and decision making in order to improve the resilience of the transportation network to damage and disruptions caused by flooding. Pilot tested in the Whetstone Brook and North Branch of the Deerfield watersheds.
- Lake Raponda: Shoreland restoration of 200 feet with bank stabilization and riparian plantings
- Johnson Dam Removal Implementation - Crosby Brook (Dummerston)
- LaRosa volunteer water quality monitoring programs:
    - Deerfield River Watershed Alliance – annually
    - Southeastern Vermont Watershed Alliance – on Whetstone Brook – annually
    - Southeastern Vermont Watershed Alliance – on Whetstone Brook temperature study & report

Appendix B. Existing Uses in Basin 12

Swimming

Much of the swimming in the basin takes places on the many lakes and ponds which have a presumed existing use of contact recreation.

Waterbody	Site	Location of Use	Lat.	Long.	Town	Ownership
Deerfield River Watershed						
Green River	Crib Dam	Timber Crib Dam below covered bridge	42.77547	-72.66765	Guilford	private
East Branch North River	Halifax Gorge		42.7463	-72.7436	Halifax	private
Connecticut River Watershed						
Whetstone Brook	Living Memorial Park/ Farmer's Market	Below LMP tennis BB court and behind Farmer's Market site	42.84885	-72.58683	Brattleboro	Town of Brattleboro
Broad Brook	Fort Dummer State Park	small parking area and trail used to access a swimming hole on Broad Brook	42.813618	-72.563209	Guilford	VDFRPR

Recreational Boating

It is the Agency's long-standing stipulation that all lakes and ponds in the basin have existing uses of boating and so only boating locations on rivers are listed below. Several locations are good whitewater or flatwater boating stretches in the basin; some highly rated by the Vermont Paddlers Association, listed in the AMC or Vermont White Water Rivers.

Waterbody	Reach	Public Access / Put In	Lat.	Long.	Take Out	Lat.	Long.
Deerfield River Watershed							
Deerfield River	Searsburg Dam to Harriman Reservoir Class III, 4.5 miles	Below Searsburg Dam	42.90132	-72.95037	Woods Rd., Wilmington	42.865095	-72.90313
Deerfield River	Somerset Rd. bridge to Searsburg Reservoir, Class II, 5.0 miles	Somerset Rd. bridge & Castle Brook Rd.	42.950574	-72.98661	Searsburg Reservoir	42.902203	-72.95029
East Branch Deerfield River	Somerset Reservoir to Searsburg Reservoir Class I-II, 6 miles	Below Somerset Dam	42.972011	-72.949259	Searsburg Reservoir	42.902203	-72.95029
West Branch Deerfield River	Heartwellville to Readsboro Village Class V, 3.0 miles to confluence/ 5.4 miles to Tunnel St.	Howe Pond Rd. end, Readsboro	42.802883	-72.974512	Tunnel St., Readsboro	42.745236	-72.92647
North Branch Deerfield River	West Dover to Harriman Reservoir, Class I-II, 7.0 miles	Rte. 100 ROW	42.922603	-72.843376	Rte. 100	42.868486	-72.90413
Green River	Stage Rd. to West Leyden, MA , Class II - III, 6.8 miles	Green River crib dam, Stage Rd.	42.775614	-72.667072	W. Leyden Rd., West Leyden, MA	42.698389	-72.66512
North River	Halifax Gorge: Route 112 to Route 112 Class IV(V) 3 mi	Rte. 112, 3/4 mi. north of Stowe Mountain Rd.	42.7463	-72.7436	Jacksonville Rd., Colrain, MA	42.719467	-72.70807
Connecticut River Watershed							
Connecticut River	Old Ferry Rd. to Vernon Dam Class I - II, 8 mi.	Old Ferry Road	42.89323	-72.53608	Vernon Dam Portage	42.78935	-72.52602
Connecticut River	Vernon Dam to Turners Falls Class I - II, 21.5 mi.	Gov. Hunt Recreation Area	42.770916	-72.515304	Pauchaug Brook Access, MA F&W	42.715516	-72.45259

Recreational Public Water Supply Sources

Several surface waters in the Basin serve as public drinking water supplies and are managed and protected for this use.

Waterbody	Reach		Supply for:	Acres
Deerfield River Watershed				
Haystack Pond	Haystack Pond and all waters within its watershed in the Town of Wilmington		Village of Wilmington water supply	36 acres
Howe Pond and Howe Pond Brook	Howe Pond and all waters within its watershed. Howe Pond Brook and all waters within its watershed above the water intake, which		Village of Readsboro water supply	62 acres
Connecticut River Watershed				
Pleasant Valley Reservoir	Pleasant Valley Reservoir and all waters in its watershed in the Town of Brattleboro.		Village of Brattleboro water supply	25 acres

Appendix C. Dams in Basin 12

State ID #	Dam Name	Stream	Town	Surface Acres	Dam Status	Purpose	Hazard Class
182.02	Billings Pond	Rake Branch	Searsburg		Breached		Low
246.02	Binney Brook	Binney Brook	Wilmington		Breached		
90.05	Gates Mill	Green River	Guilford		Breached		
164.02	Howe Pond Upper	Howe Pond Brook	Readsboro		Breached		
122.04	South Pond	Pond Brook	Marlboro		Breached		Low
243.05	Gates Pond	East Branch North River-TR	Whitingham	30	Breached (Partial)		Low
164.06	Howe Pond Lower	Howe Pond Brook	Readsboro	56	Breached (Partial)	Recreation	Low
90.07	Guilford-7	Thorne Brook	Guilford		Deleted		
201.02	East Branch	East Branch Deerfield River	Stratton		Removed		
191.01	Heartwellville	West Branch Deerfield River	Readsboro		Removed		
27.03	Holden And Martin	Whetstone Brook	Brattleboro		Removed		
-	Ruhl	Cold Brook	Wilmington	<1	Removed		Low
246.05	Wilmington Reservoir	Deerfield River-OS	Wilmington		Removed		
253.03	Adams Reservoir	Red Mill Pond Brook	Woodford	24	In Service	Recreation	Significant
-	Beaver Brook	Beaver Brook	Wilmington	2.9	In Service		
122.09	Camp Neringa	Whetstone Brook-TR	Marlboro	1.6	In Service	Recreation	Low
61.04	Carinthia Snow Pond	North Branch Deerfield River	Dover	1.5	In Service	Recreation	Low
27.08	Chestnut Hill Reservoir	Whetstone Brook	Brattleboro	1.1	In Service	Recreation	High
91.01	Deer Park Pond	Green River-TR	Halifax	22	In Service	Recreation	Low
90.03	Franklin Site No. 1	Falls River-TR	Guilford	4	In Service		Low
90.08	Guilford-8	Broad Brook	Guilford	0.5	In Service		Low

State ID #	Dam Name	Stream	Town	Surface Acres	Dam Status	Purpose	Hazard Class
243.01	Harriman	Deerfield River	Whitingham	2157	In Service	Hydroelectric	High
122.03	Hidden Lake	Marlboro Branch-TR	Marlboro	19	In Service	Recreation	Low
122.08	Hidden Lake Dike	Whetstone Brook	Marlboro	19	In Service	Recreation	Low
243.06	Jacksonville Pond	East Branch North River-TR	Whitingham	17	In Service	Other	High
243.02	Lake Clara	Lake Sadawga-TR	Whitingham	15	In Service	Recreation	High
246.01	Lake Raponda	Bill Brook	Wilmington	116	In Service	Recreation	Low
243.03	Lake Sadawga	Harriman Reservoir-TR	Whitingham	194	In Service	Recreation	High
243.11	Lake Sadawga West Dike	Harriman Reservoir-TR	Whitingham	202	In Service	Recreation	High
243.09	Laurel Lake	East Branch North River-TR	Whitingham	18	In Service		Low
253.01	Little Pond	Little Pond Brook	Woodford		In Service		Low
214.02	Mill Pond	Connecticut River - TR	Vernon	0.25	In Service		Low
122.05	Mill Pond	Whetstone Brook	Marlboro	8	In Service	Recreation	Significant
246.04	Mirror Lake	Cold Brook-TR	Wilmington	3	In Service	Recreation	Low
246.07	Mirror Lake Diversion Structure	Cold Brook	Wilmington	0	In Service		
243.07	North	No. 9 Brook-TR	Whitingham	26	In Service	Recreation	Low
61.03	North Branch Fire District No. 1	Ellis Brook-TR-OS	Dover	7	In Service	Other	Significant
27.01	Pleasant Valley Reservoir	Whetstone Brook-TR	Brattleboro	25	In Service	Water Supply	High
243.12	Purjes	No. 9 Brook-TR	Whitingham	2.6	In Service		Low
164.07	Readsboro Reservoir	Howe Pond Brook	Readsboro	0.06	In Service	Water Supply	Low
253.02	Red Mill Pond	Red Mill Pond Brook	Woodford	5	In Service		Low
253.10	Red Mill Pond Dike	Red Mill Pond Brook	Woodford	5	In Service		Low
243.04	Ryder Pond	East Branch North River	Whitingham	14	In Service	Recreation	Significant

State ID #	Dam Name	Stream	Town	Surface Acres	Dam Status	Purpose	Hazard Class
182.01	Searsburg	Deerfield River	Searsburg	25	In Service	Hydroelectric	High
243.08	Shippee Pond	Hager Brook	Whitingham	24	In Service	Recreation	Significant
90.04	Sibley	Green River	Guilford	0.9	In Service		Low
61.01	Snow Lake	North Branch Deerfield River	Dover	8	In Service	Recreation	High
191.01	Somerset	East Branch Deerfield River	Somerset	1597	In Service	Hydroelectric	High
246.03	Spruce Lake	Beaver Brook-TR	Wilmington	15	In Service	Recreation	Low
195.02	Stamford Pond	Reservoir Brook	Stamford	10.6	In Service		Low
90.01	Sweet Pond	Keets Brook	Guilford	18	In Service	Recreation	High
214.03	Vernon	Connecticut River	Vernon		In Service	Hydroelectric	
214.01	Vernon Fish Hatchery Pond	Newton Brook	Vernon	8	In Service	Recreation	Low
90.02	Weatherhead Hollow Pond	Shattuck Brook	Guilford	33	In Service	Recreation	Significant
246.06	West Lake	Cold Brook-TR	Wilmington	11.6	In Service	Snowmaking	High
91.02	Harrisville Mill	Green River	Halifax	2	In Service	Hydroelectric	
80.01	Ricker	Glastenbury River	Glastenbury		Unknown		

Appendix D. Fisheries Assessment of Basin 12

VERMONT

State of Vermont
Fish & Wildlife Department
100 Mineral Street, Suite 302
Springfield, VT 05156-3168
www.vtfishandwildlife.com

Agency of Natural Resources

[cell] 802-777-0827
[fax] 802-885-8890
[email] lael.will@vermont.gov

Memorandum

TO: Marie Caduto, Watershed Coordinator

FROM: Lael Will, Fisheries Biologist

DATE: 02/07/2019

SUBJECT: Deerfield Watershed and lower Connecticut Tribs (Basin 12) Fisheries Assessment

Deerfield Watershed Fisheries:
The Deerfield watershed and southern tributaries to the Connecticut River provide habitat for a variety of warm and cold-water species (Table 1). The waterbodies in the Deerfield watershed include large reservoirs serving for hydropower operation, lakes and ponds which provide warmwater fisheries, small headwater streams providing cold-water habitat for trout, and large tributary streams. This diversity in habitat types promotes a range of fishing opportunities throughout the basin.

- ***Large Reservoirs***

One of the more profound characteristics of the Deerfield relates to the number of impoundments operated for hydropower. Somerset, Searsburg, Harriman, and Sherman are all part of a hydro power complex within the Deerfield. While these reservoirs interrupt natural stream processes, they also provide habitat for a variety of species and are popular recreational fisheries. Harriman and Somerset are the two largest reservoirs in the Basin (Figure 1). Somerset Reservoir is a 1568-acre impoundment which serves to store water for hydropower production. Much of the land surrounding the reservoir is owned by the US Forest Service and the hydro company (currently Great River Hydro). The reservoir provides habitat for a variety of species including smallmouth bass, yellow perch, rock bass, pumpkinseed and stocked brook trout (Table 2). In 2015, the reservoir was sampled to monitor the smallmouth bass population using standardized boat electrofishing methods. These surveys

indicated that catch rates were 23 fish/hour. Compared to other waterbodies in the southern portion of the state, these catch rates are below the average of 40 fish/hour for smallmouth bass for District 1 (Table 3). Water quality at the time of sampling indicated low pH (5.62) and low conductivity (17.2 Ms/cm) which can indicators productivity.

During the spring of 2018 an angler survey was conducted at Somerset to examine fishing pressure (angler hours) and catch/harvest rates (fish/hour) of targeted fish such as smallmouth bass and stocked brook trout. Mean catch rates (during the survey period) of smallmouth and stocked brook trout were 0.96 and 1.46 fish/hour respectively. These data indicate that overall catch rates for these species are good, and Somerset provides a popular recreational fishery.

Harriman reservoir is a 1700-acre reservoir that also serves to provide hydropower and is subject to seasonal drawdowns. Harriman provides diverse year-round fishing opportunities and is a popular ice fishing location. The reservoir has self-sustaining populations of rainbow smelt, smallmouth bass, pumpkinseed, rock bass and chain pickerel, as well as other native species (Table 2). The reservoir is also stocked annually with brook trout, brown trout, rainbow trout, Atlantic salmon, and lake trout. Brown trout have also been reported to reproduce naturally in the tributary waters entering Harriman. Similar to Somerset, smallmouth bass catch rates from 2018 sampling indicated below average catch rates of 35 fish/hour (Table 3).

- ***Lakes and Ponds***

The basin also includes several other popular lakes and ponds including Sherman Reservoir, Lake Raponda, Lake Sadawga, South Pond, and Weatherhead Holllow. Sherman Reservoir straddles Vermont and Massachusetts and is known for producing large brown trout, which are stocked annually. Similarly, South pond is primarily sustained by stocked trout (Table 2). Lake Raponda provides habitat for self-sustaining largemouth and smallmouth bass populations. Bass electrofishing surveys conducted in 2018 indicated that smallmouth bass catch rates are above average in Lake Raponda when compared to other waterbodies in the southern portion of the state (Table 3). Other largemouth bass fisheries in the Basin include Lake Sadawga, and Weatherhead Hollow (Tables 2 and 4). Of note is that American eel a Species of Greatest Conservation Need (SGCN) was observed in Weatherhead Hollow during electrofishing surveys conducted in 2013.

- ***Small headwater streams***

Small headwater streams that provide habitat for native brook trout are found throughout the basin (Figures 2-3). Many of these streams are sampled routinely to monitor trout populations throughout the District (Figure 4). A subset of these sites are monitored annually for stream temperatures and trout populations (Figure 5). Trout population data in Basin 12 from 2000-2018 was analyzed to characterize abundances of trout throughout the Basin. A total of 37 sites from 21 streams were included in the analysis. Population metrics included an estimated total (all size classed combined) number of trout per mile based on standardized electrofishing surveys. For sites that included multiple sampling events during this period, a mean was taken. Overall total fish per mile (all size classes combined) ranged from 0 to 3114 for brook trout and 0 to 796 for brown trout (Table 5). Median abundances were 351, and 0 (trout/mile) for brook and brown trout respectively. Estimated mean abundances were 648 and 91 for brook and brown trout respectively (Table 5). Overall, these abundances were similar than the mean abundance of 622 and 164 brook and brown (trout/mile) when compared to 223 sites located throughout the District (Table 6). Streams that had relatively high (~1000 fish/mile) trout abundances (based on data from 2000-2018) included Bond Brook, Broad Brook, Cold Brook, Deerfield mainstem (i.e. Harriman bypass), Haystack Brook, Lamb Brook, Oak Brook, and Scooter Brook, and West Branch Deerfield (Table 5). It should be noted that trout abundances are highly variable and can be influenced by several factors, with stream temperatures being the most profound.

- ***Large Tributary Streams***

Large tributary streams include the North Branch Deerfield, East Branch Deerfield, Mainstem Deerfield, Whetstone Brook, Broad Brook and the Green River. The operations of Somerset, Searsburg, Harriman and Sherman, which are under FERC licenses, govern the flow regime in the receiving waters including the East Branch, and mainstem Deerfield. The flow regime within the East Branch is relatively flat, governed by seasonal minimum flows (9-12 cfs May-Sept; 30-48 Oct-Apr) and strict up/down ramping rates during periods of drawdown. Thus, the East Branch Deerfield below Somerset is a hydrologically altered system, primarily due to its lack of natural floods, which may be augmented by tributaries. It is not subject to daily peaking cycles or major low-flow extremes, and in many respects presents a benign flow condition. However, it is unclear how the loss of floods and/or the presence of the dam has affected river morphology below Somerset Reservoir, and whether this exacerbates the

system's naturally low productivity. Similarly, Searsburg releases a minimum flow of 35 (June 1-September 30), 55 (October 1-May 31) or 175 cfs (April 20-May 15) or inflow if less, and Harriman releases a minimum flow of 70 cfs (October 1-June 30) and 57 cfs (July 1-September 30) or inflow if less. There will be an opportunity to re-visit the current flow regime and potentially modify it to mimic more natural conditions during the FERC relicensing process, which is expected to commence in 2032.

Fish production downstream of Somerset and within the Harriman bypass, is presumed to be inhibited by the cold-water discharge from the dam (VANR 2014). Trout sampling below Somerset Reservoir took place in 1990 and in 2017 at two sites (Table 7). Based on these data, trout populations were low in both years, and 2017 had lower trout abundances than 1990. Only 67 trout/mile were estimated at the upper reach and 135 trout/mile estimated in the lower reach in 2017. In 2017, the Forest Service also conducted trout sampling within the Deerfield watershed near Somerset (Table 8). Total trout population estimates in these streams ranged from 11 to 530 trout/mile. These results indicate that even in undeveloped watersheds, in the absence of a major dam, trout productivity is on the low to mid-range for the region.

To examine longitudinal temperature gradients in these reaches, we collected basic water quality parameters (temperature, dissolved oxygen, pH and conductivity) above and below Somerset, Searsburg, and Harriman Reservoirs (Table 9; Figures 6-7). Replicate samples were collected in July and September (Table 9). Downstream of Somerset, stream temperatures were below the optimal range (13-18 °C) for brook trout for approximately ½ mile downstream of the dam (Figure 7). Stream temperatures, however, were within the optimal range for the remainder of the reach, as well as below Searsburg (Figure 7). Dissolved oxygen, and pH readings appeared to be within adequate ranges for brook trout at all sample locations (Table 9). It should be noted that these were point measurements and should be interpreted as such. To further evaluate the issues, full season (June 1 – Oct 1) temperature monitoring would provide a more robust dataset from which to draw conclusions.

Although these coldwater releases may result in sub-optimal conditions for trout growth immediately below the project, these preliminary data indicate that the affected reach is relatively short. Moreover, deep water outlet structures can provide beneficial coldwater releases below hydroelectric projects which create temperature regimes suitable for year-round survival of trout (Walters et al. 1997). Consistent coldwater releases can be

particularly important in light of climate change predictions as these releases also extend and enhance coldwater habitats and fisheries further downstream. As such, broader trout fisheries benefits may be realized and outweigh localized impacts.

The North Branch Deerfield and tributaries are generally influenced by land use development including two ski resorts and agriculture. Ski resorts, while economically and recreationally important, result in intense development along mountainsides and within headwater areas including clearing for ski trails and construction of associated infrastructure. Excessive culverting, unnatural snowpack, flow alterations, reduced riparian areas, and sediment runoff can degrade water quality, impact natural stream processes, and threaten aquatic populations. As such, many of the waters associated with ski resorts have been listed as impaired or stressed; thus requiring remediation plans (https://dec.vermont.gov/watershed/map/assessment).

Currently the North Branch flows through a snow-making pond located at Mount Snow (Snow Lake, which likely influences stream temperatures, and blocks access to upstream habitats. Trout population sampling indicate low trout abundances in the North Branch Deerfield where sampling occurred at the resort (Table 5). However, these data are dated, and sampling did not occur in the upper reaches, outside the influence of the resort.

Tributaries to the North Branch Deerfield such as Cold Brook are also influenced by snow-making due to two intakes, one located at the Hermitage and one located downstream for Mount Snow. While streamflow protection oversees conservation flows to protect aquatic resources, the structures themselves can influence movement during certain times of the year. For example, the structure located at the Hermitage is a complete barrier, while the structure located downstream is likely a partial barrier. Despite these perturbations, Cold Brook has relatively good trout abundances, and stream temperatures appear to be suitable for brook trout (Figure 8).

Tributaries to the Connecticut River include the Green River, Broad Brook and the Whetstone. All three of these streams are sampled annually to monitor trout populations concurrently with stream temperatures (Figures 9-11; Table 10). All three streams can be generally characterized as being relatively warm with low to moderate abundances of

trout. Brown trout are typically more abundant in the Whetstone. In the year 2016, stream temperatures were relatively high and trout abundances responded as such.

In sum, trout production can be influenced by many factors including food availability, water chemistry, temperature and available habitat. Trout production appears to be limited throughout the region due to natural causes such as water chemistry, stream temperatures, and in certain areas may be further impacted by flow alterations and post-Irene alterations within the system. Tributary streams provide greater trout abundances and stocking supplements catchable sized trout to support a moderate recreational fishery. Efforts to improve aquatic passage, protect riparian corridors, and re-evaluate the flow regime during the FERC relicensing process, and restoring Post-Irene reaches are management tools that could be applied to the Deerfield watershed, and tributaries to the Connecticut River.

Fish Stocking

The Department stocks trout where fishing opportunities exist but cannot be maintained by natural reproduction alone. Currently, the mainstem of the Deerfield is stocked with yearling brook trout along Somerset Road, and with yearling rainbow trout along Rte 9. The West Branch Deerfield is also stocked with yearling brook trout. Fishing opportunities via stocked fish are also provided at Somerset, Searsburg, Adams Reservoir, Red Mill Pond, Harriman, Sherman Reservoir, South Pond, Lake Raponda, and Stratton Pond.

Tropical storm Irene

Tropical storm Irene occurred in August of 2011and resulted in the deposition of over six inches of rain in the central and south-eastern portion of Vermont. As a result, hundreds of bridges, road segments, culverts, homes and other infrastructure suffered severe damage, and were in need of immediate repair. Post-flood activities required stream alteration to protect life and property and rebuild critical transportation infrastructure (Lunderville 2011). However, much of the in-stream work resulted in the widening, deepening and straightening of stream channels. In some cases, in-stream wood was removed, stream banks were bermed, and stream bed elevations were raised. As a result, aquatic habitats including a diversity of substrate types, depths, flows, and cover, necessary to support healthy fish populations, suffered severe negative impacts. In 2012, staff conducted roadside assessment of instream habitat degradation throughout the central and southern portion of Vermont (Kirn 2012). An estimated 77

miles of streams were identified as being degraded from post-flood stream alteration activities. As such, the Department has been actively working to restore reaches to more natural conditions. For example, the Whetstone was recently restored to remove an over-abundance of bed armoring which resulted in subsurface flows. Efforts to continue stream restoration in these reaches are paramount as it may take decades before these streams recover.

Management Recommendations:

1. **Protect riparian corridors:** Undisturbed, naturally vegetated buffer strips are extremely important in maintaining cool water temperatures and stable streambanks, filtering pollutants and providing food and shelter for fish and other aquatic organisms. These benefits are realized not only within the protected stream reach, but also in its downstream receiving waters. Providing outreach and education to private landowners on the benefits of riparian corridors would also benefit streams and should be promoted. Considering the amount of conserved lands within the upper portion of the watershed efforts should continue to protect these lands and associated riparian corridors.

2. **Improve aquatic habitat connectivity:** Maintaining a connected system allows fish to seek the best available habitat for reproductive needs, food resources, thermal refuge and cover. 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. During periods of stressful environmental conditions, fish will often migrate to cold-water refuges such as the mouths of tributary streams or to areas of groundwater inflow during warm periods. Providing aquatic connectivity by evaluating and replacing culverts which impede access to the cooler tributaries would benefit native trout species that have the propensity to seek thermal refuge in the warm summer months.

3. **Improve flood resiliency and restore post-Irene impacts.** Post-Tropical Storm Irene impacts, including berming, instream channelization, and removal of instream cover including boulders and wood inevitably impacted aquatic biota within the Deerfield watershed. Restoring instream complexity and access to floodplains would improve the overall quality of the system, leading to positive

impacts on fish populations (Kirn 2012). Efforts should be made to identify sites and restore these reaches back to natural conditions.

4. **Where flows are regulated, promote the natural flow regime:** Maintaining or improving flow management at hydroelectric, storage, 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. Conversely, reduced peak discharges and generally stable flows produced by regulated water releases from flood control or storage reservoirs inevitably impact natural stream processes including channel morphology and substrate composition.

5. **Help 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. **Protect water quality.** Maintaining clear, cold, and well-oxygenated water is an important habitat requirement for trout. Activities that can have negatives impacts to water quality (i.e. sediment discharges), should be avoided and/or minimized through evaluation of proposed projects. Considering VTFWD biologists provide input into several state-issued permits including stream alteration, and water quality certifications efforts to protect water quality are accomplished through several avenues. Additional efforts by interested partners to work with private landowners on riparian land stewardship will compliment state and federal regulatory efforts.

7. **Identify and designate B1 High Quality Fishing – Wild Salmonid Streams** 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. Streams designated as B1 are provided with better protections. Based on VTFWD data, streams that could potentially meet (more sampling needed) the B1 criteria are: Scooter, Negus, Cheney, Blue Brook, West Branch Deerfield, Fall, Hager, South Branch Deerfield, Cold Brook, Haystack, and Oak Brook, Broad Brook,

Whetstone[37]. Other streams may be potential candidates but have not been sampled.

[1] Some of the sites listed are not included in Table 5 because they were sampled prior to 2000 and would therefore need to be sampled again per B1 criteria. Data from outside sources are not included at this time.

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Table 1. Fish species reported to occur in Basin 12. Species followed by an asterisk indicate populations are dependent upon stocking hatchery produced fish.

Common name	Scientific name	Deerfield River	Green River	North River	Fall River	Broad Brook	Crosby Brook	Whetstone \ Brook	Newton Brook
American eel	*Anguilla rostrata*	X	X		X				
Atlantic salmon*	*Salmo salar*	X	X	X					
Banded killifish	*Fundulus diaphinus*		X						
Blacknose dace	*Rhinichthys atratulus*	X	X	X	X	X	X	X	X
Bluegill	*Lepomis macrochirus*	X		X	X				
Brook trout	*Salvelinus fontinalis*	X	X	X	X	X	X	X	X
Brown bullhead	*Ameiurus nebulosus*	X	X	X	X	X			
Brown trout	*Salmo trutta*	X	X	X		X		X	X
Chain pickerel	*Esox niger*	X		X					
Common shiner	*Luxilus cornutus*	X	X	X		X			
Creek chub	*Semotilus atromaculatus*	X	X	X	X	X	X	X	

Table 1. Fish species reported to occur in Basin 12. Species followed by an asterisk indicate populations are dependent upon stocking hatchery produced fish.

Common name	Scientific name	Deerfield River	Green River	North River	Fall River	Broad Brook	Crosby Brook	Whetstone \Brook	Newton Brook
Fallfish	*Semotilus corporalis*	X	X	X					
Fathead Minnow	*Pimephales promelas*								X
Golden shiner	*Notemigonus crysoleucas*	X	X				X		
Lake trout*	*Salvelinus namaycush*	X							
Largemouth bass	*Micropterus salmoides*	X	X		X			X	
Longnose dace	*Rhinichthys cataractae*	X	X	X	X	X	X	X	
Longnose sucker	*Catostomus*	X				X		X	
Mimic shiner	*Notropis volucellus*	X	X						
Pumpkinseed	*Lepomis gibbosus*	X		X	X				
Rainbow smelt	*Osmerus mordax*	X	X						
Rainbow trout*	*Oncorynchus mykiss*	X	X	X		X	X		

Table 1. Fish species reported to occur in Basin 12. Species followed by an asterisk indicate populations are dependent upon stocking hatchery produced fish.

Common name	Scientific name	Deerfield River	Green River	North River	Fall River	Broad Brook	Crosby Brook	Whetstone \Brook	Newton Brook
Rock bass	*Ambloplites rupestris*	X							
Slimy sculpin	*Cottus cognatus*	X	X		X	X	X	X	
Smallmouth bass	*Micropterus dolomieui*	X							
Tessellated darter	*Etheostoma olmstedi*			X					
White sucker	*Catostomus commersoni*	X	X	X		X		X	
Yellow perch	*Perca flavescens*	X		X	X				

Table 2. Fish species reported to occur in ponds within Basin 12. Species followed by an asterisk indicate populations are dependent upon stocking hatchery produced fish.

Common name	Scientific name	DEERFIELD RIVER										GREEN RIVER	FALL RIVER
		Upper Mainstem					Middle Mainstem			Lower Mainstem		Mainstem	Mainstem
		Grout Pond	Somerset Reservoir	Adams	Red Mill Pond	Searsburg Reservoir	Lake Raponda	Lake Sadawga	Harriman Reservoir	Howe Pond	Sherman Reservoir	South Pond	Weatherhead Hollow Pond
American eel	*Anguilla rostrata*												X
Atlantic salmon*	*Salmo salar*								X				
Banded	*Fundulus diaphinus*											X	
Blacknose	*Rhinichthys atratulus*											X	X
Bluegill	*Lepomis macrochirus*						X						X
Brook trout*	*Salvelinus fontinalis*		X	X	X	X			X			X	X
Brown	*Ameiurus nebulosus*	X	X	X	X	X	X	X	X	X	X	X	X
Brown trout	*Salmo trutta*								X		X	X	

Table 2. Fish species reported to occur in ponds within Basin 12. Species followed by an asterisk indicate populations are dependent upon stocking hatchery produced fish.

Common name	Scientific name	DEERFIELD RIVER										GREEN RIVER	FALL RIVER
		Upper Mainstem					Middle Mainstem			Lower Mainstem		Mainstem	Mainstem
		Grout Pond	Somerset Reservoir	Adams	Red Mill Pond	Searsburg Reservoir	Lake Raponda	Lake Sadawga	Harriman Reservoir	Howe Pond	Sherman Reservoir	South Pond	Weatherhead Hollow Pond
Chain	*Esox niger*	X	X				X	X	X	X	X		X
Common	*Luxilus cornutus*			X									
Creek chub	*Semotilus atromaculatus*				X								
Fallfish	*Semotilus corporalis*		X						X		X		
Golden shiner	*Notemigonus crysoleucas*	X	X	X	X		X		X		X	X	
Lake trout *	*Salvelinus namaycush*								X				

Table 2. Fish species reported to occur in ponds within Basin 12. Species followed by an asterisk indicate populations are dependent upon stocking hatchery produced fish.

Common name	Scientific name	DEERFIELD RIVER										GREEN RIVER	FALL RIVER
		Upper Mainstem					Middle Mainstem			Lower Mainstem		Mainstem	Mainstem
		Grout Pond	Somerset Reservoir	Adams	Red Mill Pond	Searsburg Reservoir	Lake Raponda	Lake Sadawga	Harriman Reservoir	Howe Pond	Sherman Reservoir	South Pond	Weatherhead Hollow Pond
Largemouth bass	*Micropterus salmoides*						X	X					X
Longnose	*Rhinichthys cataractae*												
Longnose sucker	*Catostomus*			X		X			X		X	X	
Mimic shiner	*Notropis volucellus*								X			X	
Northern Pike	*Esox lucius*									X			
Pumpkinseed	*Lepomis gibbosus*	X	X					X	X	X			X
Rainbow	*Osmerus mordax*								X		X	X	

Table 2. Fish species reported to occur in ponds within Basin 12. Species followed by an asterisk indicate populations are dependent upon stocking hatchery produced fish.

Common name	Scientific name	DEERFIELD RIVER										GREEN RIVER	FALL RIVER
		Upper Mainstem					Middle Mainstem			Lower Mainstem		Mainstem	Mainstem
		Grout Pond	Somerset Reservoir	Adams	Red Mill Pond	Searsburg Reservoir	Lake Raponda	Lake Sadawga	Harriman Reservoir	Howe Pond	Sherman Reservoir	South Pond	Weatherhead Hollow Pond
Rainbow	*Oncorynchus mykiss*		X				X		X		X	X	
Rock bass	*Ambloplites rupestris*	X	X				X	X	X		X		
Slimy sculpin	*Cottus cognatus*												
Smallmouth bass	*Micropterus dolomieui*	X	X				X		X		X		X
Tessellated darter	*Etheostoma olmstedi*												
White sucker	*Catostomus commersoni*	X	X		X	X			X	X	X	X	X

Table 2. Fish species reported to occur in ponds within Basin 12. Species followed by an asterisk indicate populations are dependent upon stocking hatchery produced fish.

Common name	Scientific name	DEERFIELD RIVER										GREEN RIVER	FALL RIVER
		Upper Mainstem					Middle Mainstem			Lower Mainstem		Mainstem	Mainstem
		Grout Pond	Somerset Reservoir	Adams	Red Mill Pond	Searsburg Reservoir	Lake Raponda	Lake Sadawga	Harriman Reservoir	Howe Pond	Sherman Reservoir	South Pond	Weatherhead Hollow Pond
Yellow perch	*Perca flavescens*	X	X			X	X	X	X	X	X	X	X

Table 3. Total Smallmouth Bass CPUE (fish/hr) collected in District 1 during standard electrofishing surveys mid-90's to present. For multiple years an average was taken.

Lake	Total CPUE (fish/hr)
Amherst Lake	51
Echo Lake	23
Harriman	35
Lake Raponda	88
Rescue Lake	17
Retreat Meadows	8
Townshend	77
Somerset	23
MEAN	40

Table 4. Total Largemouth Bass CPUE (fish/hr) collected in District 1 during standard electrofishing surveys mid-90's to present.

Lake	Total CPUE (fish/hr)
Bullhead	53
Echo	5
Gale Meadows	20
Lowell	25
Mill (Windsor)	50
Raponda	7
Retreat Meadows	48
Rescue	11
Sadawga	36
Shaftsbury	30
Stoughton	93
Weatherhead Hollow	105

Table 5. Basin 12 trout population data, presented as total trout per mile, collected 2000-2018. For multi-year sampling a mean was taken. Asterix indicates data not collected by VTFWD. Highlight indicates potential B1 stream.

Stream	Site	Year sampled	Latitude	Longitude	Brook Trout	Brown Trout	Total
Blue brook	Blue2119	2016 & 2018	42.983638	-72.885518	928	0	928
Bond Brook*	Bond1870	2017	42.883199	-72.956156	1945	0	1945
Broad Brook	Broad459	2007, 2013-2018	42.801231	-72.598923	778	386	1164
	Broad535	2007	42.809086	-72.610405	464	39	503
Cheney Brook	Cheney1791	2018	42.948994	-72.843483	212	505	717
Cold Brook	Cold1837	2003	42.928383	-72.888802	351	0	351
	Cold 3.4	2015-2016	42.92286	-72.88507	1310	0	1310
	Cold2.2	2016	42.915499	-72.882112	706	0	706
	Cold3.0	2016	42.922844	-72.885166	635	0	635
East Branch North River	EastBranchNorth1236	2003	42.784576	-72.812508	21	0	21

Table 5. Basin 12 trout population data, presented as total trout per mile, collected 2000-2018. For multi-year sampling a mean was taken. Asterix indicates data not collected by VTFWD. Highlight indicates potential B1 stream.

Stream	Site	Year sampled	Latitude	Longitude	Brook Trout	Brown Trout	Total
	EastBranchNorth1340	2010, '13, '14, '16	42.795578	-72.82119	271	0	271
	EastBranchNorth859	2008	42.746941	-72.747223	172	0	172
Ellis Brook	Ellis1595	2008	42.924465	-72.840759	47	31	78
Green River	Green560	2003	42.741741	-72.672935	44	0	44
	Green757	2013-2018	42.78883	-72.667953	183	0	183
GreenTrib Brook	GreenTrib890	2003	42.774506	-72.68277	372	0	372
Halladay Brook	Halladay522	2008	42.868744	-72.619949	248	109	357
Deerfield River[38]	HarrimanBypass1316	2000-2003	42.790096	-72.919594	1784	8	1792
Haystack Brook	Haystack0.1	2015-2016	42.91695	-72.88335	1490	0	1490

[38] While sampling in the Harriman bypass indicated potential B1 designation, sampling occurred just after flows were restored and transplantation efforts of brook trout occurred. Therefore, these estimates may not be representative of current conditions within that reach.

Table 5. Basin 12 trout population data, presented as total trout per mile, collected 2000-2018. For multi-year sampling a mean was taken. Asterix indicates data not collected by VTFWD. Highlight indicates potential B1 stream.

Stream	Site	Year sampled	Latitude	Longitude	Brook Trout	Brown Trout	Total
Lamb Brook*	Lamb1750	2017	42.815324	-72.972733	2805	0	2805
	Lamb1970	2005	42.823231	-72.967926	88	0	88
Medbury Brook*	Medbury1630	2017	42.868554	-72.933952	656	0	656
North Branch Deerfield	NorthBranchDeerfield1600	2008	42.923759	-72.844688	11	0	11
	NorthBranchDeerfield1745	2008	42.947548	-72.86834	13	7	20
	NorthBranchDeerfield1837	2003	42.954277	-72.882729	77	0	77
	NorthBranchDeerfield1928	2003	42.968857	-72.892426	598	0	598
Oak Brook	Oak0.1	2015	42.92532	-72.88763	1753	0	1753
Rake Brook*	Rake2150	2017	42.884891	-73.009135	111	0	111
Scooter Brook	Scooter295	2000	42.754749	-72.517929	1427		1427

Table 5. Basin 12 trout population data, presented as total trout per mile, collected 2000-2018. For multi-year sampling a mean was taken. Asterix indicates data not collected by VTFWD. Highlight indicates potential B1 stream.

Stream	Site	Year sampled	Latitude	Longitude	Brook Trout	Brown Trout	Total
Unnamed Brook	Unnamed1920	2017	42.830345	-72.980388	427	0	427
West Branch Deerfield	WestBranchDeerfield1520	2013	42.789501	-72.96093	226	211	437
	WestBranchDeerfield1815	2016	42.84606	-72.98991	3114	163	3277
	WestBranchDeerfield1575	2014-2017	42.794342	-72.966064	358	735	1093
Whetstone Brook	Whetstone241	2003	42.851017	-72.558662	0	171	171
	Whetstone328	2013-2018	42.848763	-72.578423	127	796	923
	Whetstone500	2008	42.86702	-72.615074	117	0	117
	Whetstone525	2008	42.866055	-72.621201	89	20	109
							0
				Mean	**648**	**91**	**733**
				Max	**3114**	**796**	**3277**

Table 5. Basin 12 trout population data, presented as total trout per mile, collected 2000-2018. For multi-year sampling a mean was taken. Asterix indicates data not collected by VTFWD. Highlight indicates potential B1 stream.

Stream	Site	Year sampled	Latitude	Longitude	Brook Trout	Brown Trout	Total
				Median	**351**	**0**	**437**

Table 6. Summary statistics of total trout per mile from 223 sites throughout the District including data from 2000-2018.

Total		BKT		BNT	
Mean	793	Mean	622	Mean	164
Standard Error	61	Standard Error	54	Standard Error	32
Median	516	Median	348	Median	0
Mode	0	Mode	0	Mode	0
Standard Deviation	910	Standard Deviation	806	Standard Deviation	477
Sample Variance	827259	Sample Variance	649136	Sample Variance	227641
Kurtosis	13	Kurtosis	22	Kurtosis	50
Skewness	3.0	Skewness	4	Skewness	6
Range	7260	Range	7260	Range	4933
Minimum	0	Minimum	0	Minimum	0
Maximum	7260	Maximum	7260	Maximum	4933
Sum	176944	Sum	138644	Sum	36693
Count	223	Count	223	Count	223

Table 7. Comparison of brook trout population estimates 1990 and 2017.

East Branch Deerfield2020- Somerset 8/2/1990			East Branch Deerfield2020- Somerset 9/22/2017	
Brook Trout Size Class	EST (N)	Pop/mi	EST (N)	Pop/mi
YOY	3	91	1	17
<6	9	272	3	50
6-10	4	121	0	0
10-12	0	0	0	0
12+	0	0	0	0
Total	16	483	4	67

East Branch Deerfield 1775- Somerset 1990			East Branch Deerfield 1775- Somerset 9/22/2017	
Brook Trout Size Class	EST (N)	Pop/mi	EST (N)	Pop/mi
YOY	7	162	2	54
<6	4	93	3	81
6-10	2	46	0	0

10-12	0	0	0	0
12+	0	0	0	0
Total	13	301	5	135

Table 8. US. Forest Service trout population estimates in select tributaries to the Deerfield near Somerset Reservoir.

Blind Brook	BKT Size Class	Est(N)	Pop/mi	Lbs/acre
	YOY	24.0	386.2	2.4
	<6	7.0	112.7	1.7
	6-10	2.0	32.2	1.1
	10-12	0.0	0.0	0.0
	12+	0.0	0.0	0.0
	Total	33.0	531.1	5.2

Castle Brook	BKT Size Class	Est(N)	Pop/mi	Lbs/acre
	YOY	2	32.2	0.1
	<6	4	64.4	1.2
	6-10	4	64.4	3.8
	10-12	0	0.0	0
	12+	0	0.0	0
	Total	10.0	161.1	5.0

Table 8. US. Forest Service trout population estimates in select tributaries to the Deerfield near Somerset Reservoir.

Deer Cabin Brook	BKT Size Class	Est(N)	Pop/mi	Lbs/acre
	YOY	6	97	0
	<6	3	48	1
	6-10	2	32	1
	10-12	0	0	0
	12+	0	0	0
	Total	11	177	2

Deer Lick Brook	BKT Size Class	Est(N)	Pop/mi	Lbs/acre
	YOY	8	129	0
	<6	12	193	2
	6-10	2	32	2
	10-12	0	0	0
	12+	0	0	0

Table 8. US. Forest Service trout population estimates in select tributaries to the Deerfield near Somerset Reservoir.

	Total	22	354	4
Glastenbury River	BKT Size Class	Est(N)	Pop/mi	Lbs/acre
	YOY	1	18	0
	<6	12	211	2
	6-10	1	18	1
	10-12	0	0	0
	12+	0	0	0
	Total	14	246	3
Rake Branch	BNT Size Class	Est(N)	Pop/mi	Lbs/acre
	YOY	0	0	0
	<6	0	0	0
	6-10	1	11	0
	10-12	0	0	0

Table 8. US. Forest Service trout population estimates in select tributaries to the Deerfield near Somerset Reservoir.

	12+	0	0	0
	Total	1	11	0

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Table 9. Water Quality measurements conducted in 2017 by VTFWD.										
	SOMMERSET RESERVOIR									
Site ID	**Description**	**U/S OR D/S?**	**N**	**W**	**Elevation**	**Date**	**Temp (C°)**	**COND(µs/cm)**	**D.O. (mg/L)**	**pH**
Som1	Kelly Stand Road bridge	U/S	43.061162	-72.968426	2236	7/5/2017	12.9	10.3	10.98	NA
						9/5/2017	13.3	18.6	11.11	7.7
Som2	off Grout Pond West loop trail	U/S	43.03986	-72.968537	2220	7/5/2017	15	10.7	9.88	NA
						9/5/2017	14.6	15.6	8.87	6.9
Som3	below reservoir outflow	D/S	42.971716	-72.949801	2200	7/5/2017	7.8	9.9	12.43	NA
						8/29/2017	9.3	10.4	11.9	7.6
Som4	north of E. Branch mainstem confluence	D/S	42.92898	-72.94369	1826	7/5/2017	15.6	12	9.88	NA
						8/29/2017	14.4	12.2	8.96	6.7
Som5	at E. Branch trail bridge crossing	D/S	42.912918	-72.946227	1790	7/5/2017	14.8	20	10.4	NA
						8/29/2017	15.1	13.1	8.8	7.2
Sam1	East Branch Deerfield	D/S	42.96966	-72.95207	2037	8/29/2017	11.3	10.7	10.45	6.9
Sam2	East Branch Deerfield	D/S	42.96739	-72.95488	2029	8/29/2017	12.7	10.9	9.94	6.9
Sam3	East Branch Deerfield	D/S	42.96567	-72.95748	2011	8/29/2017	13.6	11.2	10.32	6.7
Sam4	East Branch Deerfield	D/S	42.96294	-72.96184	2030	8/29/2017	14.4	12.2	8.96	6.7

Sam5	East Branch Deerfield	D/S	42.95921	-72.96657	1982	8/29/2017	15.1	13.1	8.8	7.2
Sam6	East Branch Deerfield	D/S	42.95275	-72.9598	1956	8/29/2017	13.3	18.6	11.11	7.7
Sam7	East Branch Deerfield	D/S	42.9455	-72.96144	1823	8/29/2017	14.6	15.6	8.87	6.9
	SEARSBURG RESERVOIR									
Site ID	**Description**	**U/S OR D/S?**	**N**	**W**	**Elevation**	**Date**	**Temp (C°)**	**COND(µs/cm)**	**D.O. (mg/L)**	**pH**
Sears1	Searsburg inlet, current present	U/S	42.90978	-72.94603	1763	6/29/2017	18.8	14.9	8.8	NA
						9/5/2017	14.7	18.2	9.63	7.1
Sears2	Searsburg Outlet	D/S	42.901506	-72.949091	1722	6/29/2017	13.4	14.5	11.8	NA
						9/5/2017	14.1	17.3	9.61	6.5
Sears3	Rt. 9. Bridge next to Lind Rd. cul-de-sac	D/S	42.878567	-72.945312	1609	6/29/2017	16.2	26.9	10.68	NA
						9/5/2017	15.7	37.4	8.71	6.9
Sears4	Medburyville Rd. Bridge	D/S	42.870893	-72.919558	1506	6/29/2017	15	19.7	10.18	NA
						9/5/2017	14.8	30.6	9.65	6.8
	HARRIMAN RESERVOIR									
Site ID	**Description**	**U/S OR D/S?**	**N**	**W**	**Elevation**	**Date**	**Temp (C°)**	**COND(µs/cm)**	**D.O. (mg/L)**	**pH**
Harr1	N. Br. DF. Behind dirt lot in Wilmington	U/S	42.868375	-72.873472	1507	6/29/2017	16.2	118.8	9.87	NA
						9/5/2017	16.3	109.6	9.81	7.1
Harr2		U/S	42.874302	-72.863832	1515	6/29/2017	16.2	108.4	10.73	NA

	N. Br. DF. Behind Blue Mt. Produce					9/5/2017	16.4	104.8	9	7.6
Harr3	Below Harr. Dam outflow	D/S	42.791681	-72.916455	1314	6/29/2017	13.4	34.5	11.54	NA
						9/5/2017	7.7	28.2	12.6	6.8
Harr4	Trail, East of School on Phelps Ln.	D/S	42.770836	-72.938879	1185	6/29/2017	14.1	35.7	11.27	NA
						9/5/2017	9.4	34.6	12.52	6.8
Harr5	Just above W. Br. Confluence	D/S	42.770293	-72.946935	1164	6/29/2017	14	36.3	11.75	NA
						9/5/2017	10.4	32.8	12.04	7

Table 10. Number of Days greater than 65, 68, 72, 75, 80 °F from the period of May 15 to November 1, 2015-2017.

Site	Days >65°F			Days >68°F			Days >72°F			Days >75°F		
	2015	2016	2017	2015	2016	2017	2015	2016	2017	2015	2016	2017
Broad459	63	90	18	21	58	1	2	17	0	0	5	0
Green757	13	97	68	5	87	33	2	64	3	1	29	0
Whetstone328	84	100	51	47	76	14	7	24	0	0	0	0

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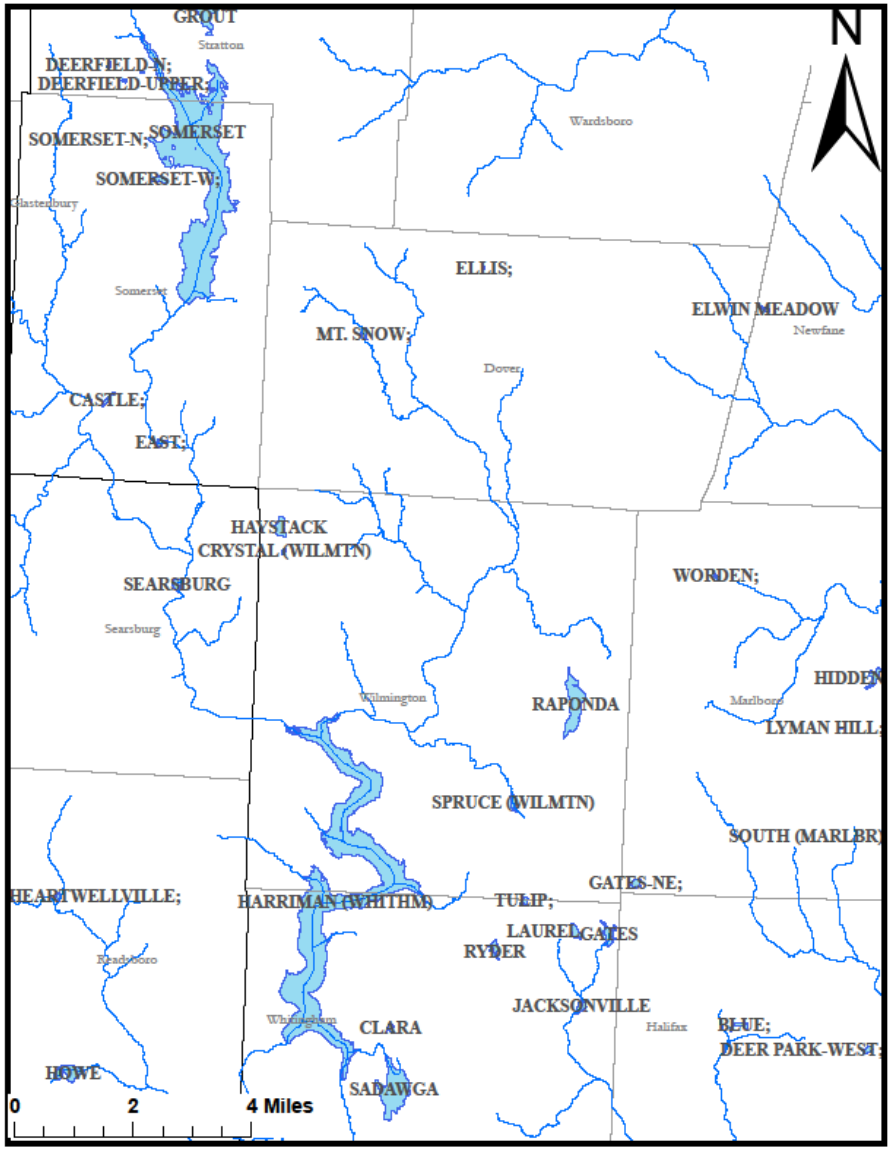
N
GROUT
Stratton
DEERFIELD-N;
DEERFIELD-UPPER;
SOMERSET-N;
SOMERSET
SOMERSET-W;
Glastenbury
Somerset
Wardsboro
ELLIS;
ELWIN MEADOW
Newfane
MT. SNOW;
Dover
CASTLE;
EAST;
HAYSTACK
CRYSTAL (WILMTN)
SEARSBURG
Searsburg
WORDEN;
HIDDEN
Wilmington
RAPONDA
Marlboro
LYMAN HILL
SPRUCE (WILMTN)
SOUTH (MARLBR)
GATES-NE;
HEARTWELLVILLE;
HARRIMAN (WHITHM)
TULIP;
LAUREL
GATES
RYDER
Readsboro
JACKSONVILLE
Whitingham
CLARA
Halifax
BLUE;
DEER PARK-WEST
HOWE
SADAWGA
0
2
4 Miles

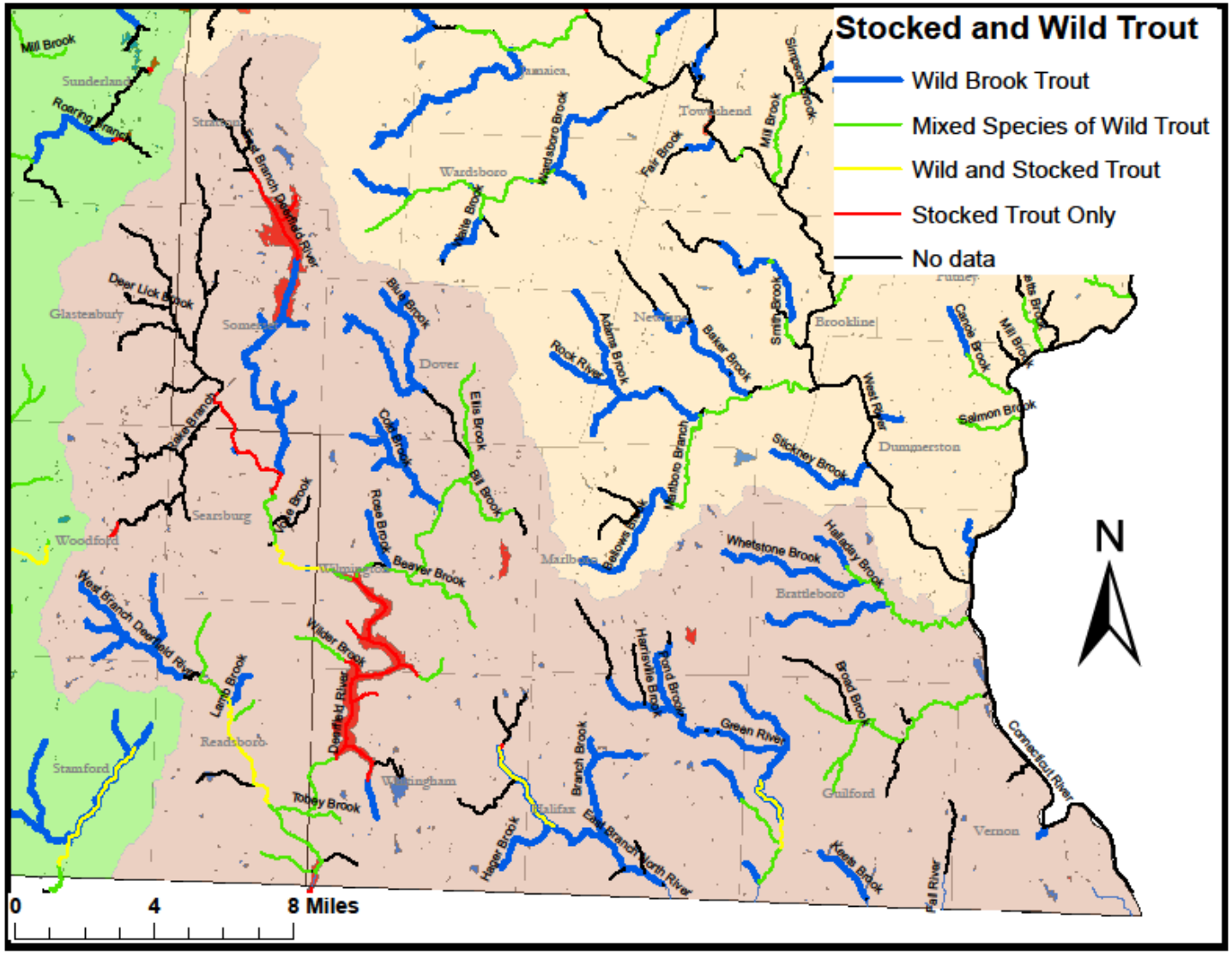

Figure 2. Streams providing habitat for trout within the Deerfield watershed.

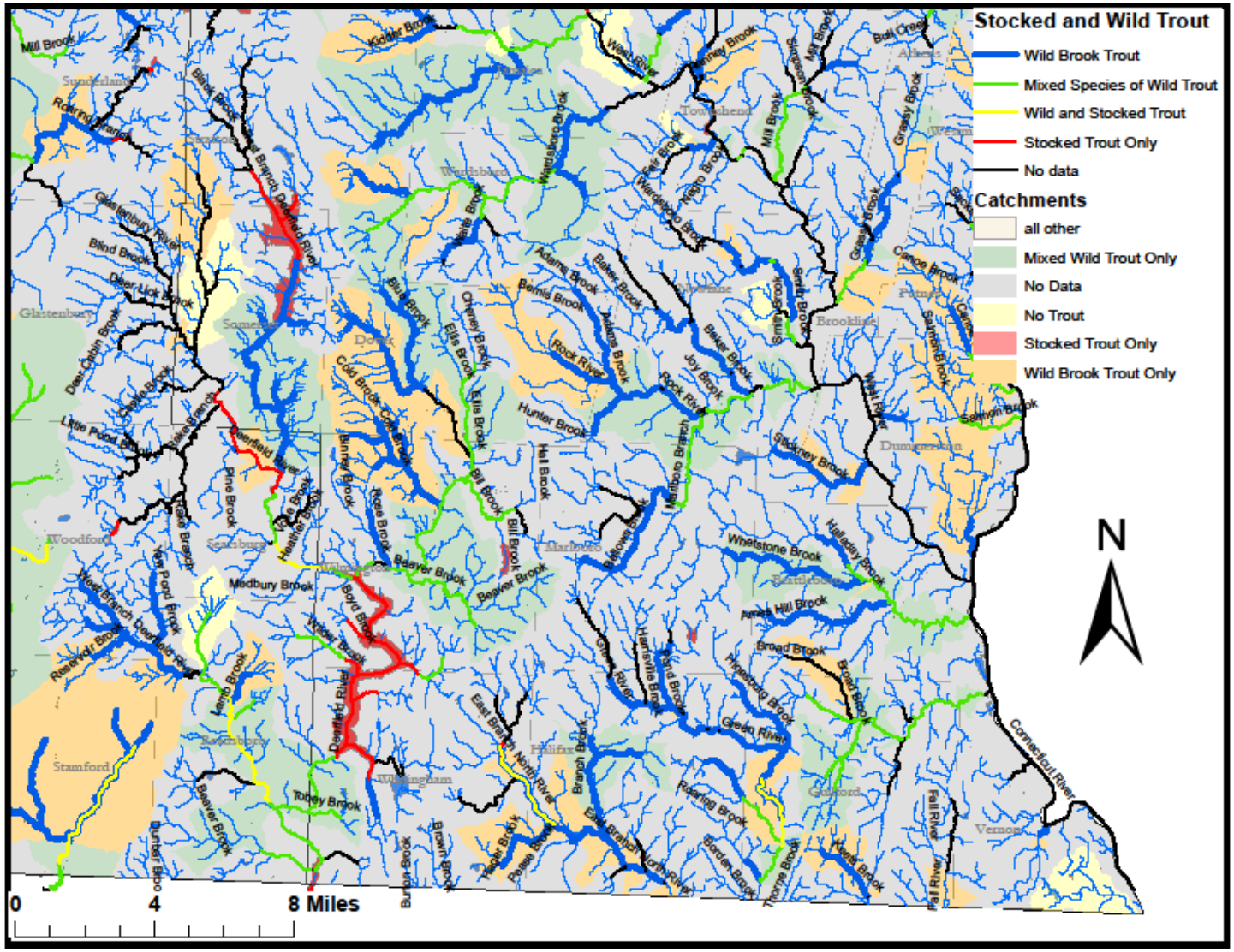

Figure 3. Catchments providing habitat for wild trout.

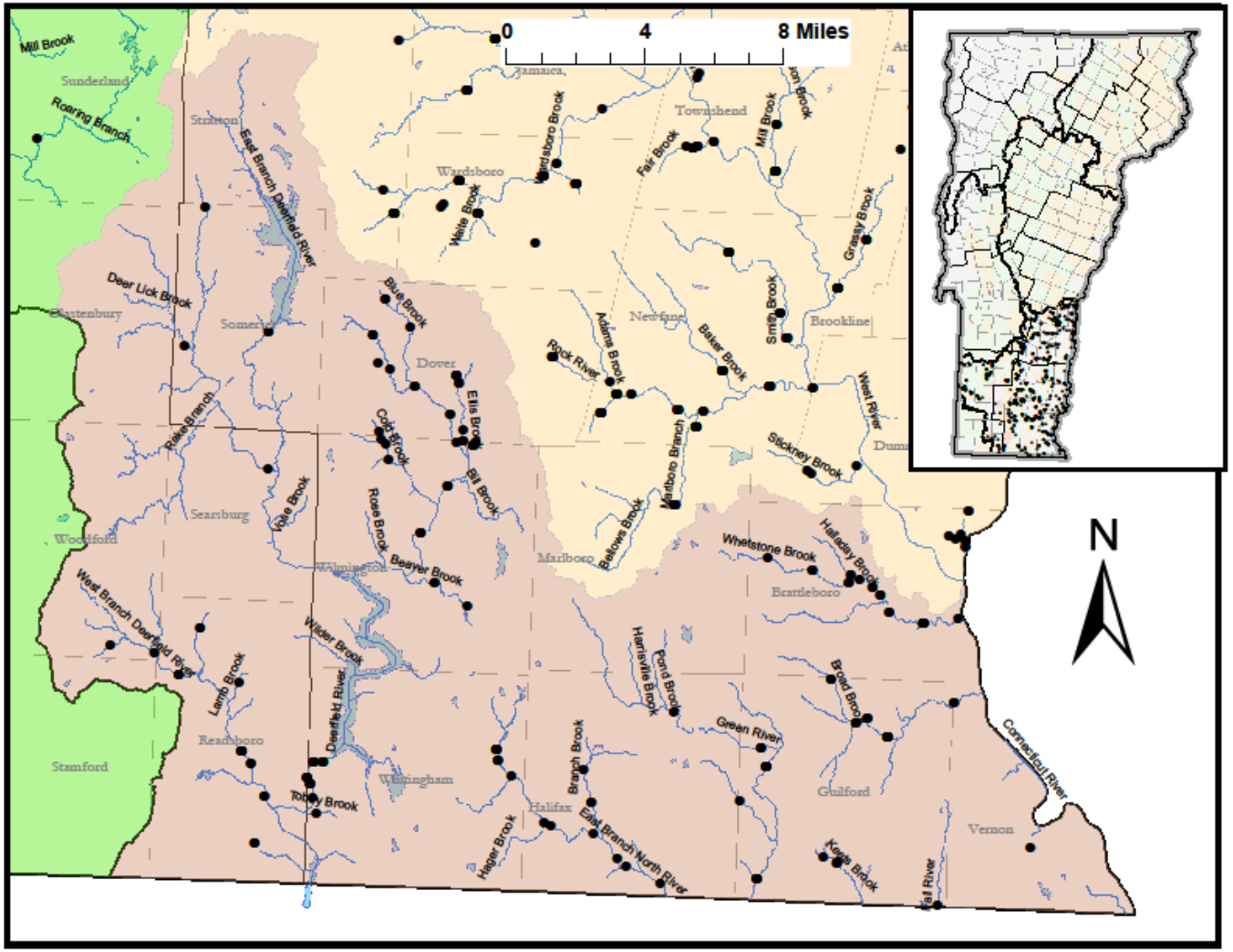

Figure 4. Trout population sampling sites throughout the basin.

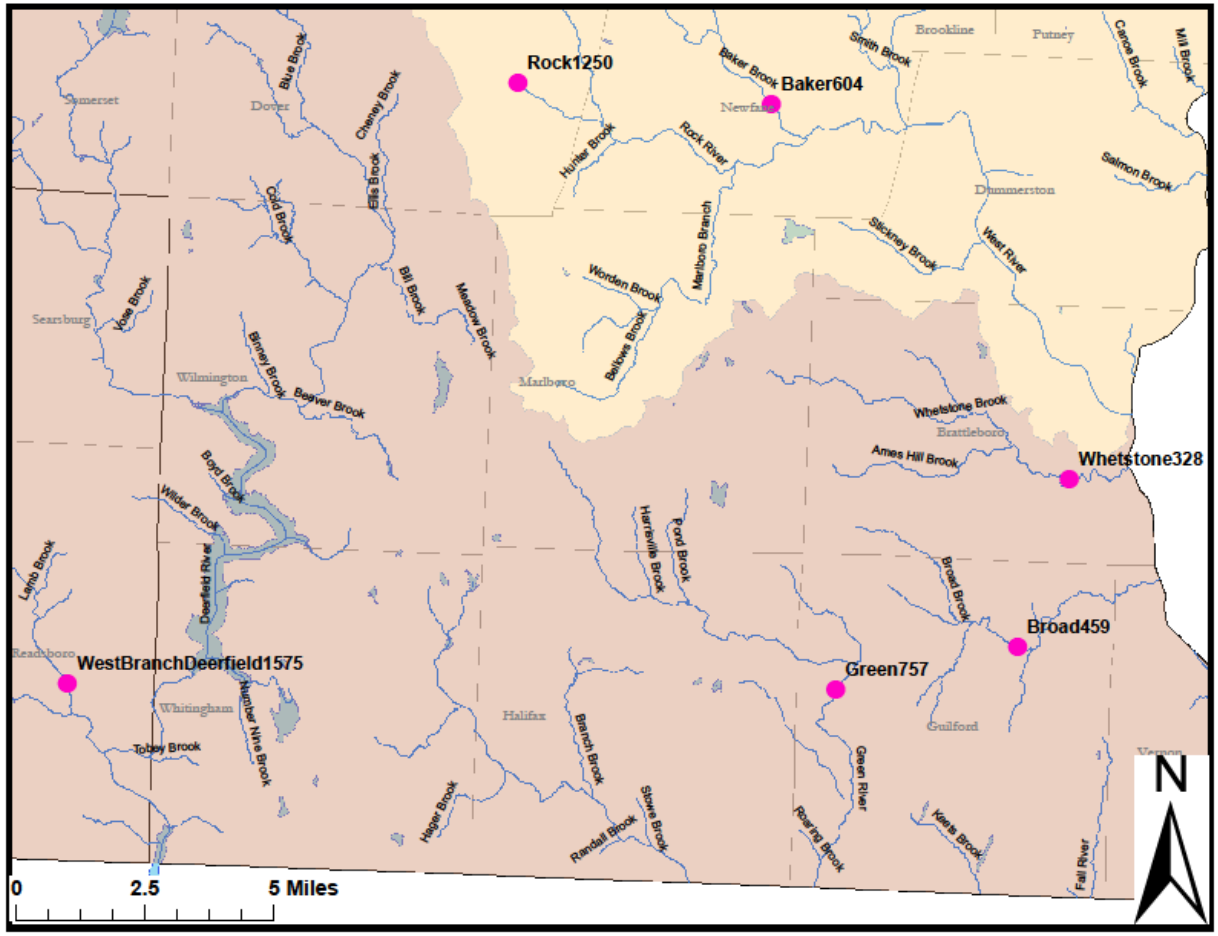

Figure 5. Sites monitored annually for stream temperatures and trout populations.

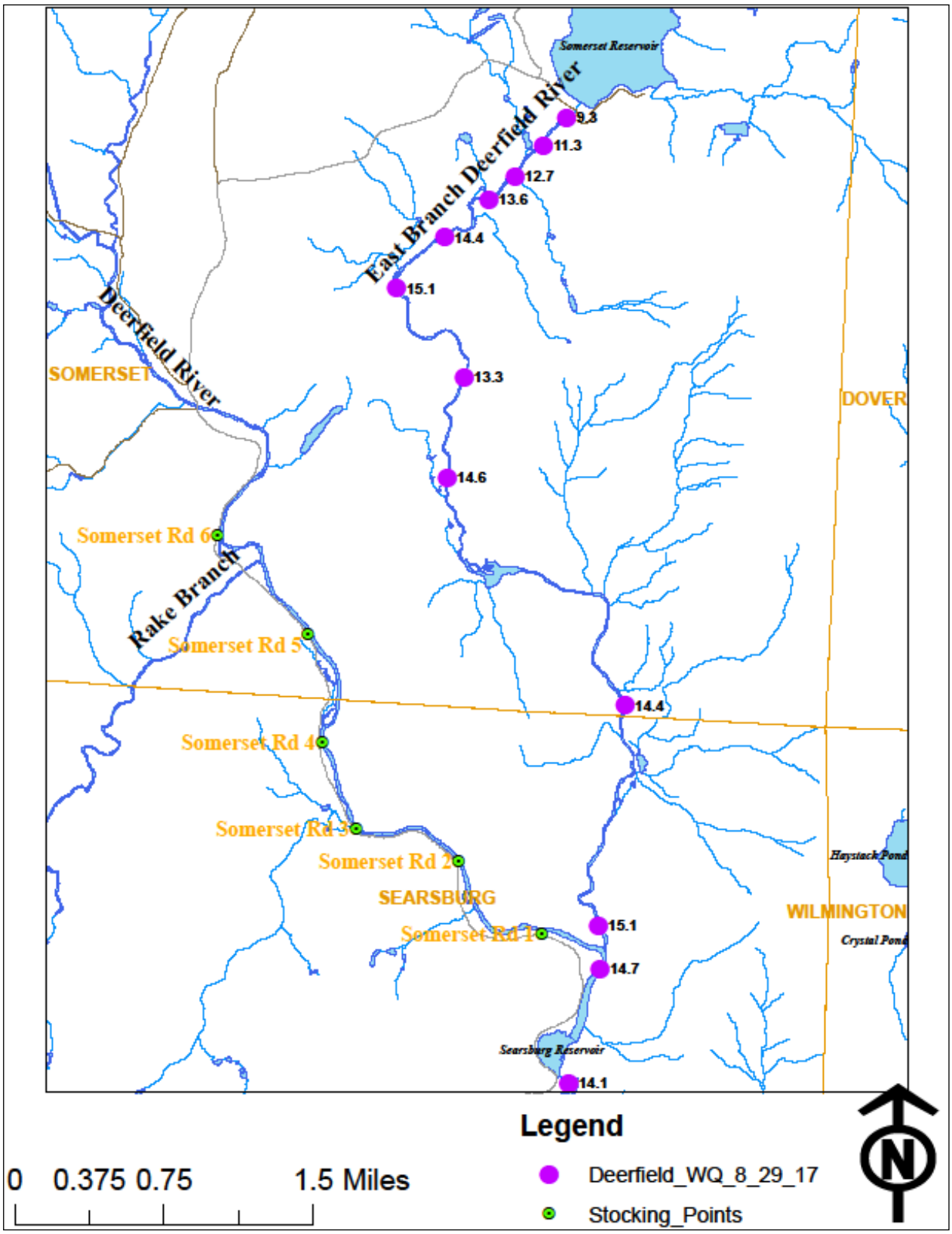

Figure 6. Stream temperatures in Celsius collected in September 2017.

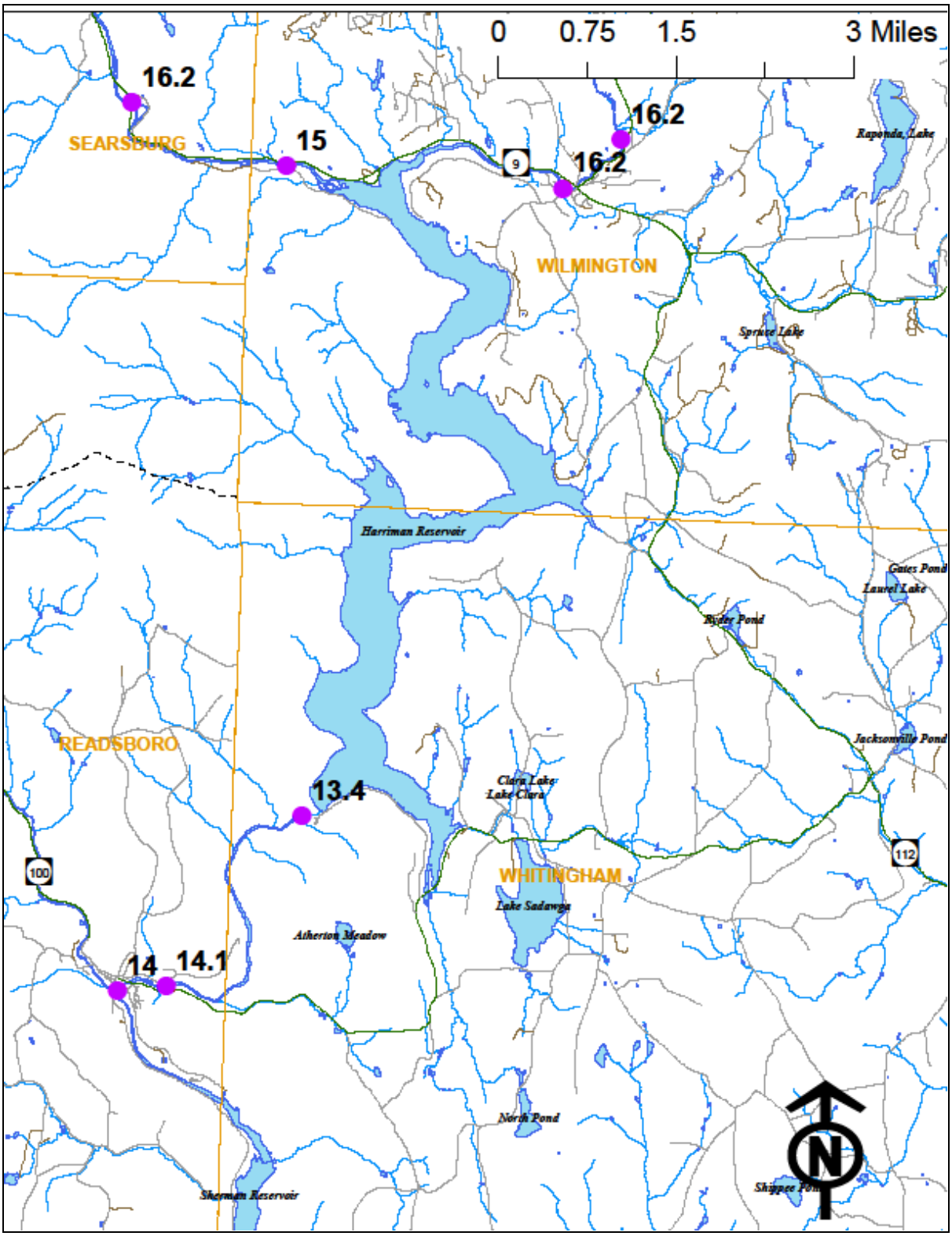

Figure 7. Stream temperatures in Celsius collected in September 2017.

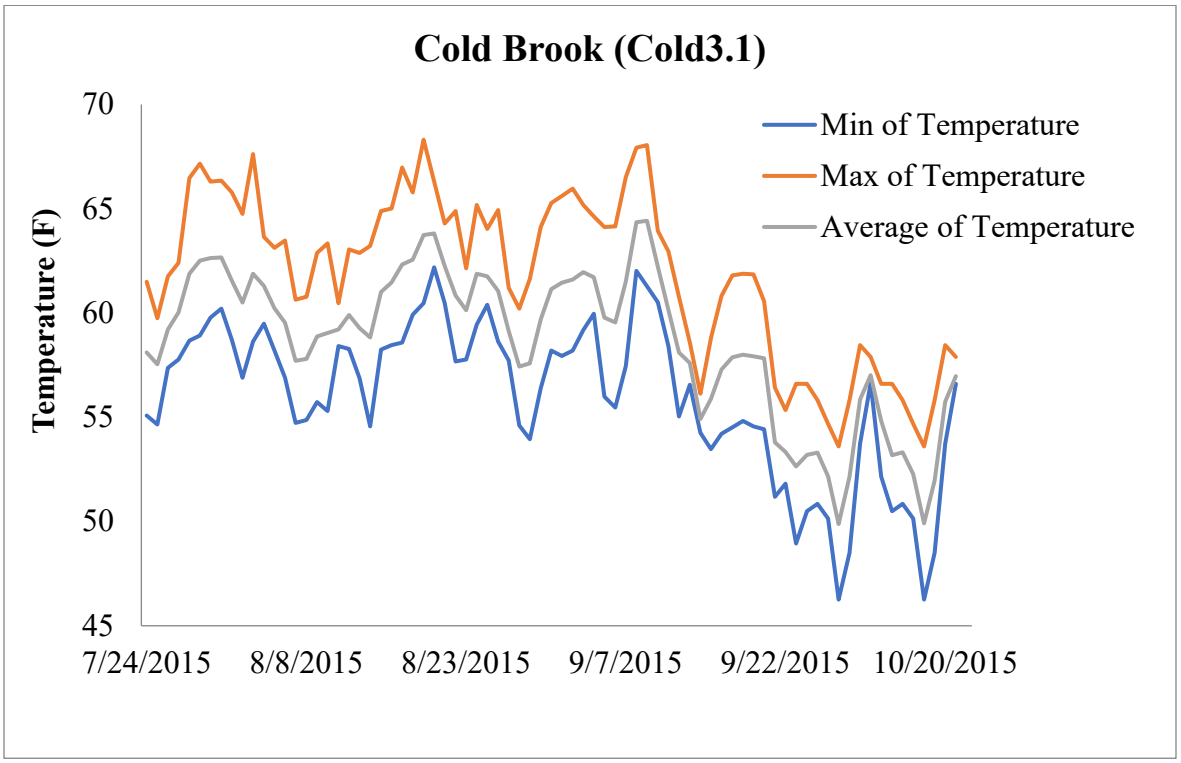

Figure 8. Stream temperatures in Cold Brook monitored at the Hermitage 2015.

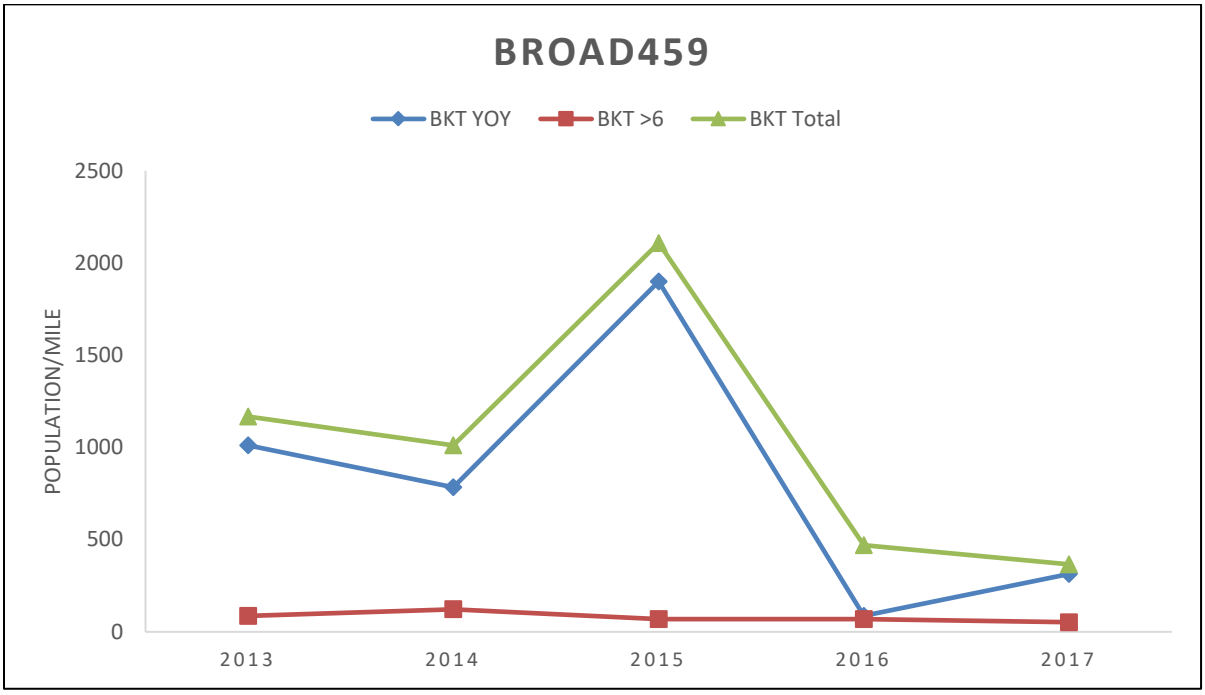

Figure 9. Population estimates for brook trout by size class and year at long-term monitoring site in Broad Brook.

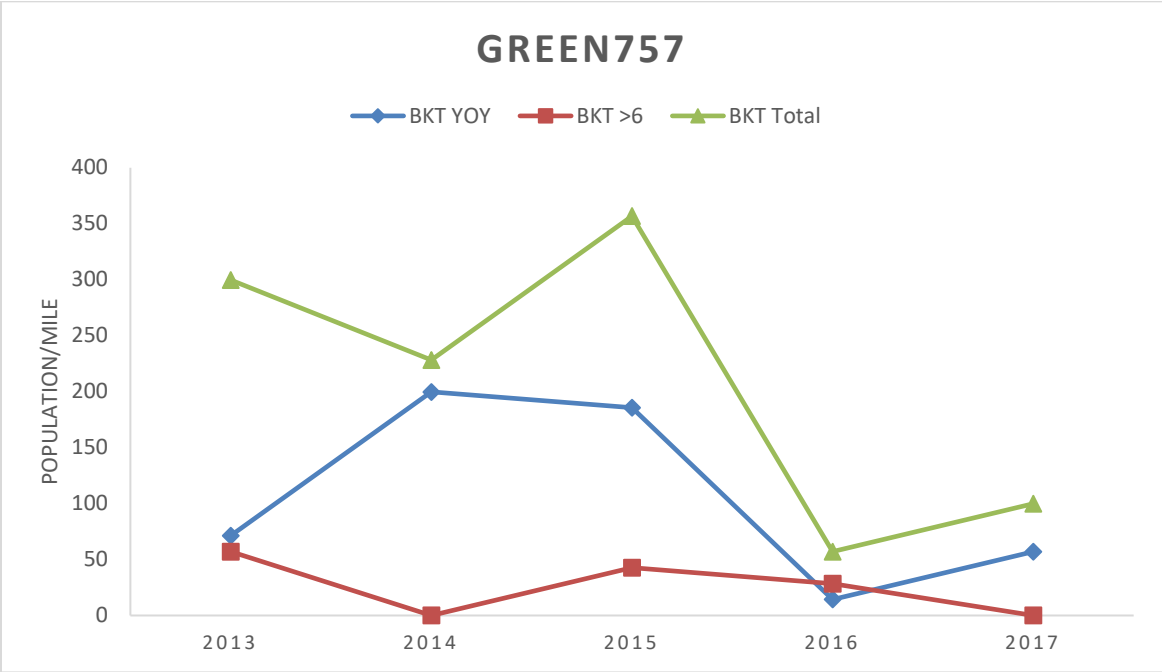

Figure 10. Population estimates for brook trout by size class and year at long-term monitoring site in Green River.

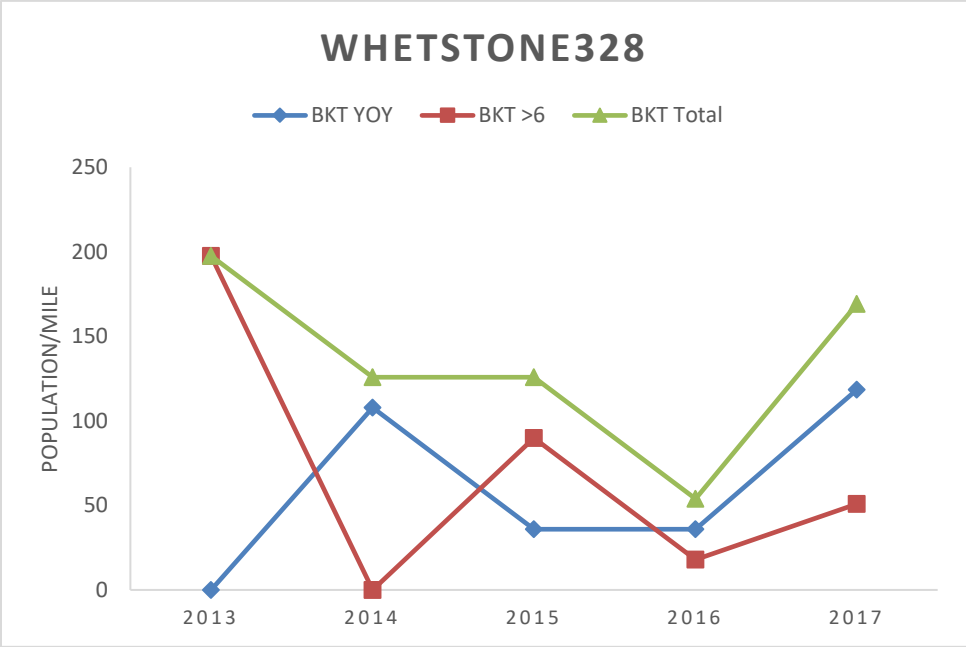

Figure 11. Population estimates for brook trout by size class and year at long-term monitoring site in the Whetstone.

Appendix E. Municipal Protectiveness Matrix for Basin 15

Town	National Flood Insurance Program (NFIP)	Road and Bridge Standards	Emergency Management Plan (LEMP)	Hazard Mitigation Plan (LHMP)	River Corridor Protection	ERAF	Flood Resilience in Town Plan	Stormwater Mapping	Illicit Discharge Detection and Elimination	Stormwater Master Plan
Status -->	*Enrolled?*	*Adopted?*	*Completed?*	*Adopted?*	*Adopted?*	*Percent*	*Completed?*	*Completed?*	*Completed?*	*Completed?*
Brattleboro	Yes	Yes	Yes	Yes	Yes/No	17.5	Yes	Yes	Yes	No
Dover	Yes	Yes	Yes	Yes	No	12.5	Yes	Yes	Current Study	No
Dummerston	Yes	Yes	Yes	Yes	No	12.5	Yes	Yes	Current Study	No
Glastenbury	No	Yes	No	Yes	No	7.5	No	No	No	No
Guilford	Yes	Yes	Yes	Yes	No	12.5	Yes	Yes	Current Study	No
Halifax	Yes	Yes	No	Yes	Interim	7.5	Yes	No	No	No
Marlboro	Yes	Yes	No	Yes	Yes	7.5	No	Yes	Current Study	No
Readsboro	Yes	Yes	Yes	No	Interim	7.5	No	Yes	Current Study	No
Searsburg	No	Yes	Yes	No	No	7.5	No	No	No	No
Somerset	No	Yes	No	No	No	7.5	No	No	No	No
Stamford	Yes	Yes	Yes	Yes	Yes	17.5	Yes	No	No	No
Stratton	Yes	Yes	Yes	Yes	No	12.5	Yes	Yes	Current Study	No
Sunderland	Yes	Yes	Yes	Expired	Yes	7.5	Yes	No	No	YES
Vernon	Yes	Yes	Yes	Yes	Interim	17.5	Yes	Yes	Current Study	No
Wardsboro	Yes	Yes	Yes	No	No	7.5	No	Yes	Current Study	No
Whitingham	Yes	Yes	Yes	Yes	No	12.5	Yes	Yes	Current Study	No
Jacksonville Village			Yes	Yes	No	12.5				
Wilmington	Yes	Yes	Yes	Yes	No	12.5	Yes	Yes	Current Study	No
Woodford	Yes	No	No	Expired	No	7.5	Yes	No	No	No

Appendix F. Responsiveness Summary