Vermont Agency of Natural Resources

Basin 17 Water Quality Management Plan

January 2012

Vermont Surface Water Management Strategy

THE WATER QUALITY PLAN FOR THE BASIN 17 WAS PREPARED IN ACCORDANCE WITH 10 V.S.A. § 1253(d), THE VERMONT WATER QUALITY STANDARDS, THE FEDERAL CLEAN WATER ACT AND 40 CFR 130.6.[1]

Approved:

David Mears, Commissioner
Department of Environmental Conservation

Jan. 27, 2012
Date

Deborah Markowitz, Secretary
Agency of Natural Resources

1-25-12
Date

VERMONT
AGENCY OF NATURAL RESOURCES

Agency of Natural Resources

Department of Environmental Conservation

Water Quality Division

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Cover photo: May Pond in Barton, VT

[1] The revised Water Quality Standards require that all basin plans place Class B waters into one of the three water management management types, and the Panel's ability to promulgate these designations. These challenges are listed in detail in VDEC's 2010 Report to the Vermont General Assembly on Basin Planning. As such, recommendations for water management types are not presented in this basin plan.

Executive Summary

This river basin water quality management plan provides an overview of the health of Basin 17, the Lake Memphremagog Tomofobia and Coaticook Basin, and a description of the priority future and ongoing steps to restore and protect its surface waters. With the purpose of improving both water quality and aquatic habitat, this plan presents the recommendations of local watershed residents, stakeholders from varying interests, the Agency of Natural Resources (Agency) and natural resource professionals from other state and federal agencies to guide protection and improvement efforts in this basin for the next five years. The central component of this water quality management plan is the implementation table, which includes 79 specific actions to address these threats to surface waters in the basin. This is expected to be a working document that will be revised over the life of this plan as new information is obtained, especially with the completion of a Total Maximum Daily Load (TMDL) to address the phosphorous impairment of Lake Memphremagog.

Basin 17 includes all the waters in Vermont that flow to Lake Memphremagog including the Black, Barton, Clyde and Johns Rivers as well as the Tomifobia and Coaticook watersheds that together make up the Vermont portions of the Saint Francis River watershed. Waters in this basin support many uses including swimming, boating and fishing in its extensive rivers, streams, lakes, ponds, and wetlands. Threats to these uses include: nutrient enrichment, which has caused the impairment of Lake Memphremagog and threatens other lakes in the basin; aquatic invasive species that are present in a number of waters and are a threat to all waters; and finally alterations to aquatic and riparian habitat along rivers, lakes and wetlands. The top ten priority actions in this management plan are to:

1. Develop a TMDL to address the phosphorus impairment of Lake Memphremagog.
2. Complete stormwater system mapping and illicit discharge detection for the City of Newport, Village of Derby, Village of Orleans and Village of Barton.
3. Work with all towns in the Vermont portion of the basin to apply for at least one Better Backroads Grant to address one of the major water quality issues identified by the road review committee.
4. Establish an agricultural water quality group that will represent the interest of the Memphremagog region; and leverage the positive attention of the legislature, the press, and the watershed community; and promote the best use of government cost share dollars.
5. Make direct contact with agricultural producers to promote existing programs such as the Conservation Reserve Enhancement Program that provide incentives for fencing, watering tanks.
6. Work with Vermont towns to include protection for floodplains, Fluvial Erosion Hazard zones and buffer zones in local zoning.
7. Hold an annual Vermont Invasive Patrollers (VIP) training in the basin to support the establishment of VIP programs for lakes and ponds in the basin.
8. Working closely with local land trusts, lake associations, and towns to contact landowners of the highest priority undeveloped lakeshore parcels to determine interest in conservation and conserve at least one of the top priority parcels.
9. Develop specific wetland conservation priorities for high value wetlands for both habitat and phosphorus retention and use the priorities to focus the wetland conservation and restoration work of the many different partners involved in such work in the basin.
10. Work with Hydro Coaticook, the Public Service Board, and local residents to identify and address the water resource concerns associated with water level fluctuations at Norton and Great and Little Averill ponds so these and downstream waters will meet the Vermont Water Quality Standards.

The importance of basin planning in the face of Tropical Storm Irene

Tropical storm Irene dumped four to five inches of rain on the narrow river valleys of Basin 17. With soils already saturated from a wet August, the runoff quickly filled river channels beyond their recognized floodplains and rivers, with a newly acquired energy, ripped out roads, bridges, culverts and buildings, although this basin was spared the worst of the flooding that was seen across much of central and southern Vermont. After tropical storm Irene the discharge at the Black River in Coventry was at a level that has just a two percent chance of occurring in any given year based on historical records of flows at this site since 1952. But Irene wasn't the only weather story of 2011. In the spring, rain and melting snow filled streams, albeit at a slower pace, raising Lake Memphremagog to levels not seen since the late 1930's and the Clyde River to levels not seen since 1936. These early spring storms and tropical storm Irene also led to eroding rivers and land erosion, which sent plumes of phosphorus-loaded sediment into lakes nearly doubling previous average levels of annual phosphorus loading from major tributaries.

We can expect to see the intensity and extensiveness of these storms repeated in the future with greater frequency as Vermont's climate warms, so the Agency of Natural Resources has been considering how we can best adapt to protect the most vulnerable resources, areas, and sectors in the state through an adaptation plan[2]. Much of the adaption plan's white paper on water resources focuses on preparing for a greater frequency of intense rain events which is also reflected in strategies listed in the Vermont Surface Water Management Strategy[3] as well as the Basin 17 plan. All three of these documents address the loss of the natural landscape to urbanization and increased runoff from developed lands, improving infrastructure to handle more intense storms (such as increasing the size of culverts), and most importantly, minimizing conflicts with the river corridor which together can reduce the impacts from future flood events.

In the face of the destruction wrought by Irene, how do we help communities to rebuild to reduce damages from the next storm? Development and implementation of hazard identification and mitigation plans are part of the solution and the agency, regional planning commissions and other partners will provide assistance to communities to produce robust plans to reduce conflicts with rivers and improve infrastructure, particularly culverts to be able to handle these greater flows. We must also consider fluvial geomorphic principals when rebuilding our infrastructure adjacent to rivers. To paraphrase from Barry Cahoon, stream alteration engineer for the Agency of Natural Resources; We cannot isolate ourselves from rivers, confine rivers to where we perceive they are "supposed to be, belong, or always were", or ignore the message we have been given, that the rivers often need the space we have chosen to take away from them. With all that we have invested over generations, in our homes, our commerce, and our public infrastructure, we have created tremendous conflict with the physical imperatives of rivers when rivers are energized by storm events, now of increasing frequency and magnitude. Some strategic separation and confinement of these incredibly powerful and dynamic natural systems is needed to protect these investments, but this work must be done in a way that embraces an informed recognition and implementation of fluvial conflict reduction options for the benefit of this and future generations, and the rivers themselves.

[2] http://www.anr.state.vt.us/anr/climatechange/Adaptation.html
[3] http://www.vtwaterquality.org/swms.html

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Chapter 1 – Introduction

Purpose of the Basin Plan and the Basin Planning Process

This river basin water quality management plan describes strategies to restore and protect the values and beneficial uses of surface waters in Basin 17, such as swimming, boating and aquatic habitat. The surface waters in Basin 17 include the small rivers and streams in Vermont that drain north into the Saint Francis River along with the ponds and wetlands in this watershed. The Vermont portion of the Saint Francis River Watershed includes all the waters that drain into Lake Memphremagog including the Black, Barton, Clyde and Johns Rivers as well as the Tomifobia and Coaticook river watersheds.

The majority of strategies identified in this plan are the result of a basin planning process that sought community involvement to identify and build upon existing interest and resources in the basin to protect and improve water quality. The remaining strategies describe the Agency of Natural Resources' (Agency's) existing programs and efforts to have all surface waters meet the Vermont Water Quality Standards. In addition to guiding the Agency in its work, individuals and groups will be able to use these strategies to identify resources and opportunities to address water quality issues. The Agency and others began implementing strategies during the basin planning process and will continue implementation until the planning process begins again in five years.

Planning at the Watershed Level

A watershed, or a larger unit such as a river basin, is a distinct land area that drains into a particular waterbody either through channelized flow or surface runoff. Preparing a plan at a watershed level allows for the consideration of all contributing sources of surface water runoff to the waterbody.

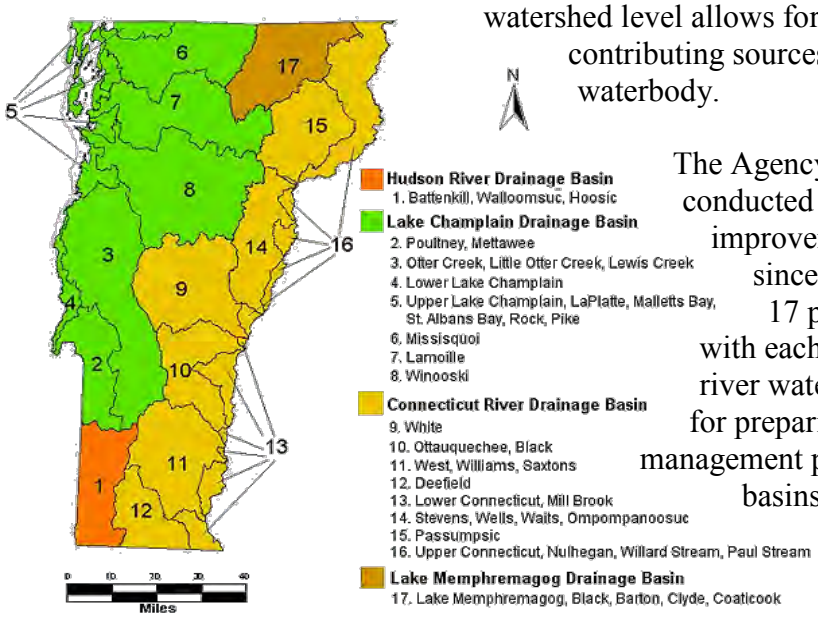


Figure 1. Major Planning Basins in Vermont

The Agency of Natural Resources has conducted water quality assessment and improvement efforts at a watershed level since the 1970s. The state is divided into 17 planning basins for this purpose, with each basin including one or more major river watersheds. The Agency is responsible for preparing river basin water quality management plans for each of the 17 major basins and updating them every five years. In 2010, the Agency developed a new state wide Surface Water Management Strategy and will be using the process laid out therein to streamline forthcoming basin plans into tactical basin plans. The statewide management strategy was not in place until the end of the planning process for Basin 17 so this plan adopts a different appearance than prior basin plans for other

areas, and should be considered a hybrid between the old basin plan format and the new tactical format.

Plan Development as a Collaborative Process

Planning through a collaborative process with the communities in the basin, local, state, and federal governments, private organizations and individuals is an effective method for addressing present water quality problems in Vermont. This is because the state's water quality problems are predominantly the result of runoff from many dispersed activities on the land, such as cropping, lawn care and landscaping, and urban stormwater management, which are all considered nonpoint source pollution. Reducing the load of pollutants from these activities requires the participation of many different sectors of the community, each composed of numerous parties.

As many as 65 volunteer-based groups in the state have already begun this collaborative planning process as they are working with members of their community and resource agencies to improve water quality within their own watersheds. The Agency's basin planning process helps advance existing efforts within the community as well as its own efforts by documenting community-voiced problems and solutions, facilitating the exchange of information among resource agencies, groups, and individual citizens, and finally, directing existing resources towards the priorities of active groups and landowners within the communities. Opening the basin planning process to the entire community also serves to increase public awareness of opportunities to promote and preserve water quality in the basin.

Waters from Basin 17 flow north into Quebec so this planning effort has been done in close coordination with Quebec partners. A majority of Lake Memphremagog is in Quebec and to address international issues associated with this waterbody, the Quebec Vermont Steering Committee on Lake Memphremagog was created. This group is appointed by the Governor of Vermont and Premier of Quebec with the aim of coordinating efforts to protect and restore the water quality of the lake. The group has been working to coordinate monitoring in the basin and updating recommendations in a 1993 report "On Managing Lake Memphremagog and its Environment." The recommendations in this 1993 report are relatively general in nature and support the more specific actions that are identified in this water quality management plan.

A Quebec-based Saint Francis River watershed group called COGESAF, has recently completed a watershed plan for this large basin including the Lake Memphremagog and Tomifoia River watersheds and there is ongoing coordination between these efforts and the Basin 17 watershed planning effort.

Watershed Council and Watershed Plan Development

In the spring of 2007, the Agency sent out an open invitation to the communities within the Vermont and nearby Quebec portions of the Saint Francis River watershed to participate in the development of a water quality management plan. The community members that came together as a watershed council represented a diverse mix of stakeholders from within the watershed. They included farmers, foresters, business owners, municipal officials, anglers, local watershed and lake shore organizations, environmental groups, teachers, and regional planners. The

Department of Environmental Conservation (VDEC) watershed coordinator and the watershed council went through the following steps:

- Issue identification
- Issue prioritization
- Strategy and solution development; and
- Identification of resources and funding

The VDEC watershed coordinator worked with conservation commissions and conservation districts in the watershed and many lake and watershed groups. The Memphremagog Watershed Association has been closely tied in with the planning efforts as this group was founded through the initial planning efforts in this basin and continues to play an active role in developing the plan and completing projects that have been identified throughout the basin planning effort.

Council membership and meeting attendance was continually open to the public. Technical advisors provided the council and watershed coordinator with information necessary to develop strategies to be included within the watershed plan. The watershed council was integral in the development of this document. Each of the council members took on a variety of roles including:

- Encouraging constituents' participation and conducting outreach and education to inform constituents about known watershed issues;
- Developing and conducting watershed forums to identify water resources issues (assets and problems), related community needs, and potential solutions;
- Identifying immediate or ongoing water quality improvement projects to be undertaken during the planning process;
- Guiding the plan through review, revision, and approval process.

Progress Reporting

The key component to the plan is the implementation table that identifies specific actions, lead and key players, potential funding sources, and a target date and status of the action. This table is meant to be a working document that will evolve over the 5 year span of this planning document. As actions are completed, updates will be added to the table with the status of the action as an ongoing report card of work completed in the basin.

On an annual basis, the Watershed Council and partners will meet to address the accomplishments made toward achieving the basin plan goals and the goals of the Statewide Strategy. This will include an analysis of the number of strategies successfully completed from the basin plan on a yearly basis. In addition, every year strategies scheduled to be completed will be reviewed by the watershed councils, VDEC, and key players to ensure efforts are moving forward and to identify and address any obstacles which may prevent implementation. Further, longer range strategies will be reviewed to make sure progress is being made and to identify intermediate actions that may be necessary. In addition, as the process continues and new information is made available actions may be added, modified or targeted more specifically to areas of the basin where they will have greater impact. This review process will keep community partners engaged and allow for accountability in achieving the goals laid out in this basin plan.

Chapter 2 – Introduction to Basin 17
Water Quality Conditions and Priority Concerns

Basin description

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

The Lake Memphremagog drainage basin encompasses a total of 687 square miles of which 489 square miles (71%) are in Vermont and 198 square miles (29%) are in the Province of Quebec in Canada. Although much more of the watershed is in the United States, about three-quarters of the lake's area is in Canada.

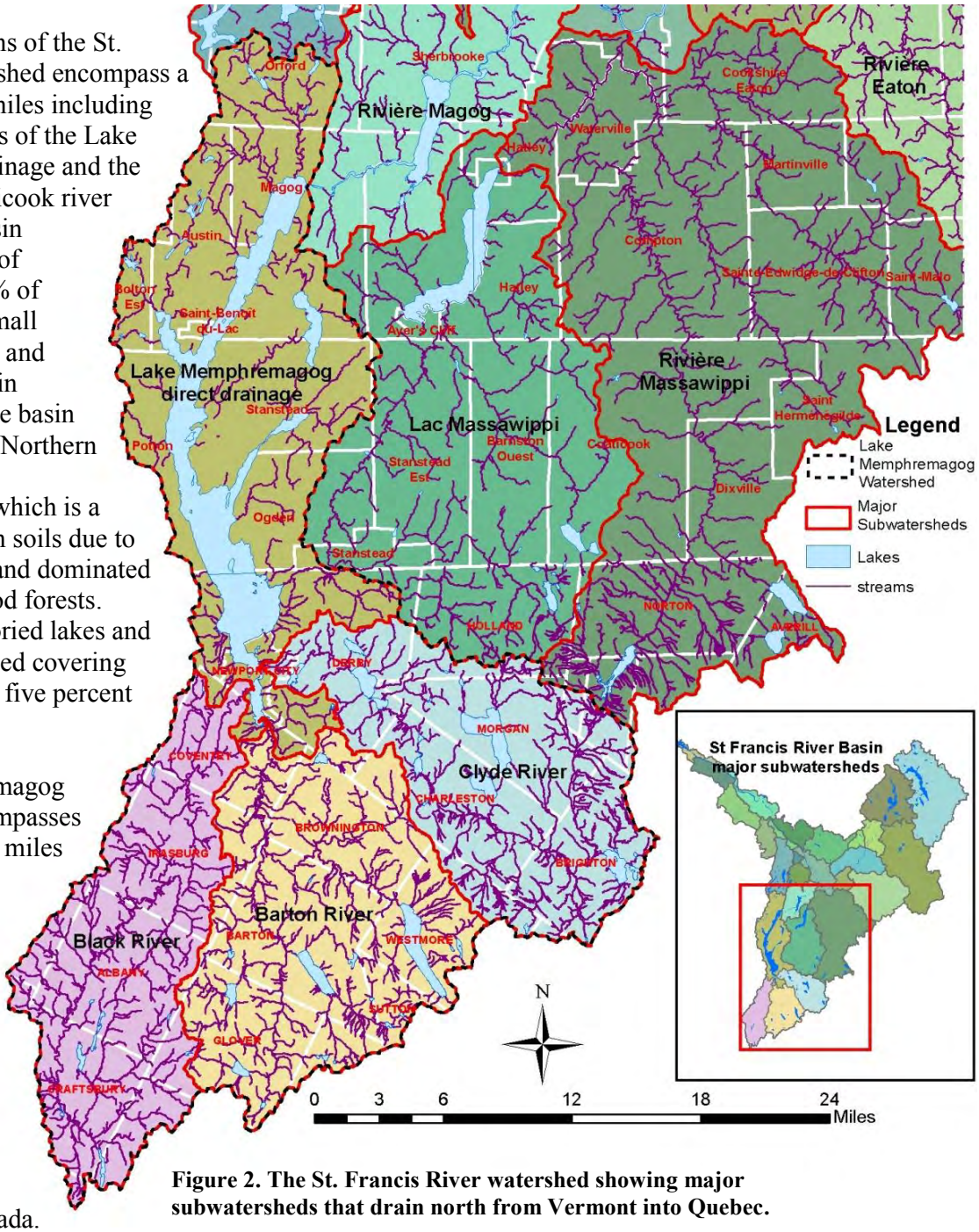


Figure 2. The St. Francis River watershed showing major subwatersheds that drain north from Vermont into Quebec.

There are three main rivers in the U.S. portion of the Lake Memphremagog basin - the Black, Barton and Clyde Rivers, which flow northerly into the southern end of Lake Memphremagog. A smaller river, the Johns River begins in the town of Derby, flows northwesterly into Canada and then back into the United States into Lake Memphremagog.

Black River Watershed
The Black River, 26 miles in length, originates east of Great Hosmer Pond with headwater tributaries flowing west off Ames Hill in Albany then turning north to flow into South Bay. It drains 134 square miles of land. This river has the lowest gradient of the three main rivers in the basin with an average slope of about eight feet per mile. The Black River watershed contains over 600 acres of lakes and ponds, the three largest being Lake Elligo, Little Hosmer Pond and Great Hosmer Pond.

Barton River Watershed
The Barton River watershed, which includes the Willoughby River subwatershed, flows north into the southernmost end of Lake Memphremagog's South Bay. The Barton River is 22 miles long and its watershed drains 174 square miles. The principal tributary of the Barton River, the Willoughby River, originates at Lake Willoughby in the town of Westmore. The Barton River drops 600 feet from Runaway Pond to Orleans for an average of about 40 feet per mile. From Orleans to Lake Memphremagog, the slope of the river is less than 2 feet per mile and flows through extensive wetlands as part of the Willoughby Falls and South Bay Wildlife Management Areas. There are approximately 3,410 acres of lakes and ponds within the basin. The three largest are Lake Willoughby, Crystal Lake and Lake Parker.

Clyde River Watershed
The Clyde River, 30 miles long, rises in Island Pond in the town of Brighton and drains 142 square miles. The watershed is characterized by many large lakes including Seymour Lake, Echo Lake, Lake Salem and Island Pond, along with extensive swamps and marshes. Several dams and bypasses are along the river. The Clyde River drops only 32 feet in its first 16 miles, but then plunges 160 feet in the two miles below Pensioner Pond and another 170 feet in less than one mile below Clyde Pond. It flows into Lake Memphremagog in Newport City.

Johns River and Memphremagog direct Watershed
There are a number of smaller streams that flow directly into Lake Memphremagog covering an area of just under 30 square miles. Most of this area is drained by the Johns River which originates in Derby west of Nelson Hill. It flows northwesterly from its headwaters to the Canadian border re-entering the United States before flowing through a large forested, scrub/shrub, and emergent wetland complex and entering Derby Bay. There are also a number of smaller streams on the eastern and western sides of Lake Memphremagog that drain areas of Newport and Newport town, Coventry and Derby, in addition to Halls Creek that flows from Quebec into the town of Derby and entering Lake Memphremagog at Eagle Cove.

Tomifobia River Watershed
Almost all of the Tomifobia River is in Canada although two significant tributaries, Holland Brook and Stearns Brook and their watersheds, are largely in the United States. Holland Brook originates at Holland Pond and flows northwesterly about three miles to the border. Its sixteen square mile watershed in Vermont includes Holland, Turtle, Round, and Beaver Ponds which are all part of the Bill Sladyk WMA. Stearns Brook originates between Mt. John and Mead Hill and flows northwesterly to Tice and then northerly to the Canadian border all in the town of Holland. The Vermont portions of the Tomifobia River watershed cover 34 square miles.

Coaticook River Watershed
The Coaticook River originates at the outlet of Norton Pond and flows northeasterly for over six miles passing just west of Norton and into Canada. Tributaries in the U.S. include Station Brook,Sutton Brook, Davis Brook, Gaudette Brook, Moser Meadow Brook, Number 5 and Number 6

Brooks, and Averill Stream which drains Great and Little Averill ponds. The Vermont portions of the Coaticook Watershed cover 66 square miles.

Basin assessment and priority water quality concerns

The area covered by the Saint Francis River watershed in Vermont is well known for its clear waters, deep lakes and exceptional fisheries. Biological monitoring on the Black and Barton and Clyde Rivers has shown good to very good macroinvertebrate communities on the main stems of these larger rivers. Biological sampling of rivers in the basin has identified sites with notably

Table 1. Biological sampling sites in Basin 17. Bold Blue = Notable high quality water / *Orange Bold italics = potential issues* / Grey highlight = impaired / Sites with (sw) are slow winders.

Stream station	Macroinvert. sample date	Macroinver. Assessment results	Fish sample date	IBI type	Fish Community assessment	comments
Barton River Watershed						
Alder Brook 1.0	9/14/2009	Vg-Good				
Annis Brook .7	9/14/2010	Ex-Vgood				
Annis Brook .7	10/12/2009	Good-Fair				
Annis Brook 1.9	10/9/2006	Good-Fair				
Barton River 9.7	9/17/2009	Good				
Barton River 9.8	9/17/2009	Vg-Good				
Barton River 9.8	9/17/2004	Vg-Good				
Barton River 14.5	**9/17/2009**	**Verygood**				Potential sedimentation stress and nutrient enrichment
Brownington Branch 1.3	**9/16/2009**	**Excellent**	**9/16/2009**	**Both**	**Very Good**	
Duck Pond Brook Trib .2	**9/12/2009**	**Ex-Vgood**				
Roaring Brook .6	**10/21/2009**	**Ex-Vgood**				Sampled to follow up on reported nutrient discharge.
Roaring Brook 2.4	***10/21/2009***	***Fair***				
Roaring Brook 3.5	***10/21/2009***	***Good-Fair***				
Stevens Brook 3.0	**9/17/2009**	**Excellent**				Very small - No fish community
Willoughby Brook Trib .1	9/12/2009	Vg-Good				
Willoughby River 4.9	**9/23/2004**	**Ex-Vgood**				
Black River Watershed						
Black River 12.1	**9/14/2009**	**Very good**				Indicators of slight nutrient enrichment and elevated turbidity in 2004 and 2009.
Black River 12.1	**9/21/2004**	**Very good**				
Black River 12.1	**9/8/1999**	**Excellent**				
Black River 12.1	**10/4/1991**	**Ex-Vgood**				
Black River 30.5 (sw)	10/13/2004	Vg-Good				
Black River 34.8	9/8/1999	Good				
Brighton Brook .9 (sw)	9/21/2004	Good	9/21/2004	MW	Pass	
Lords Creek 2.4	9/21/2004	Very good				
Lords Creek 2.4	9/8/1998	Good				
Stony Brook 1.8	*9/17/2010*	*Good*				2009 assessment suggested

Stream station	Macroinvert. sample date	Macroinver. Assessment results	Fish sample date	IBI type	Fish Community assessment	comments
Stony Brook 1.8	***9/14/2009***	***Poor***	**9/14/2009**	**Both**	**Very Good**	nutrient enrichment but 2010 assessment after moderate flow was good. Elevated nitrogen also measured.
Stony Brook 1.8	***8/1/1990***	***Good***				
Stony Brook 2.8	**9/17/2010**	**Ex-Vgood**				
Stony Brook 3.6	**9/17/2010**	**Ex-Vgood**				
Clyde River Watershed						
Clyde River 11.3	10/3/1991	Good				
Pherrins River 1.9	**9/23/2003**	**Excellent**	**8/20/2003**	**MW**	**Very Good**	
Memphremagog Direct Watershed						
Crystal Brook .3	9/16/2010	Ex-Vgood	9/16/2010	CW	Pass	A manure pit that was leaking into Crystal Brook was replaced in 2006 and the brook has shown signs of recovery and may be soon removed from the list of impaired waters.
Crystal Brook .3	9/16/2009	Good-Fair	9/16/2009	None	Pass	
Crystal Brook .3	9/7/2006	Poor				
Crystal Brook .3	9/16/2004	Poor				
Crystal Brook .3	9/14/1999	Poor				
Crystal Brook .3	9/4/1997	Fair	9/4/1997	CW	Fail	
Crystal Brook .4	9/4/1997	Good				
Crystal Brook 1.4	9/16/2004	Ex-Vgood				
Crystal Brook 1.4	9/4/1997	Good				
Darling Hill Brook .1 (sw)	**9/16/2009**	**Ex-Vgood**	***9/16/2009***	***CW***	***Fair***	94% nonnative fish species. Has elevated Nitrogen levels
Johns River 1.4 (sw)			***9/14/2006***	***MW***	***Poor***	Slow winder no fish IBI. Elevated nitrogen levels measured from 2005-2010.
Johns River 1.4 (sw)			***8/20/2003***	***MW***	***Poor***	
Johns River 1.4 (sw)			***9/4/1997***	***MW***	***Fair***	
Johns River 1.6 (sw)	***9/16/2009***	***Good-fair***	***9/16/2009***	***CW***	***Fair***	
Johns River 3.1	9/16/2009	Very good	***9/16/2009***	***Both***	***Poor***	100% nonnative fish species
Johns River 3.1			***9/4/1997***	***CW***	***Fair***	94% nonnative fish species
Johns River 4.8	**9/16/2009**	**Excellent**				
Sunset Acres Brook .5	**9/16/2009**	**Excellent**	9/16/2009	CW	Pass	Only one native species no IBI Has elevated Nitrogen levels
Tomifobia Watershed						
Holland Pond Trib .5	**9/16/2009**	**Ex-Vgood**				
Stearns Brook 1.7	9/14/1999	Good				Assessment suggests nutrient enrichment and sedimentation caused by nearby farming
Stearns Brook 1.7	9/8/1998	Good	9/8/1998	None	Good	
Stearns Brook 2.3	9/16/2004	Vg-Good				
Stearns Brook Trib .1	9/16/2009	Fair-Poor	9/16/2009	CW	Good	Stearns Brook is listed as impaired due to sediment and nutrient enrichment associated with agricultural runoff.
Stearns Brook Trib .1			9/16/2004	CW	Poor	
Stearns Brook Trib .1	9/8/1998	Fair	9/8/1998	CW	Poor	
Coaticook Watershed						
Mosher Meadow Brook .2	**9/23/2003**	**Excellent**	8/21/2003	MW	Good	
Number Six Brook .5	9/17/2009	Vg-Good	9/17/2009	CW	Pass	
Sutton Brook .4	**9/17/2004**	**Excellent**	9/16/2004	Both	Good	

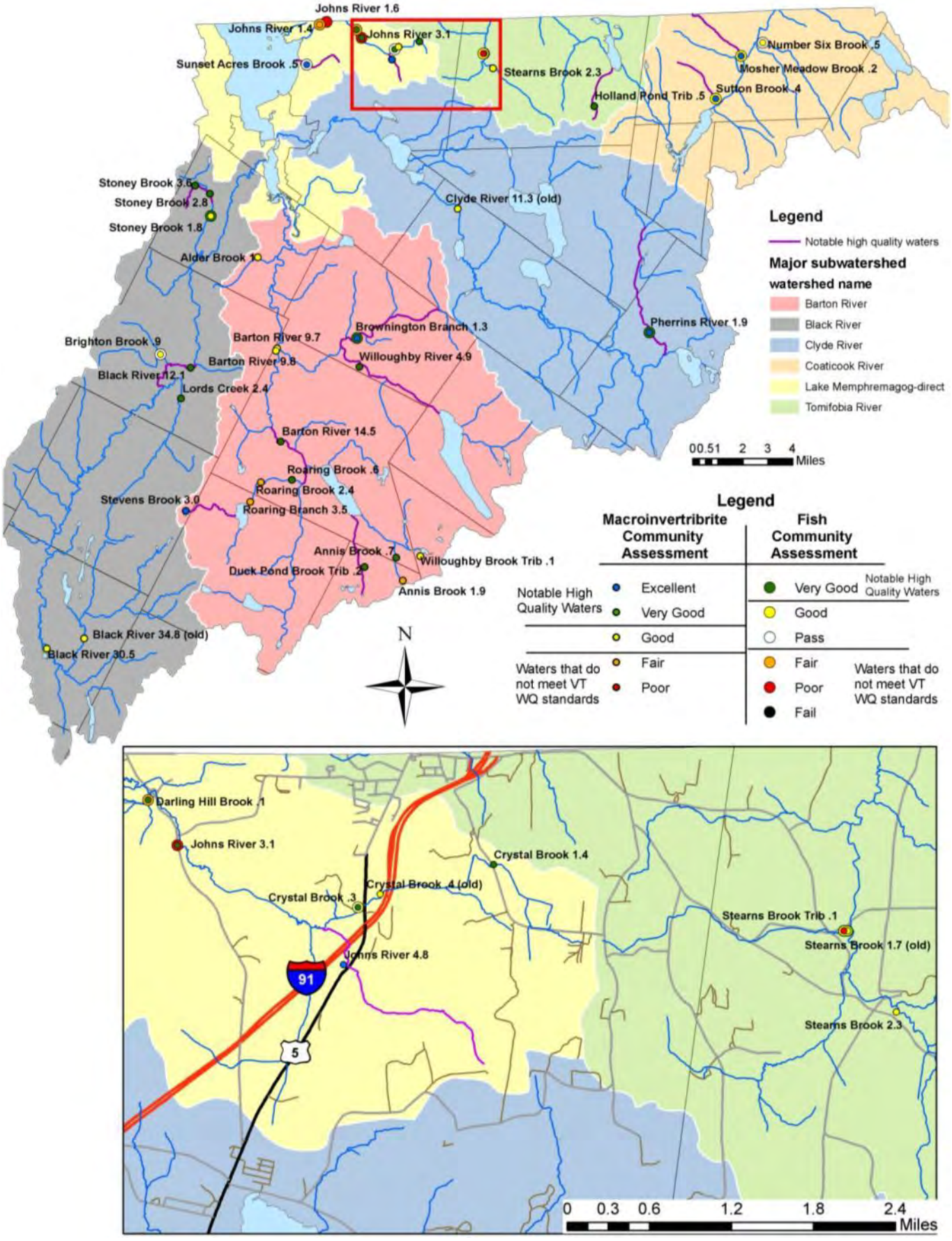


Figure 3. Biological assessment sites in Basin 17 showing most recent community assessment and notably high quality waters with an inset around the Johns River and Stearns Brook watersheds.

high water quality on the Pherrins River, Willoughby River, Brownington Branch, Johns River (at mile 4.8), Duck Pond Tributary, Holland Pond Tributary, Mosher Meadow Brook, Stony Brook above mile 2.8, Stevens Brook and Sutton Brook. While fish IBI scores for the Johns River are low due to the low abundance of native fish species, VFWD sees the Johns River as critical and productive spawning habitat for non-native steelhead and brown trout, two species highly sought after by anglers in the basin.

Among the 90 inventoried lakes in the basin are many of Vermont's largest, clearest and deepest lakes along with the second largest lake in the state, Lake Memphremagog, which is shared with the province of Quebec. There are also a number of shallower lakes in the basin that support warm water fisheries and some of the state's most extensive wetlands complexes. Three of the ponds - Beaver, Halfway and Turtle - have been given the highest rating afforded by the VDEC Lake Protection Classification System for their wilderness character, of which there are only 20 in the state of Vermont. In addition to this, the lakes in the basin support a diversity of fisheries including arguably some Vermont's premier lake trout and landlocked salmon fisheries but also a number of warmwater fisheries on shallower lakes in the basin.

On the other end of the spectrum there are a number of waters in the basin that are either considered impaired (not meeting Vermont Water Quality Standards) or are threatened from a number of stressors. Biological sampling in Basin 17 has identified impaired stream reaches of a tributary to Stearns Brook and Crystal Brook with fair to poor macroinvertebrate communities and poor fish communities because of agricultural runoff. The replacement of a manure pit at a farm adjacent to Crystal Brook has resulted in reduced nutrient levels and an improved biological community and this waterbody may now meet water quality standards (VDEC 2011). In addition to this, the Coaticook River and Averill Brook are altered due to flow modifications associated with dams at Norton Pond and the Averill ponds which are managed by Hydro Coaticook under public service board regulations. Shadow Lake and a small unnamed tributary to the Clyde may also be impacted by water level fluctuations caused by a seasonal draw down and possible lack of minimum flow below the water supply withdrawal, respectively. Finally, there are also a number of streams in the basin that have been negatively impacted by channel management or encroachment including a half mile stretch of the Seaver Branch.

Out of a total of 17,660 acres of inventoried lakes and ponds in the basin, 5,966 acres of Lake Memphremagog are impaired due to elevated phosphorus levels. 764 acres in the basin (Lake Salem) are impaired due to elevated levels of mercury in Walleye tissue which have resulted in a no consumption advisory for this fish species for children and woman of childbearing age" see http://www.mercvt.org/fish/index.htm for more information on the current fish consumption advisories, An additional 60 acres are impaired due to acid deposition including Duck, Turtle, Line and Halfway ponds. On top of this, 55 acres are altered due to the presence of invasive exotic species and 1,878 acres are altered because of artificial water level fluctuations. Norton, Great and Little Averill ponds are altered due to water level fluctuations associated with dams on each of these waterbodies which are managed by Hydro Coaticook under Vermont Public Service Board regulations.

An additional 849 acres of lakes and ponds are stressed due to elevated phosphorus and nutrient levels, 1841 acres are stressed due to Eurasian watermilfoil, 935 acres are stressed due to acid deposition, and 943 acres are stressed due to sedimentation and siltation. Analysis of phosphorus trends of lakes in the basin monitored through the spring phosphorus and lay monitoring programs has identified a number of lakes including Lake Elligo, Shadow Lake, Lake

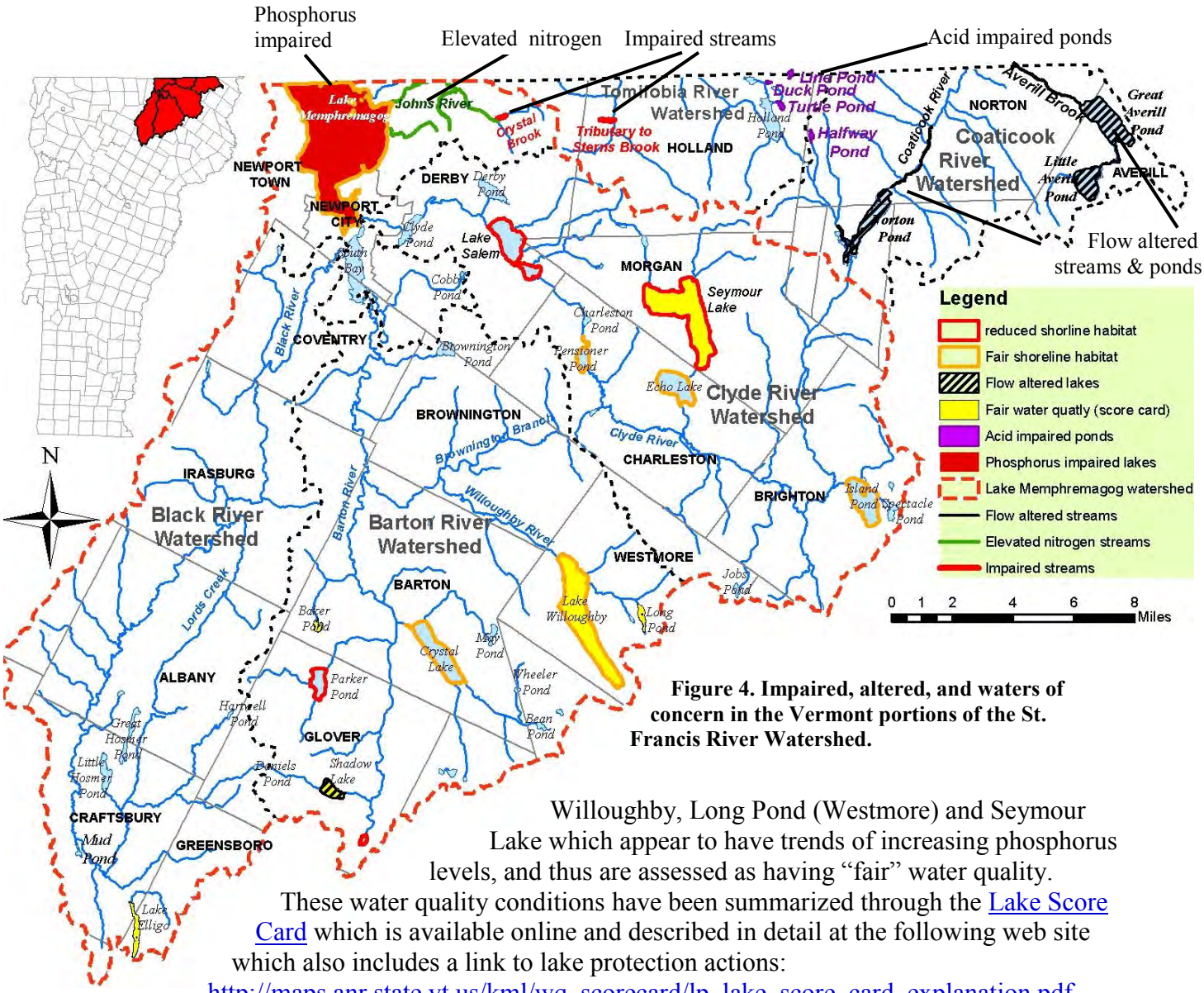


Figure 4. Impaired, altered, and waters of concern in the Vermont portions of the St. Francis River Watershed.

Willoughby, Long Pond (Westmore) and Seymour Lake which appear to have trends of increasing phosphorus levels, and thus are assessed as having "fair" water quality. These water quality conditions have been summarized through the Lake Score Card which is available online and described in detail at the following web site which also includes a link to lake protection actions: http://maps.anr.state.vt.us/kml/wq_scorecard/lp_lake_score_card_explanation.pdf

All lakes and ponds in the basin are stressed due to limits on the number of meals or size of meals consumed for one or more fish species due to elevated levels of mercury in fish tissues and many have had the quality of the aquatic habitat reduced through development of the shoreland. Figure 4 above also shows the lakes that have been identified as having poor conditions (over 50% lawn to shore) for shoreland habitat (Seymour Lake, Shadow Lake, Parker Pond and Salem Lake) and fair (25-50% lawn to shore) shoreland habitat (Lake Memphremagog, Island Pond, Crystal Lake, Lake Willoughby, Pensioner Pond, and Echo Lake) which has been evaluated based on a number of studies summarized as part of the Lake Score Card. A joint Quebec Vermont study of Lake Memphremagog called Operation Healthy Lake was completed in 2006 also showed a high degree of development on the shores of Lake Memphremagog, high levels of sedimentation and plant growth in the Narrows, Derby Bay, Holbrook Bay, Eagle Point, and South Bay.

Public concerns have been raised regarding potential water quality impacts from the Kingdom Community Wind development and NEWSVT landfill in Coventry. Both of these projects have gone through extensive permitting processes and involve continued monitoring to ensure Vermont Water Quality Standards are being met. The permitting and monitoring requirements for each of these projects is discussed in detail in Appendix J. A complete description of the basins waters and their conditions is presented in the Basin 17 assessment report available online at: http://www.anr.state.vt.us/dec/waterq/mapp/docs/mp_basin17.assessment_report.pdf.

During the planning process, the public was invited to identify water related concerns in the basin. These comments dealt with general concerns, such as blue green algae or the quality of fisheries, as well as the perceived causes of these problems such as streambank erosion, stormwater runoff, and agricultural runoff as well as specific concerns such as the location of a regularly occurring road wash out. The community concerns that were brought up fell under the four general categories of: nutrient enrichment, exotic invasive species, poor aquatic habitat, and contamination. The watershed council prioritized these concerns along with the perceived causes of each of the problems. This process was done after a series of presentations by Agency staff and other technical experts on water quality conditions in the basin to help the council base these decisions on all the information available. The results of this prioritization process were:

1. **Nutrient enrichment** and algae blooms on Lake Memphremagog and concerns about levels on other lakes in the basin caused by:
    a. Stormwater runoff (Link to developed land activity description)
    b. Road erosion and runoff (Link to transportation activity description)
    c. Agricultural runoff (Link to agricultural activity description)
    d. Forestland management (Link to forestland activity description)
    e. Streambank erosion
    f. Poor shoreland development (Link to encroachment activity description)

2. **Exotic Invasive Species** (Link to AIS spreading activity description)

3. Poor Aquatic Habitat caused by:
    a. Sedimentation (link to Sedimentation pollutant description)
    b. Streambank erosion
    c. Poor shoreland development
    d. Concerns about water level fluctuations in the Coaticook River watershed
    e. Barriers to aquatic species passage

4. **Metals** and **Organic** Contaminants caused by:
    a. Hazardous waste sites/ landfills
    b. Stormwater runoff
    c. Mercury deposition

In the outline above, links have been provided to the descriptions of the major pollutants of concern in this basin (nutrients, exotic invasive species, sedimentation, metals and organic contaminants), as well as the relevant sections on each major landuse activity and their influence on water quality in *Statewide Surface Water Management Strategy*. The complete *Statewide Surface Water Management Strategy* is online at http://www.anr.state.vt.us/dec/waterq/wqdhome.htm .

The newly developed *Statewide Surface Water Management Strategy* looks at water quality issues through a slightly different lens of water quality stressors to meet its goals: to protect, maintain, enhance and restore the biological, chemical, and physical integrity of all surface waters, to support the public use and enjoyment of water resources, and to protect the public health and safety. Generally, stressors emerge from an activity on the landscape; result in the release of a pollutant, flooding hazard or destruction of aquatic and riparian habitat and thus impact to one or more of the above goals as shown by example in Figure 5.

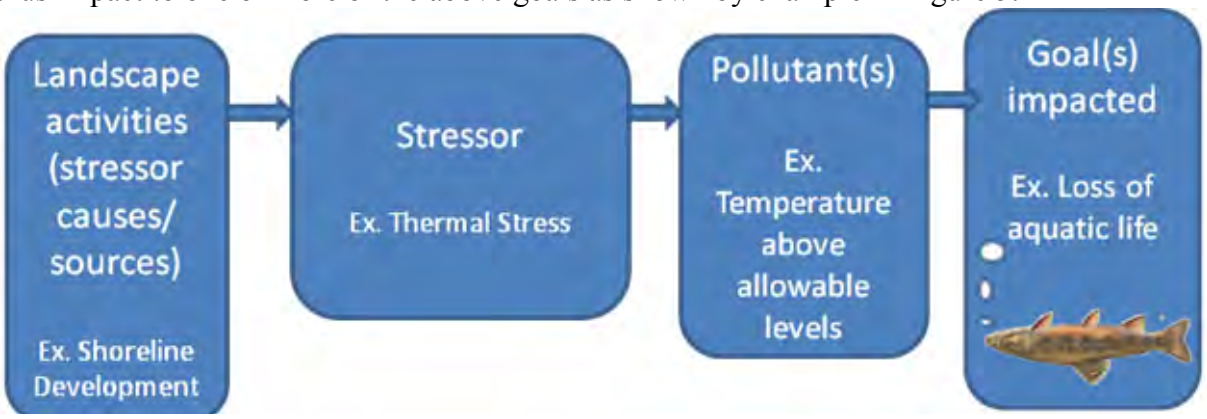


Figure 5. An example of the cascading effects of landscape level activities that result in stressors which produce pollutants.

The statewide strategy has identified the following 10 stressors shown in the table below which also shows the relationship of these stressors to the priority concerns in Basin 17:

Table 2. Relationship between statewide stressors and priority concerns in Basin 17.

Basin 17 Priority Concerns	Nutrient enrichment	Aquatic habitat	Invasive species	Metals/organic contaminants
Watershed covered by water quality concern / **Statewide Stressors**	Lake Memphremagog watershed, tributary to Stearns Brook and watersheds of nutrient sensitive lakes shown as "fair" in Figure 4.	The entire watershed with priorities on lakes in the basin and streams and rivers with notable high quality in Table 1.	Entire watershed	Mercury is an issue for the whole basin and for Lake Salem specifically. No specific areas have been identified in the basin for other toxics.
Acidity				
Channel Erosion	X	X		
Flow Alteration		X		
Encroachment	X	X		
Invasive Species			X	
Land Erosion	X			
Nutrient Loading	X			
Pathogens				
Toxics – mercury				X
Thermal Stress				

The list of stressors above allows for hyperlinks to chapters of the statewide strategy which discuss these stressors in detail and the general statewide approach to addressing them. The following sections describe the top priority concerns in the basin in further detail to set the stage

for the implementation actions in chapters three and four of this plan. The lowest priority concern identified in the initial outreach meetings was toxic contaminants, and this was not addressed in detail during this planning process. Much of the impact in this category is due to mercury levels in fish tissues, and this is a broad regional issue beyond the scope of this plan and for which a TMDL has already been completed. A number of hazardous waste sites are listed in the Basin 17 assessment report, but no impairments to surface waters have been linked to contamination from these sites so this issue was not addressed in detail in this water quality management plan; however VDEC is continuing to monitor many of these sites. There has been some migration of metals and organic contaminants into groundwater from the unlined Nadeau landfill in Coventry but recent sampling results from two wells located in the shallow groundwater in wetlands north of the unlined Nadeau and lined NEWSVT landfills along with surface water sampling in the Black River show no indications of landfill impacts. There is a proposal to move the waste in the unlined Nadeau landfill into a new lined cell at the NEWSVT landfill.

Acid deposition was not addressed directly in this plan in spite of the fact that this impairs four ponds and stresses many others in the basin, because the cause of this stressor is largely from regional air emissions which are beyond the scope of this plan to address. There is also a TMDL that covers acid impaired lakes and ponds. Links to the acidity and toxic substances chapters of the statewide strategy above provide an overview of actions at the state and regional level to address these issues. The following sections provide an overview of the three primary issues addressed in this plan which are nutrient enrichment, aquatic invasive species, and alterations to aquatic habitat.

Nutrient Enrichment

Phosphorus is a nutrient that is naturally limited in the environment. High levels of phosphorus in northern fresh water lakes cause aquatic plants and algae to grow in much greater densities than the aquatic ecosystem can normally support. In excessive amounts, algae can impair recreational uses, aesthetic enjoyment, the taste of drinking water, and the biological community. In some cases, algal blooms can produce toxins that harm animals and people. Phosphorus levels in lakes are closely correlated with chlorophyll-a and inversely correlated with water clarity as these are both related to algal density and so measurements of chlorophyll-a and water clarity are often used as another measure of the level of nutrient enrichment in lakes and ponds.

Figure 6. Blue Green Algae Bloom on Lake Memphremagog at Horseneck Island on 9-13-08. Photo taken by Stephen King.

Although the basin is best known for clear lakes that have low levels of phosphorus and nutrients, there is a diversity of lakes in the watershed including some that naturally have higher nutrient levels. Higher levels of phosphorus become a particular concern when caused by human changes to the landscape such as increases in land and channel erosion and non-erosion nutrient

loading in a lakes watershed. Lake Memphremagog is the only lake in the basin considered impaired due to elevated phosphorus levels, however, there are five other lakes (shown in Figure 4) that have had trends of increasing phosphorus levels based on lay monitoring and spring phosphorus data or have been identified as stressed due to nutrient levels through other assessments. These lakes include: Lake Elligo, Shadow Lake, Lake Willoughby, Long Pond (Westmore) and Seymour Lake. Note that none of these lakes are experiencing water quality problems, rather the increasing phosphorus trend should be considered an early warning sign. Even though Lake Massawippi is not in the Vermont portion of the basin, the fact that this waterbody is considered by Quebec to have elevated levels of phosphorus is relevant to this basin plan because the waters in the Tomifobia River watershed flow into this lake and may be contributing to this issue.

In Lake Memphremagog levels of phosphorus are variable, reflecting both the natural background nutrient levels in the segments, and potential watershed-based loadings. In the United States portion of the lake, water quality conditions meet Vermont Water Quality Standards in the South Bay, but not in the open water segments of the lake, where total phosphorus concentrations are elevated by approximately 2 parts-per-billion (ppb) above standards (Quebec Vermont Steering Committee on Lake Memphremagog, 2008).

Cyanobacteria (blue-green algae) have been observed in numerous locations in Lake Memphremagog with increasing frequency, particularly in 2006 and again in 2008 and 2011 when there were also a blue-green algae blooms in nearby Lake Salem. In 2010 a bloom was confirmed in Island Pond. However, quantities of toxic algae (measured as "cell densities") are low relative to heavily impacted locations such as the Missisquoi Bay of Lake Champlain, and concentrations of algal toxins are very low. As such, while Lake Memphremagog may not at this time have a serious cyanobacteria problem, it is a phenomenon that must be monitored and prevented to the extent possible. The degree to which newly observed cyanobacterial blooms in sections of the lake are related to phosphorus sources in the Johns or Black Rivers, or from sources in the Fitch Bay watershed, is unclear (Quebec Vermont Steering Committee on Lake Memphremagog, 2008).

The cause of the impairment of Crystal Brook and tributary to Stearns Brook is likely due to elevated nutrient levels. In Crystal Brook, phosphorus levels were measured to be as high as 600 ppb during low flow conditions, but sampling in 2009 has shown a drastic reduction in phosphorus levels. This reduction in phosphorus levels is likely related to the improvement in the biological community that was seen in the fall of 2009 and 2010. Similar information on nutrient levels is not available for the tributary to Stearns Brook but, because the source of this impairment is agricultural runoff, it is likely that nutrient levels are a significant factor in the impairment of this stream. Water quality sampling done from 2008 through 2010 has also shown high levels of phosphorus in minor tributaries to the west side of Lake Memphremagog.

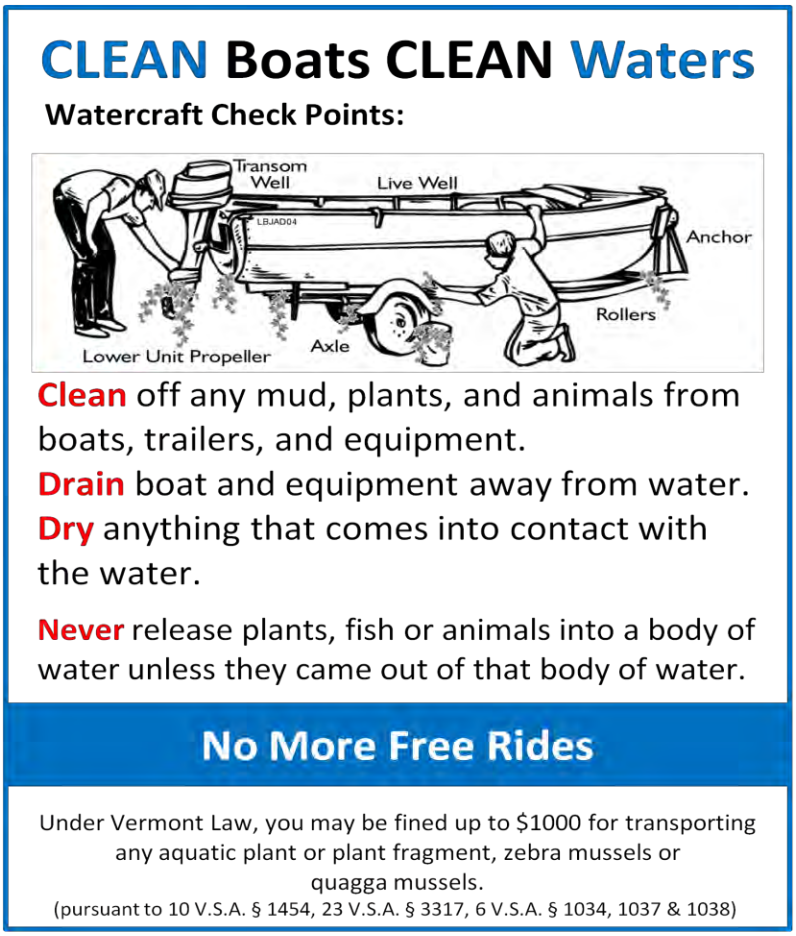
Studies by the Memphremagog Watershed Association and Beck Pond LLC have also shown high levels of nitrogen in the Johns River, an unnamed tributary that drains into the Johns River adjacent to the Darling Hill Road, as well as an unnamed tributary to Lake Memphremagog that flows into the lake south of the Sunset Acres development (see Figure 4) (Gerhardt F. 2010, Gerhardt F. 2009 and Gerhardt F and Dyer M. 2007.) While these nitrogen levels are quite high for Vermont, bioassessments done in the fall of 2009 showed healthy macroinvertebrate

communities in all three streams so these nitrogen levels are not causing any impairment of these waters nor do these levels appear to be having a significant negative impact on the aquatic communities of these streams. These nitrogen levels could play a role in blue green algae blooms in Derby Bay and Lake Memphremagog although the balance of nitrogen and phosphorus in the lake make this scenario unlikely. Moreover, water sampling shows that the nitrogen levels dropped between 2005 and 2009 (likely due to reductions in nitrogen fertilizer applications on farm fields in these watersheds) and appear to have stabilized since. The complete reports on these results can be found at a link at the following web site:
http://www.anr.state.vt.us/dec/waterq/planning/htm/pl_memphremagog.htm
Actions to address nutrient enrichment are listed in the implementation table on page 31.

Non-native Aquatic Invasive Species

Many non-native aquatic invasive species can seriously hinder the recreational use of a waterbody, out-compete beneficial native plants and animals, and otherwise alter the natural environment. Eurasian watermilfoil (*Myriophyllum spicatum* L.) is the major invasive species that currently affects Basin 17 surface waters, and is known to occur in Lake Memphremagog, Derby Lake, Clyde Pond, Brownington Pond, Crystal Lake, Lake Willoughby, Great Hosmer Pond and Shadow Lake. Eurasian watermilfoil is known for its rapid growth and ability to spread, which can lead to significant problems within a lake. Commonly found in shallow bays and along shorelines, Eurasian milfoil forms dense beds that can impair the recreational use of a lake and negatively alter a lake's natural environment.

The invasive curly-leaf pondweed is also found in Lake Memphremagog, Daniels Pond and Island Pond as shown in Figure 7. There are also a number of wetland and riverbank non-native invasive species in the basin including purple loosestrife (*Lythrum salicaria* L), phragmites (*Phragmites australis)*, and Japanese knotweed (*Fallopia japonica*) which can reduce the quality of riparian and aquatic habitats and spread along river corridors. The distribution of these species is not well understood, but a map of the location of some of the more common riverbank invasives has been developed where Phase 2 Stream Geomorphic Assessments have been completed, although the prevalence of these species in the watershed is much more widespread.



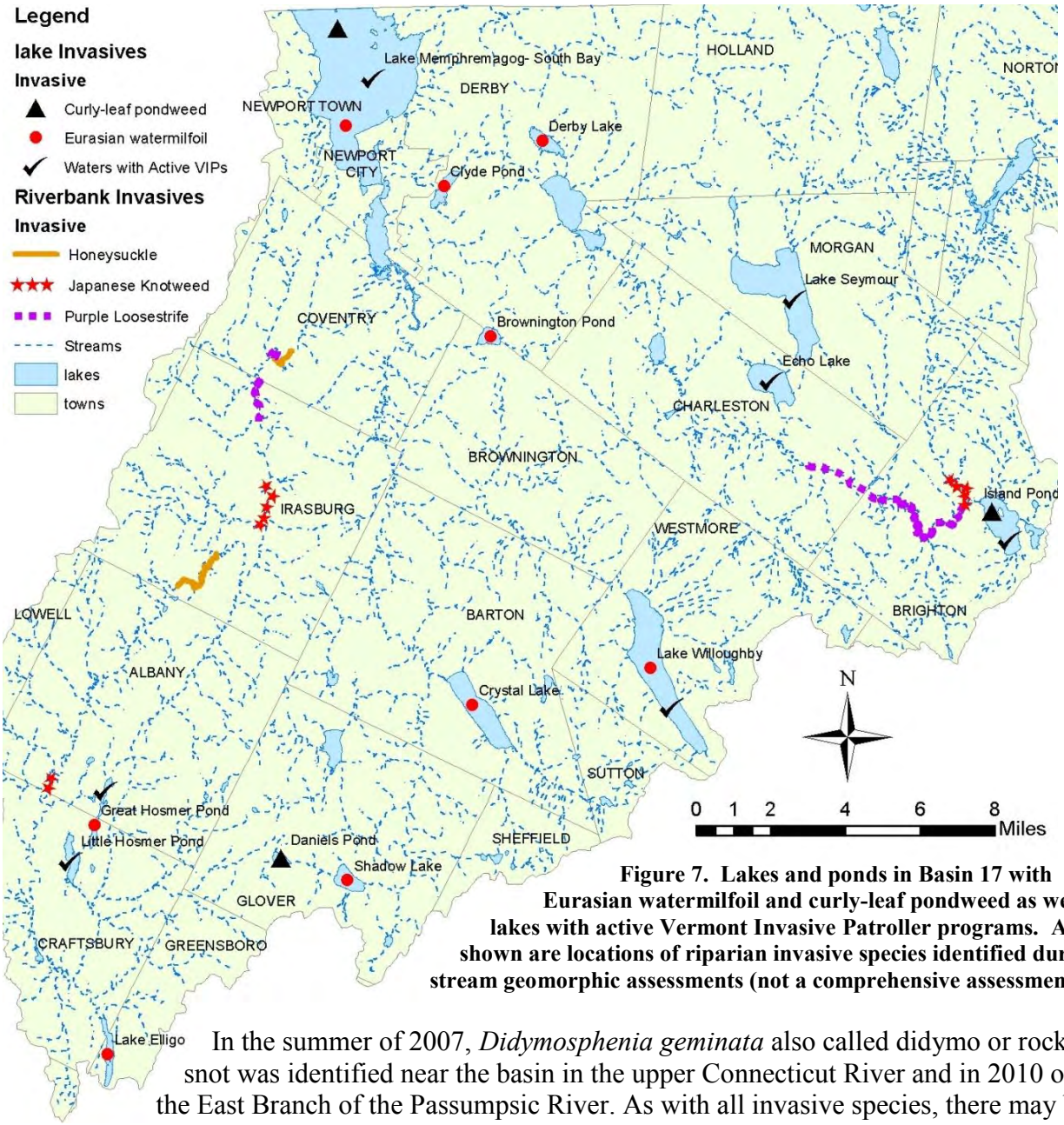


Figure 7. Lakes and ponds in Basin 17 with Eurasian watermilfoil and curly-leaf pondweed as well as lakes with active Vermont Invasive Patroller programs. Also shown are locations of riparian invasive species identified during stream geomorphic assessments (not a comprehensive assessment).

In the summer of 2007, *Didymosphenia geminata* also called didymo or rock snot was identified near the basin in the upper Connecticut River and in 2010 on the East Branch of the Passumpsic River. As with all invasive species, there may be other populations of didymo that we are not yet aware of. All waters should be treated as if they harbor an invasive species and spread prevention measures should be practiced.

Nonnative fish species are also a threat to waters in this basin. Brown trout, rainbow trout, common carp, largemouth bass, and smallmouth bass are not native to the basin but have been introduced and spread throughout the basin over the last century. Northern pike, native to the lower Lake Champlain drainage, were introduced into Norton Pond in the 1970s, and in Lake Memphremagog sometime in the late 1980s. Nonnative white perch have been living in Parker Lake for decades and in 2009, a population of greater redhorse suckers was documented in Lake Memphremagog and the lower Black River for the first time. Additionally, species native to the basin, like yellow perch and chain pickerel, have also been transferred by humans to waters where they did not previously exist.

Introduced fish species can reduce or eliminate native fish species populations through competition or predation. While all waters in the basin could potentially be affected by the introduction of nonnative fish species, there are some waters in the basin that are particularly vulnerable. The only known population of round whitefish remaining in Vermont is in Willoughby Lake. Studies in the Adirondacks found that smallmouth bass introductions contributed to the elimination of round whitefish from many waters there (Steinhart et al. 2007), and it is likely that the introduction of smallmouth bass to Seymour Lake contributed to the extirpation of round whitefish in that water. The introduction of bass or another warmwater predator to Lake Willoughby could threaten the long term survival of round whitefish in the basin and in the state. Pond-dwelling brook trout populations are also highly susceptible to extirpation by predation and competition with introduced warmwater species like bass and perch (Bonney 2006). For example, a self-sustaining population of brook trout was eliminated from Round Pond in Holland when chain pickerel were introduced. Job's Pond is the best known brook trout pond in the basin and produces some of the biggest brook trout in the state. The introduction of warmwater fish to Job's Pond or any other brook trout pond would be devastating to these unique and popular fisheries.

There are a number of other problematic non-native aquatic invasive species including zebra mussels, water chestnut, European frog-bit, white perch, alewife, and hydrilla that have been established in waters in the state or region and pose a threat to waters in the basin. Actions to manage non-native aquatic invasive species are listed in the implementation table on page 36.

Alterations to Physical Habitat

Healthy aquatic communities require more than just clean water: the in-lake or in-stream habitat, the near shore vegetation, the flows and water level fluctuations, and the connectivity of waters all play a role in the ability of waters to support aquatic communities and fisheries. In Basin 17, there are four types of alterations to physical habitat are a particular concern. These include: alterations to lakeshores in the basin; alterations to streambanks, channel conditions and stream flows; alterations to wetlands and wetland buffers; and finally barriers to aquatic species passage that limit access of fish and other species to portions of aquatic habitat in the basin.

As lakeshores are converted from forests to lawn, impervious surface, and sand, enhanced runoff results in increased shallow water embeddedness, (filling in of spaces by fine sediment)increased temperature (due to loss of shading) and, in most cases, more abundant aquatic plant growth in the shallows. Physical integrity of littoral habitat is further simplified by the direct removal of woody structure (fallen trees and branches) from the shallows, and interruption in the resupply of this critical habitat component. Ultimately, the cumulative effects of this type of lakeshore development impact considerably on physical integrity and habitat, affecting many types of aquatic and terrestrial wildlife. Impacts on lakes from shoreland development in this basin are widespread: Seymour Lake, Shadow Lake, Parker Pond and Salem Lake have been identified as having poor shoreland habitat and Lake Memphremagog, Daniels Pond, Crystal Lake, Lake Willoughby, Pensioner Pond, and Echo Lake have been identified as having fair shoreland habitat. Few towns in the basin (with exception of the Unified Towns and Gores, the Town of Norton, the Town of Greensboro, and the Town of Westmore) have any zoning that prevents the continued loss of lakeshore vegetation, and many towns allow the building of houses and

impervious surfaces right up to the shoreline of lakes and many streams in the basin. However, there have been ongoing educational efforts in the basin as a whole and in a number of targeted lake subwatersheds to increase public understanding of the need to protect and restore vegetated buffers around the lakes and the Agency working with partners like the Vermont League of Cities and Towns can provide technical assistance to towns interested in strengthening zoning

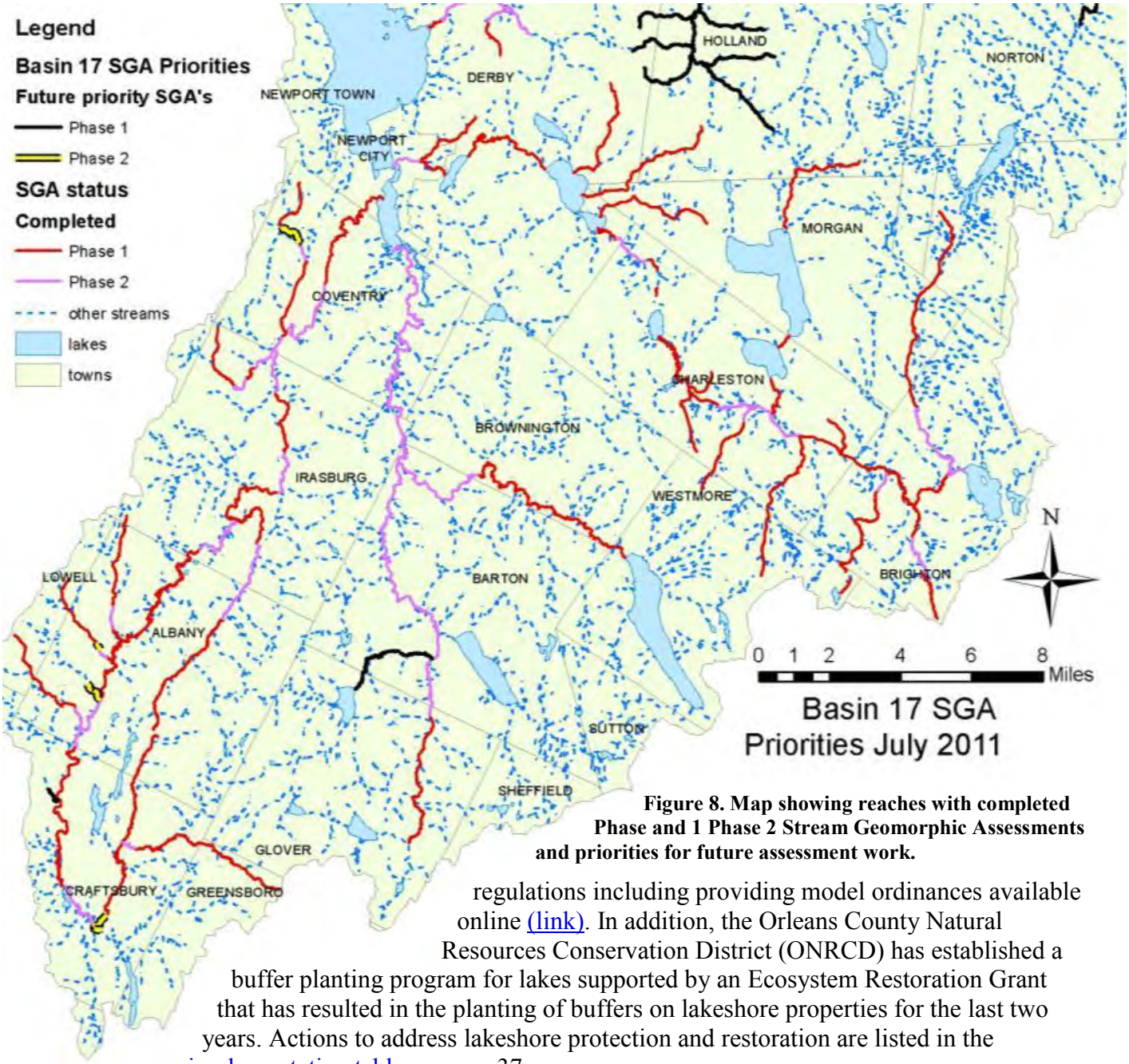


Figure 8. Map showing reaches with completed Phase and 1 Phase 2 Stream Geomorphic Assessments and priorities for future assessment work.

regulations including providing model ordinances available online (link). In addition, the Orleans County Natural Resources Conservation District (ONRCD) has established a buffer planting program for lakes supported by an Ecosystem Restoration Grant that has resulted in the planting of buffers on lakeshore properties for the last two years. Actions to address lakeshore protection and restoration are listed in the implementation table on page 37.

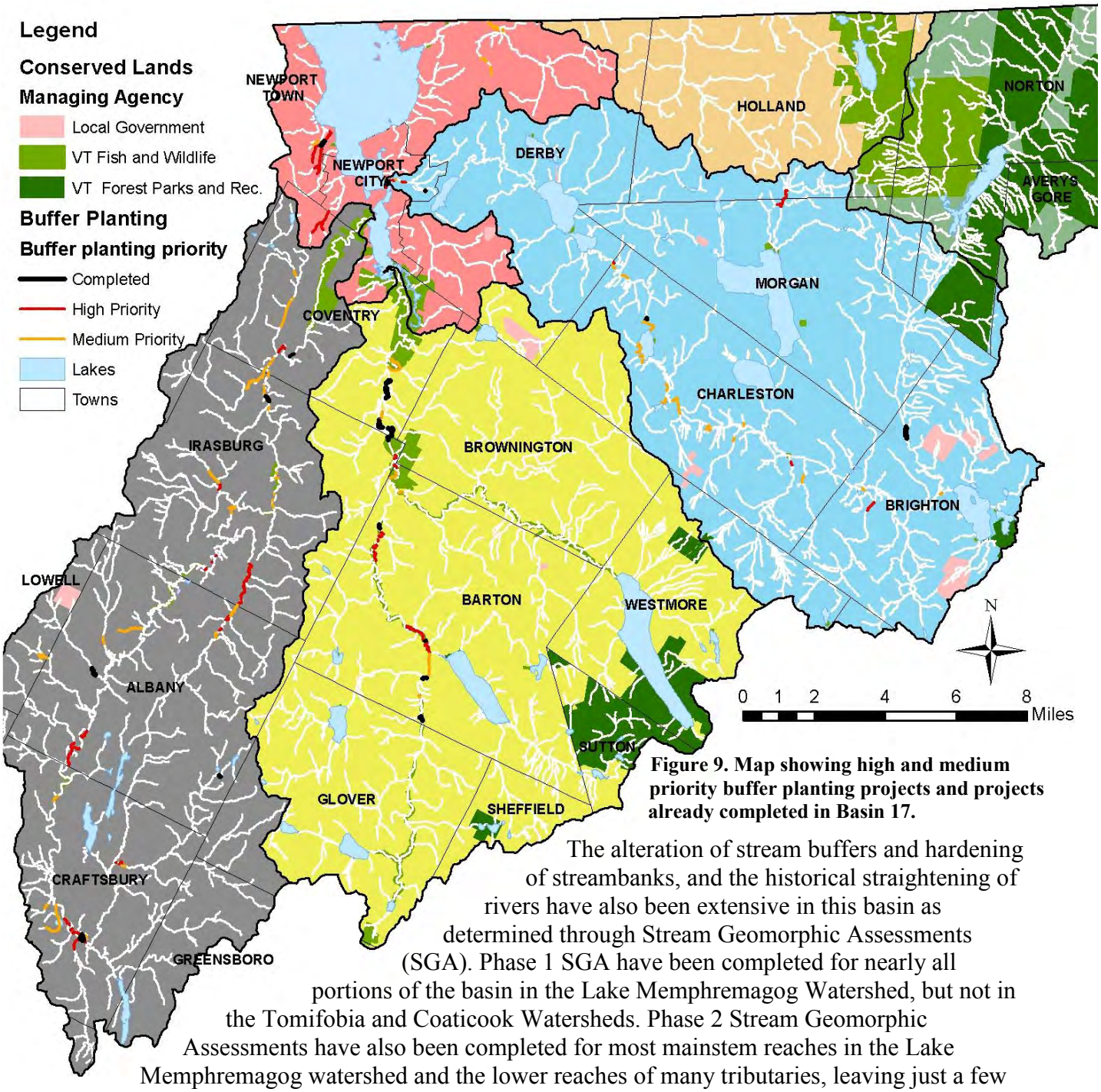


Figure 9. Map showing high and medium priority buffer planting projects and projects already completed in Basin 17.

The alteration of stream buffers and hardening of streambanks, and the historical straightening of rivers have also been extensive in this basin as determined through Stream Geomorphic Assessments (SGA). Phase 1 SGA have been completed for nearly all portions of the basin in the Lake Memphremagog Watershed, but not in the Tomifobia and Coaticook Watersheds. Phase 2 Stream Geomorphic Assessments have also been completed for most mainstem reaches in the Lake Memphremagog watershed and the lower reaches of many tributaries, leaving just a few sections of the watershed in need of additional Phase 1 and Phase 2 assessment as shown in Figure 8. These assessments have identified extensive areas that have less than a 25 foot buffer and where buffer planting projects are a priority (as determined through the Vermont River Corridor Planning Guide). In addition to the lack of buffers, historical straightening and rip rap along streams have resulted in the loss of streams ability to access floodplains in a number of locations, and have caused some streams to move away from their natural equilibrium condition. In general the areas most susceptible to this stressor have been the lowest reaches of tributaries as they reach the broader valley of the larger rivers in the basin and along the larger rivers themselves. SGA work has resulted in the identification of many protection and restoration

projects in the basin (see Figure 9 showing priority buffer planting locations and Figure 10 showing priority river corridor easement locations and Appendix H showing completed projects). This will be of limited use, however, if local towns don't address the protection of buffers and need for consideration of erosion hazards in local zoning to prevent future encroachments on streams and rivers in the basin. Because streambank erosion is also such a significant source of sediment that contributes to the nutrient enrichment of Lake Memphremagog, the actions to address these issues are listed under nutrient enrichment in the implementation table on page 35.

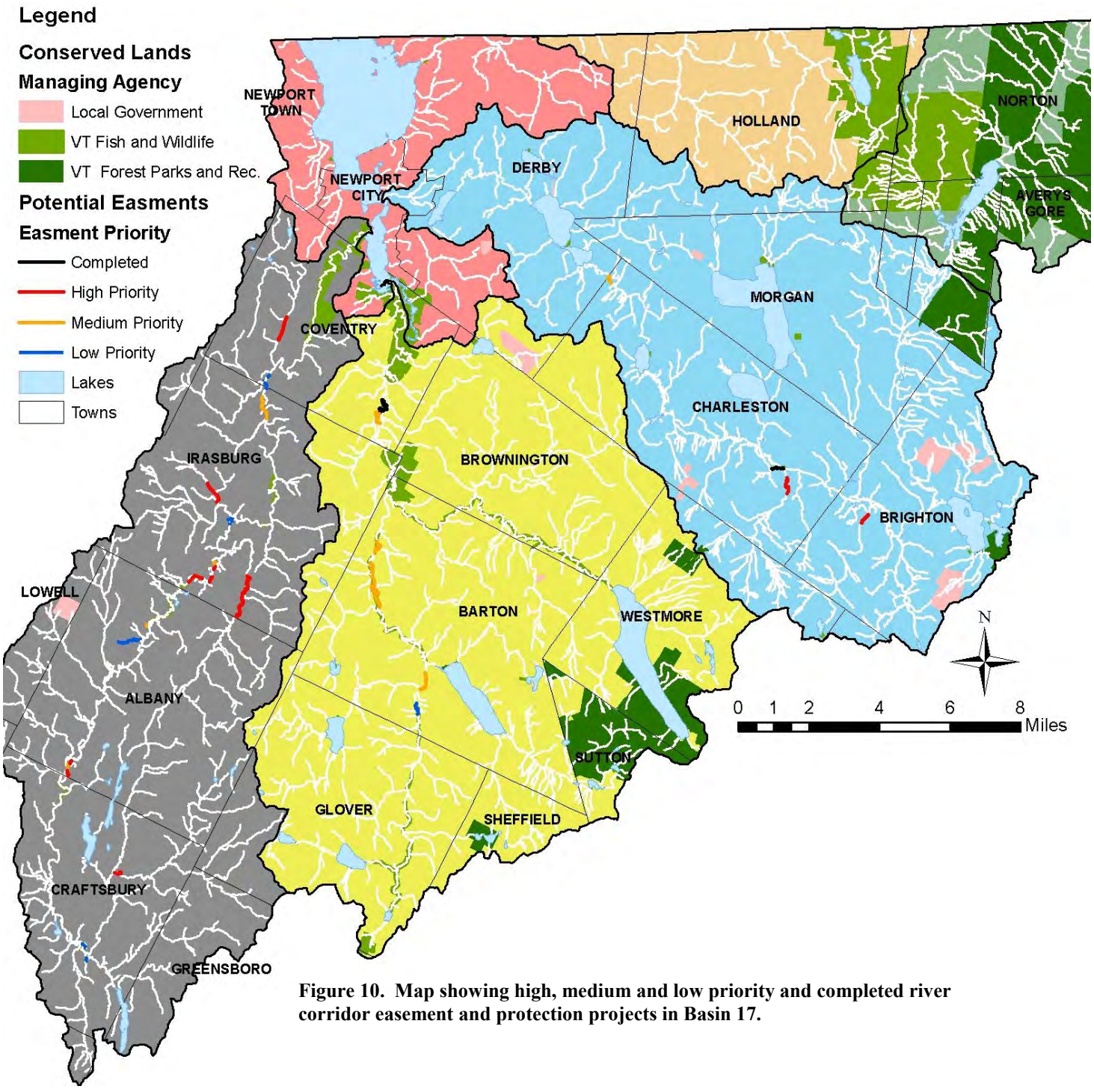


Figure 10. Map showing high, medium and low priority and completed river corridor easement and protection projects in Basin 17.

There are some of the largest wetland complexes in the state in this basin. These include the upper Clyde River and Pherins River wetland complex, the wetland complexes along the lower Barton and Black Rivers, and wetlands along the upper Black River (Engstrom 1999). Significant wetlands and a 50 foot buffer around them have been protected in the state through the Vermont Wetland Rules, however many wetlands were drained before these rules came into effect and these lands are now marginal farm land and there may be opportunities to restore these converted wetlands through the Wetland Reserve Program. For some of the unique wetlands in the basin conservation or reclassification would provide additional protections. Actions to address wetland protection and restoration are listed in the implementation table on page 38.

Bridge and culvert assessments have been done on many of the stream crossings in the basin; helping to identify structures that are causing impacts to the stream and/or are an impediment to aquatic organism passage (AOP). AOP through stream crossings is an important issue for waters in Basin 17, in large part due to the celebrated populations of steelhead rainbow trout, brown trout and landlocked Atlantic salmon that annually travel from Lake Memphremagog into tributaries to spawn. The fish that live in Lake Memphremagog travel up the Black, Barton, Clyde and Johns rivers and smaller tributaries of the lake. In these areas of the watershed AOP is essential to providing the habitat these fish species need for natural reproduction. In addition to Lake Memphremagog, most lakes and ponds in Basin 17, but especially Willoughby, Crystal, Salem, Echo, and Seymour lakes and Island, Norton and Great and Little Averill ponds support fish species that move into tributaries to spawn. AOP is critical on the minor tributaries to these waterbodies to allow for natural reproduction to sustain fish populations and the valuable fisheries they support. Figure 11 and Table 3 identify stream crossings in the basin known to impede or completely obstruct the passage of fish and that are targets for retrofit or replacement to restore AOP. The replacement of some of these stream crossings would also help to restore equilibrium conditions on streams, which could improve aquatic habitat in the stream and reduce streambank erosion and associated nutrient enrichment.

Other species of fish and wildlife also depend on stream continuity for their survival. This is explained well in the following excerpt from the Vermont Stream Crossing Handbook "Streams provide important connections within a watershed for fish and wildlife that need to move in search of food, to avoid extreme conditions or to reach habitats suitable for reproduction. Thus, free passage through stream corridors is critical to the ecology and health of the aquatic community. Some animals, such as amphibians, reptiles and some mammalian furbearers can also be affected when they are forced to cross roads where they become vulnerable to mortality from traffic, exposure to predators, and other dangers. For reasons as simple as the need to escape extreme floods or as complex as maintaining genetic diversity, animals living in or along streams need to be able to move unimpeded through the watershed (VFWD 2010)." It is therefore important to consider AOP in all areas of the basin. Actions to address AOP in the basin are listed in the implementation table on page 39.

Table 3. Stream crossings in Basin 17 known to impede or completely obstruct the passage of fish and that are targets for retrofit or replacement to restore AOP.

Target watershed	Primary species impacted	Stream name	Road name	Structure #	Comments
Lake Willoughby	rainbow trout, rainbow smelt, white suckers	Dorin Brook	Route 5a	300287001010191	
		Myers Brook	Route 5a	300287000910191	
		Wells Brook	Route 5a	300287000810191	
		Schoolhouse Brook	Route 5a	300287000610191	
Barton River	brown trout, steelhead rainbow trout	Roaring Brook	I-91	200091103S10022 200091103N10022	retrofit
		unnamed tributary to the Barton River	I-91	300091H51S10021 300091H51N10021	
		Day Brook	Pine Hill Rd	401005000910051	
		Day Brook	I-91	300091H83S10051 300091H83N10051	
Crystal Lake	rainbow trout, rainbow smelt, white suckers	Sucker Brook	Pageant Park Rd	401002005210021	Local structure
Black River	brown trout, steelhead rainbow trout	Stony Brook	Route 14	300251013210051	
		Stony Brook	Route 14	# Not Available	
		Brighton Brook	Gage Brook	# Not Available	Privately maintained
		Brighton Brook	Route 58	300308000510111	
		Unnamed Tributary to Black River	Route 58	300310000710111	
		Lords Creek	Daniels Rd	401001002310011	
		Shalney Branch	Route 14	300251011510011	
		Rogers Branch	Route 14	300251011410011	
		Seaver Branch	Route 14	300251011310061	
		Cass Brook	Cemetery Rd	# Not Available	
		Cass Brook	Route 14	300251010810061	
Clyde River	brook trout	Oswegatchie Brook	VAST	VAST 2	Eastern brook trout joint venture- potential funding source
Johns River	brown trout, steelhead rainbow trout, brook trout	Crystal Brook	VAST	VAST 1	
		Crystal Brook	US Route 5	# Not Available	

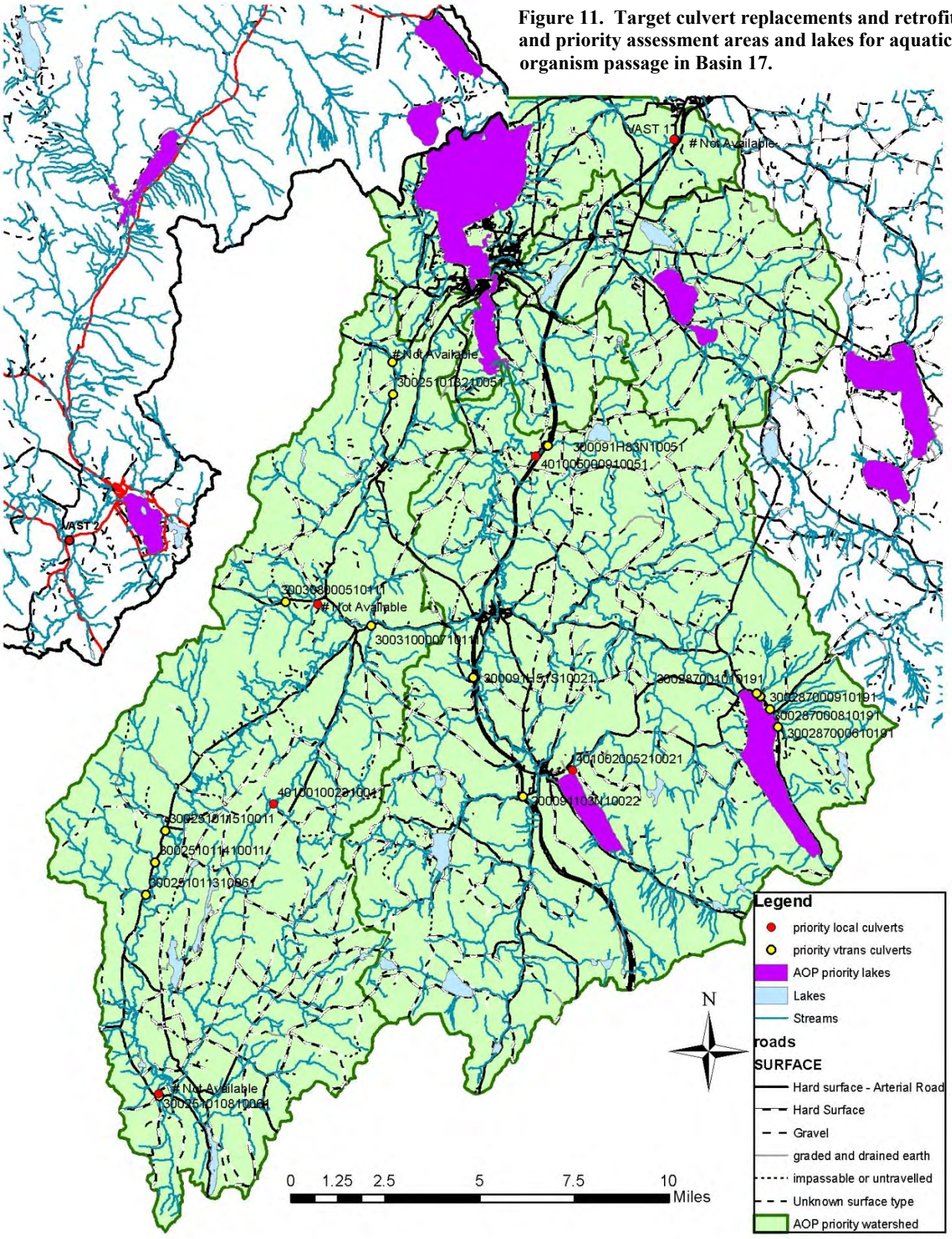


Figure 11. Target culvert replacements and retrofits and priority assessment areas and lakes for aquatic organism passage in Basin 17.

Chapter 3 – Specific waters with water quality problems

Agricultural impairments of Crystal Brook and the tributary to Stearns Brook

Crystal Brook and a tributary to Stearns Brook are listed as impaired by runoff from agricultural lands. The primary source of nutrients causing the impairment of Crystal Brook was a leaking manure pit and this has been addressed. Follow up monitoring suggests that this water now meets VWQS and so may soon be removed from the list of impaired waters (VDEC 2011). A watershed assessment was completed in 2011 to determine the source(s) of the impairment of the tributary to Stearns Brook which identified a number of actions completed in recent years so another biological assessment of this site should be done to determine if these actions have addressed this impairment. If the assessment shows that the stream is still impaired than additional water sampling targeting phosphorus and nitrogen to constrain nutrient sources and work with landowners to identify and address potential pollution sources should be done.

Objective: Restore Crystal and Stearns Brooks to meet water quality standards.

Action	**Lead**/Key Players	Cost/ Funding	Target Date/Status
1. Monitor Crystal Brook to confirm that this stream has been restored and can be removed from the list of impaired waters.	**VDEC** / OCNRCD	VDEC Funds	**2011/ 2009 and 2010 results suggest this water now meets VWQS.**
2. Complete a watershed assessment of the tributary to Stearns Brook to identify potential projects to reduce runoff to this waterbody	**OCNRCD** / VDEC, NRCS	Ag resource specialist funding	**2011- completed**
3. Biologically assess the Sterns Brook tributary site to determine if recent efforts have addressed impairment and if the tributary to Sterns Brook is still impaired consider water sampling to constrain nutrient sources and work with landowners to identify and address pollution sources.	**OCNRCD** / VDEC, NRCS, VAAFM	319, EQIP, CREP, VT BMP programs	**2012-15**

Phosphorus impairment of Lake Memphremagog

The phosphorus impairment of Lake Memphremagog in Vermont is a complex issue with a broad array of sources and potential solutions. A Total Maximum Daily Load (TMDL) is required for the Vermont portion of the lake and its watershed under the Clean Water Act because Lake Memphremagog is impaired by the pollutant phosphorus. A TMDL for Lake Memphremagog will specify the maximum permissible phosphorus loads from all sources that can enter the lake and still have the lake meet the Vermont Water Quality Standards. EPA approves a TMDL and then the Agency of Natural Resources must consider the TMDL when granting permits for discharges for activities where phosphorus could be released to the water. Essentially, the TMDL is the combination of the Waste Load Allocation (comprising all point sources such as waste water treatment plant discharges) plus the Load Allocation which captures all nonpoint sources, and a margin of safety. In the Lake Memphremagog watershed, the point sources amount to just a few percent of the total phosphorus load so much of the effort to resolve this impairment will have to focus on the wide array of nonpoint sources. However, the TMDL will include an evaluation of phosphorus effluent levels for the four waste water treatment plants in the basin to determine if additional phosphorus reductions are necessary. Presently, the

Brighton treatment plant does not have a phosphorus effluent limitation and the phosphorus effluent limitation for treatment plants in Orleans and Barton is 1 mg/l and the limit for the Newport treatment plant is 0.8 mg/l.

For the development of the TMDL the loading of phosphorus that can enter the lake and allow it to maintain an average concentration below the Vermont standard for phosphorus for the lake of 14 ppb needs to be determined. There is not a direct relationship between reductions in phosphorus loading entering the lake and phosphorus concentrations in the lake because some of the phosphorus loading to the lake settles out on the bottom of the lake and so does not contribute to raising in-lake concentrations. Similar to the process undertaken for the 2002 Lake Champlain TMDL, a model will be developed to estimate the phosphorus loading reductions that will be required from the Lake Memphremagog watershed to reduce in-lake phosphorus concentrations to meet Vermont Water Quality Standards. While the TMDL just addresses the Vermont portion of the lake and watershed, a model that includes the Quebec portion of lake as well will be more accurate because it will address the flow of water and phosphorus back and forth between the Quebec and Vermont portions of the lake. The Agency of Natural Resources in cooperation with the Quebec Vermont Steering Committee on Lake Memphremagog and international partners is in the process of developing such a lake model for Lake Memphremagog in Quebec and Vermont.

A sampling program has been initiated to determine phosphorus concentrations in the lake and phosphorus loading from major tributaries in both Quebec and Vermont to allow for the creation of this model. Tributary monitoring has shown that the phosphorus export per watershed area is highest in the Black River and Johns River watersheds, nearly half this level in the Barton River watershed and roughly half again lower in the Clyde River watershed as shown in Table 4.

Table 4. Phosphorus loading for the Black, Barton, Clyde and Johns rivers from 2005-2010 determined through monitoring and estimated by a phosphorus export model.

Tributary	Area (km^2)	Monitored Load (kg/yr)	Monitored Load per km^2 ($kg/yr/km^2$)	Modeled Load (kg/yr)	Modeled Load per km^2 ($kg/yr/km^2$)
Black	350	21,730	62	13,754	39
Barton	429	15,607	36	13,882	32
Clyde	375	6,868	18	4,683	13
Johns	25	1,643	66	1,351	54
TOTAL	**1,179**	**45,848**	**39**	**33,670**	**29**

The Agency has been working with the Quebec Vermont Steering Committee on Lake Memphremagog and international partners to refine a watershed phosphorus export model developed in a collaborative effort lead by SMi Amematech and the MRC Memphremagog. The watershed phosphorus export model allows the estimation of phosphorus loading from portions of the watershed where there is no direct monitoring of phosphorus loading. This model also allows for the estimation of the proportion of phosphorus reaching the lake from various landuse sectors of the watershed including estimated loading from septic systems along with the measured loading from wastewater treatment plants in the basin (Vézina 2009.)

The phosphorus export model under predicts the loading of phosphorus from the major tributaries in Vermont by a nearly 27% compared with measured loadings as shown in Table 4. However, the model does provide an estimate of loading by land use in the watershed although this may change as the model is refined to more closely match the measured loading. The model suggests that the loading of phosphorus in the Vermont portion of the Lake Memphremagog watershed comes mostly from developed and agricultural lands as shown in Table 5, although forested lands are a significant source largely because they cover nearly two thirds of the basin. The estimated percent contribution from agricultural land is higher when retention in lakes is considered because much of the agricultural land in the basin is along the Black and Barton rivers where there are few lakes that act to retain phosphorus. One significant source of phosphorus which has not been addressed through this model is the contribution of phosphorus from channel erosion which may partly explain why the model underestimates phosphorus loading. Work in progress that will estimate loads from channel erosion in the Missisquoi River watershed may develop a method of estimating these loadings using Phase 2 stream geomorphic assessment results that could be applied to this basin.

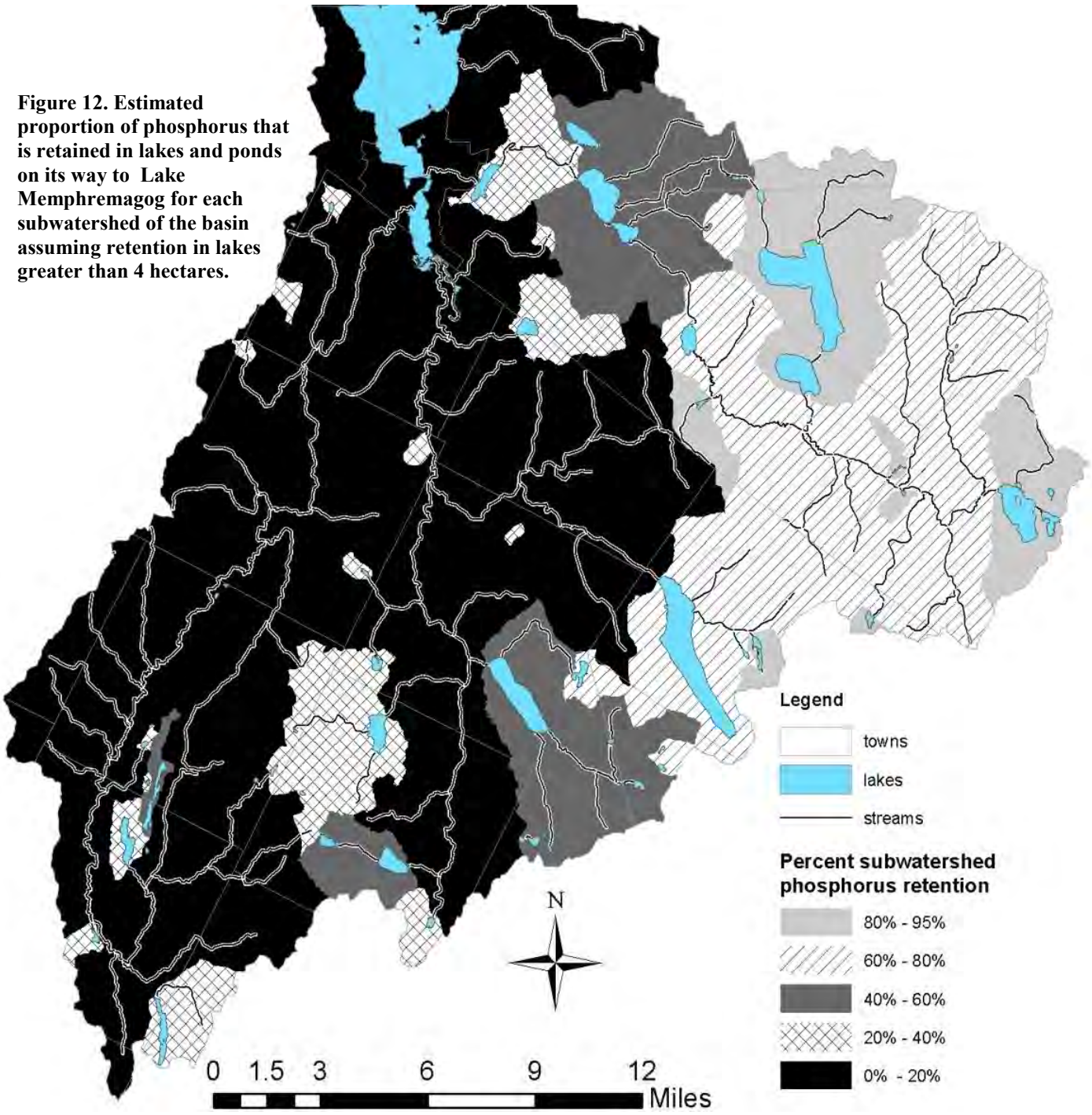
Table 5. Land use area (updated from 2006 NLCD) and estimated loading for the Vermont portions of the Lake Memphremagog basin based on refined phosphorus export model developed by SMi Amematech showing loading with and without estimated retention of phosphorus in lakes.

	Area in square kilometers	Percentage of basin in landuse	Model estimated Phosphorus load (kg/yr)	Percentage phosphorus load	Model estimated Phos. load with retention (kg/yr)	Percentage Phos. load with retention
Agricultural land	**196.1**	**15.5%**	**19,915**	**42.4%**	**17,196**	**46.1%**
Pasture/Hay	145.4	11.5%	8141	17.3%	6970	18.7%
Cultivated land	50.7	4.0%	11774	25.1%	10226	27.4%
Natural lands	**993.4**	**78.4%**	**9,335**	**19.9%**	**6,251**	**16.8%**
Forest	837.2	66.1%	5860	12.5%	3956	10.6%
Herbaceous/shrub	33.5	2.6%	670	1.4%	447	1.2%
Water	67.9	5.4%	611	1.3%	384	1.0%
Wetland	54.8	4.3%	2194	4.7%	1463	3.9%
Developed land	**77.1**	**6.1%**	**17,966**	**37.8%**	**13,878**	**37.1%**
Barren land	2.6	0.2%	792	1.7%	633	1.7%
Residential	74.5	5.9%	14536	30.9%	11476	30.8%
septic systems			1493	3.2%	1022	2.7%
WWTP*			924	2.0%	696	1.9%
Total estimate	**1,267 km**	**100.0%**	**46,995**	**100.0%**	**37,273**	**100.0%**

* Phosphorus loading was estimated based on measured concentrations and flows at WWTPs in the basin

In addition to identifying the relative importance of various land uses, the model also estimates retention of phosphorus in lakes in the basin which allows the estimation of the percent of phosphorus that makes it to Lake Memphremagog from each subwatershed of the basin. Phosphorus reduction projects in subwatersheds with lower potential for downstream retention will result in greater net phosphorus reductions in Lake Memphremagog than from other areas of the basin. Because of this projects should be prioritized in the areas of the watershed shown in Figure 12, in the black and cross hatched subwatersheds where it is estimated that at least 60% of the phosphorus reductions achieved in these areas would be reflected in reduced loading to Lake Memphremagog.

Figure 12. Estimated proportion of phosphorus that is retained in lakes and ponds on its way to Lake Memphremagog for each subwatershed of the basin assuming retention in lakes greater than 4 hectares.



Another way to target phosphorus reduction efforts is to target subwatersheds in the basin that have been shown to have high levels of phosphorus based on phosphorus sampling completed in the basin by the NorthWoods Stewardship Center and the Memphremagog Watershed Association with the support of Beck Pond LLC and the OCNRCD. Figure 13 shows average phosphorus concentrations from subwatersheds captured by each sampling site since 2005.

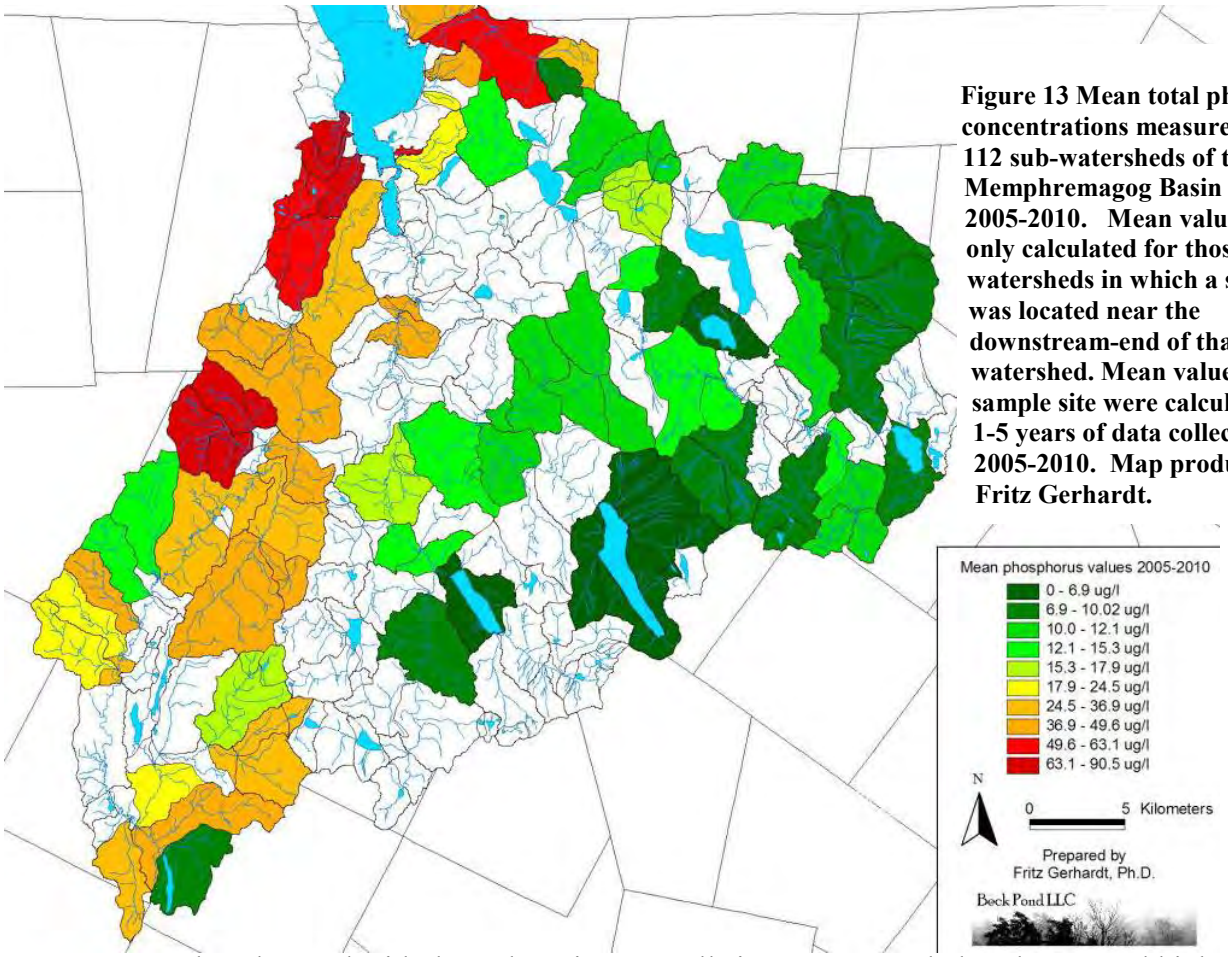


Figure 13 Mean total phosphorus concentrations measured from 112 sub-watersheds of the Lake Memphremagog Basin during 2005-2010. Mean values were only calculated for those sub-watersheds in which a sample site was located near the downstream-end of that sub-watershed. Mean values for each sample site were calculated using 1-5 years of data collected during 2005-2010. Map produced by Fritz Gerhardt.

Some care needs to be used with these data since not all sites were sampled each year and high flow events were targeted to a greater extent in recent years which would be expected to increase phosphorus concentration and loadings as compared to earlier years. However efforts are continuing to identify more localized phosphorus source areas in the basin so we can target project development in these areas.

Because efforts to target phosphorus levels in the Lake Memphremagog watershed require actions across such a wide array of sources, the strategies have been broken out in detail in Chapter Four in a number of sections targeting specific landscape activities. The primary landscape activities targeted for these efforts are: developed lands, broken down into stormwater runoff and road runoff; forested lands, including the importance of both maintaining forested lands and addressing runoff from these lands; runoff of nutrients and sediments from agricultural lands; and finally, streambank erosion. The strategies to address shoreland development on lakes and the protection and restoration of wetlands that target improvements in aquatic habitat will also help in reducing phosphorus export in the basin, as may the replacement of stream crossings to improve fish passage that may also be causing streambank erosion. As a TMDL is completed for the Vermont portion of Lake Memphremagog, it will allow the identification of more specific targets for phosphorus reductions in the basin for each landuse which will allow the actions listed in Chapter Four to be fine tuned.

The following action table identifies specific actions for the development of a TMDL to address the phosphorus impairment of Lake Memphremagog.

Objective: Develop a TMDL and refine the Basin 17 Water Quality Management Plan to address the phosphorus impairment of Lake Memphremagog.

Action	**Lead**/Key Players	**Cost**/ Funding	**Target Date**/Status
4. Coordinate monitoring of phosphorus and chloride loading from major tributaries and in Lake Memphremagog to allow for the development of a Bath Tub model for Lake Memphremagog.	**VDEC** / MCI, MDDEP, MRC, MWA, COGESAF,	VDEC operational funds, Watershed grant, ERP	**2010-2012/** Joint monitoring was initiated on lakes(2010) and tributaries (2011)
5. Refine the watershed phosphorus export model for the Lake Memphremagog watershed.	**VDEC** / MDDEP, MRC	Staff time	**2010-2012**/updated with 2006 nlcd in 2011.
6. Complete targeted tributary sampling program to identify target watersheds for phosphorus reduction.	**MWA /** VDEC, ONRDC, Beck Pond LLC	**$10,000 year**/ ERP, Watershed grant, LaRosa, 604(b)	**2011-2012/** Targeted sampling on the Black River for 2011.
7. Develop a Bath Tub model for Lake Memphremagog or another method to model the necessary reductions in phosphorus load from the Vermont portions of the watershed to meet Vermont Water Quality Standards	**VDEC** / MDDEP, MRC	Staff time	**2011-2012**
8. Develop a TMDL to address the phosphorus impairment of Lake Memphremagog.	**VDEC** / EPA	Staff time	**2012**
9. Update action plan based on the TMDL phosphorus reduction targets and watershed loading model targeting the most efficient projects and locations to reduce phosphorus loading across contributing land uses.	**VDEC** / MWA, OCNRCD, NRCS, Towns, watershed groups and partners	Staff time	**2013**
10. Develop a sustainable long term water sampling program to monitor changes in phosphorus load for the Vermont portions of the Lake Memphremagog Watershed and changes in in-lake phosphorus concentration to evaluate success of TMDL implementation efforts.	**VDEC** / MWA, City of Newport (LMP), Beck Pond LLC	Staff time and Department Laboratory resources	**2012-2015**

Flow alterations on the dams in the Coaticook River Watershed

Norton and Great and Little Averill ponds have all been listed as altered due to water level fluctuations caused by water releases at the dams on these three waterbodies described in Table 6. Coaticook Hydro owns and operates the three dams to support downstream power generation in the village of Coaticook. Because these dams are associated with a hydroelectric project, they are under the jurisdiction of the Vermont Public Service Board. Considerations associated with the water level management include: loon nesting, wetlands, aquatic habitat in the lakes and ponds, and downstream flow regulation. The latter issue is important to ensure that regulation of outflow from the dams does not result in unacceptable impacts to aquatic life and habitat. There are also public concerns regarding an apparent increase in water levels in recent years that residents believe has resulted in increased erosion of the lakeshore in some locations. Conservation flow determinations, possible structural changes and operating protocols to address the aforementioned issues at each dam have not been developed.

A meeting was held in October 2008 to discuss the operations of these dams with participation of staff from Hydro Coaticook, VDEC, VFWD, and the PSB. The meeting included a tour of the three dams and a discussion of water level management. Nonetheless, it remains on the list of flow regulation issues to be addressed. Visits to the dam on Little Averill Pond by Agency staff in 2009 and 2010 indicate that downstream flows may not conform to current conservation flow standards, and there are reports from lake residents of both high and low lake levels. These levels may still be within the requirements of a 1953 Public Service Commission order establishing maximum and minimum lake levels for the lake.

Table 6. Water level management and PSB regulations at the three dams in the Coaticook River Watershed.

Lake	Maximum Water Level	Normal Water Level	Minimum Water Level	Water level Variation Allowed	Loon Management (May through July)	Current Min. flow plans
Norton Pond Drainage Area = 14 sq. miles Surface Area = 583 acres Dam height = 10 feet	Stoplog crest + 17 inches	Stoplog crest	49 inches below stoplog crest	PSB order allows 5.5 foot variation in water level	Optimum = +34" (+86 cm) above concrete crest Maximum = +35" (+89 cm) above concrete crest	One gate open 2.0 inches = approx. 5 cfs
Little Averill Pond Drainage Area = 5 sq. miles Surface Area = 483 acres Dam height = 14 feet	Crest + 6 inches	Crest	To bottom of outlet conduit = 10 feet below crest	PSB order allows 10.5 foot variation in water level	Optimum = -11 inches (-28 cm) Maximum = -9 inches (-23 cm)	One gate open 2.0 inches = approx. 5 cfs
Great Averill Pond Drainage Area = 12 sq. miles Surface Area = 847 acres Dam height = 10 feet	Crest + 16 inches	Crest	4.0 feet below crest	PSB order allows 5.3 foot variation in water level	North nesting site uses platform since 1998 Inlet area at SW has natural nesting site that was flooded in 2005	One gate open 2.0 inches = approx. 5 cfs

Objective: Ensure the flow altered waters in the Coaticook River watershed meet Vermont Water Quality Standards.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
11. The Agency of Natural Resources will work with Hydro Coaticook, the PSB, and local residents to identify and address the water resource concerns associated with water level fluctuations at Norton and Great and Little Averill ponds so these waters will meet the Vermont Water Quality Standards.	**VDEC** / VFWD, HydroCoaticook, PSB, Averill lakes association,	Staff time	**2014**
12. An agreement should be made to establish more formal conservation flows for each of the dams, to determine what height of gate opening would equate to these flows, and if not already existing, make modifications to the dams to ensure these minimum flows are met at all times.	**VDEC** / VFWD, Hydro Coaticook, PSB, Averill lakes association	Staff time	**2014**

Chapter 4 – Implementation Table

The table below is organized in four columns, the first of which describes the action, the second lists the lead and key players, the third includes the estimated cost (when this is available) and funding sources and the fourth column includes target date for the action to be completed as well as an update on the status of the action. Actions in bold have been prioritized as one of the top ten priority actions in the basin.

GOAL: REDUCE PHOSPHORUS LOADING IN THE BASIN TO ALLOW LAKE MEMPHREMAGOG TO MEET WATER QUALITY STANDARDS AND REDUCE AND/OR PREVENT INCREASES IN PHOSPHORUS LEVELS IN OTHER NUTRIENT SENSITIVE LAKES IN THE BASIN.

Objective: Reduce the impacts from stormwater runoff from developed lands.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
13. Complete stormwater system mapping and illicit discharge detection for the City of Newport, Village of Derby, Village of Orleans and Village of Barton.	**VDEC** / cities and towns, ONRCD	**$40,000**/ ERP, 319, SEP	**2012-2014**
14. Increase awareness of stormwater runoff issues and available solutions through newspaper articles and outreach materials.	**MWA** / NVDA, Local newspapers, VDEC, OCNRCD	Watershed grant	**ongoing**
15. Complete demonstration projects addressing stormwater issues in the basin, such as rain barrels or rain gardens, to show how these practices can be used and increase awareness of these methods. Target priority areas identified through stormwater mapping.	**Lake and watershed organizations** / OCNRCD	Watershed grant, ERP, 319 program	**2012**/ Workshop held in 2010 to discuss rain barrels and to distribute them.
16. Work with a local developer to complete a low impact development project in the basin and publicize this to increase awareness of the social, economic and environmental benefits of using low impact development techniques.	**local developer**/ Lake and watershed groups, NVDA, Towns		**2013**
17. Increase awareness of landscaping techniques to minimize nutrient, herbicide and other pollutant runoff from lawns. Techniques include: aerating, increasing organic content, maximizing natural vegetative cover, and using less and only phosphorus free fertilizers except where soil testing show low soil phosphorus levels.	**Lake and watershed organizations /** master gardener program, VDEC	Watershed grants, 319 grant program	**ongoing**

Objective: Reduce impacts from roads and other transportation infrastructure on aquatic resources.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
18. Organize a road review committee to identify roads, ditches and stream crossings in the basin that are having an impact on water resources, focusing initially on towns which have not yet participated in the Better Backroads Program including Irasburg, Coventry, Albany and Craftsbury.	**Road commissioners and foreman** / watershed groups, landowners, environmental consultants, conservation and planning commissions. Better Backroads tech.	Group could be ad hoc w/o funding or could apply for Better Backroads grants.	**2012**/ MWA has meet with local towns and developed a Better Backroads project with Newport Town.
19. **Work with all towns in the basin to apply for at least one Better Backroads Grant to address one of the major water quality issues identified by the road review committee.** Initially, the following towns which are in areas characterized by low watershed phosphorus retention will be targeted: Derby, Irasburg, Coventry, Albany, Craftsbury and Newport town Newport City.	**VDEC**/ road commissioners and foreman, conservation commissions, private landowners	**$5,000-10,000 per town**/ ERP, Better Back Roads	**2013**/ Grants received for: Charleston, Morgan Westmore roads.
20. Host and advertize local workshops for road crews and commissioners on the best management practices to address road/water quality issues. Include a workshop in the Roads Scholar program on minimizing impacts from roads on surface waters.	**Local Roads Program**, road commissioners and foreman, watershed associations, VANR, landowners, conservation and planning commissions.	Northern VT RC&D Council, VT Better Backroads Program	**2012**
21. Identify and promote funding sources for towns to address road/water quality issues, and work to increase funding sources that are targeted for this purpose.	**Vtrans/** watershed groups, local, state and national elected officials	Better Backroads	**ongoing**
22. Educate towns on the advantages of following locally adopted road and bridge standards in order to increase compliance with these standards in the basin. Submit articles on reducing the impact of roads on water quality in the *Vermont Local Road News* that goes to town staffs.	**Vtrans/** watershed groups, landowners, conservation commissions, road commissioners and foreman, VANR	Watershed grants, 319 grant program	**Ongoing**/ 2010 Act 110 included updates to the standards effective for 2012 and required towns to annually certify compliance.
23. Provide VANR bridge and culvert assessment results to towns in the basin so this information can be used to help towns in prioritizing stream crossing replacement.	**VANR**/ road commissioners and foreman, conservation commissions.	604(b), ERP	**Ongoing /** Coventry survey completed.
24. Encourage towns in planning for land use changes and resulting changes in hydrology on stream crossings, encouraging proper stream crossing sizing and rock aprons at outlets.	**VDEC**/ NVDA, Towns	604(b)	**Ongoing**

Objective: Maintain the coverage of forested lands while reducing sediment and phosphorus runoff occasionally associated with forestland management.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
25. Increase educational opportunities and outreach to the general public, landowners, and loggers on good forestry practices and the mechanics of logging.	**NorthWoods Stewardship Center**/ VDFPR, OCNRCD, VT Coverts	Watershed grant	**ongoing**

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
26. Work with logging equipment distributers to provide information pamphlets on logging practices and contacts when specific equipment is sold for private logging use.	**OCNRCD,** VDFPR,	Watershed grant	**2013**
27. Organize and publicize a field tour of a logging operation on state lands to demonstrate BMPs, paired with tour of a problem site if possible.	**VDFPR,** OCNRCD, NorthWoods Stewardship Center		**2013**
28. Organize a welcome kit with information for new landowners on managing forested lands as well considerations for hiring a forester and logger.	**OCNRCD,** NorthWoods Stewardship Center		**2013**
29. Maintain extensive forested lands in the basin due to the water quality and habitat benefits through the current use program, Forest Legacy Easements and the creation of new or expansion of existing town forests.	**VDFPR**/ VLT, towns, private landowners, environmental consultants	VHCB, forest legacy	**2013**
30. Initiate a portable skidder bridge project in the basin to provide bridges for lease to local loggers and outreach on their use.	**OCNRCD**/ VDFPR, loggers, LandVest,	**$4,000 - $20,000 depending on scale** / ERP, SEP, 319	**2011**/ Portable skidder bridge program initiated in the basin.

Objective: Establish an agricultural water quality group that will represent the interest of the Memphremagog region and to leverage the positive attention of the legislature, the press, and the watershed community and to promote the best use of government cost share dollars.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
31. Create a Steering Committee to look at the different models for such a water quality group and provide overall direction	**OCNRCD**	ERP	**2011**
32. Assemble a membership from the various agricultural groups, and create an agenda for targeted funding and technical assistance based on goals below **Key players continued:** Grain and Feed Dealers, Farm Equipment Sales, Local Work Group, Watershed Association, local legislators	**OCNRCD**/ Farm Bureau, NOFA, Grange, VT Fruit and Vegetable Growers Assoc, Milk haulers, Large Animal Vets…	In-kind from members	**2011**
33. Refine phosphorus reduction estimates for practices funded and prioritize those with highest potential for positive impacts	**NRCS**/ VAAFM	319, ERP	**2012**

Objective: Minimize the acreage and number of days of fields in bare soil.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
34. Conduct a vulnerability analysis to identify specific areas (based on soil types, land use, agronomic practices, etc) and prioritize technical assistance and funding to these	**OCNRCD**/ NRCS, Agency of Ag, UVM Coop Ext	Watershed grants, Partners	**2011**/ initiated targeted assessments on ag lands in 2011 based on water sampling results

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
35. Conduct extensive outreach of existing programs that provide financial incentives for cover crop, conservation cropping, no-till etc. to all farms	**NRCS**/ Agency of Ag, OCNRCD	VACD	**on-going/**
36. Use Local Work Group to provide priority points to NRCS projects that address bare soil.	**OCNRCD**/ NRCS	NA	**on-going**
37. Conduct research trials on grasses best suited for cover crops for this region and shorter season corn varieties that preserve yields.	**UVM Coop Ext**/ OCNRCD	SARE grants	**2011**

Objective: Reduce opportunities for grazing animals to be in streams and break down stream bank vegetation.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
38. Make direct contact with producers to promote existing programs such as the Conservation Reserve Enhancement Program (CREP) that provide incentives for fencing, watering tanks, and stream crossings.	**VACD**/ OCNRCD, NRCS, VAAFM	NRCS, VAAFM	**ongoing /** 2011 ARS started targeted CREP outreach to farmers to promote this program.
39. Encourage use of rotational or planned grazing plans.	**NRCS**/ VOFA, UVM, SARE, Holistic Management Practitioners	NRCS, VAAFM	**ongoing**
40. Promote preservation and restoration of riparian and wetland areas for their other benefits such as thermal cooling, nutrient retention, and habitat enhancement.	**OCNRCD**/ VACD, NRCS, VAAFM, VFWD, USFWS, Beck Ponds LLC, NorthWoods Stewardship Center	USDA, VAAFM, VFWD, US Fish and Wildlife Services	**ongoing /** 2010 grants included trees for streams project and wetland assessment and proj. development for WRP program.

Objective: Reduce the number of acres of agricultural land that transition to commercial and residential development which would increase nutrient loading and stormwater runoff.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
41. Continue to conserve prime agricultural lands to prevent the change in landuse to developed lands	**VLT/** VAAFM, NRCS, VACD	VHCB,	**ongoing**
42. Inventory idle farm land in the basin and connect farmers who are interested in CREP or other programs and have a limited land base to these landowners to increase the ability of farmers to participate in these programs.	**VAAFM /** ONRCD, Environmental Consultants	VAAFM	**2012**

Objective: Improve nutrient management and soil health on vegetable and small farms

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
43. Conduct nutrient management planning workshops for small and hobby farms	**VACD,** NERC, UVM Ext	VAAFM, UVM Ext, SARE, VACD,	**2011 on**
44. Provide outreach on efficient use of Nitrogen and Phosphorus fertilizers for vegetable operations	**VACD,** UVM Ext, VT Fruit &Vegetable Growers Assoc.	VACD, UVM Ext, VT Fruit & Vegetable Growers Assoc.	**2011 on**
45. Promote soil testing and manure analysis to determine nutrient requirements for individual fields for small farms.	**VACD,** UVM Ext	NA	**ongoing**
46. Promote workshops, programs, and materials specific to equine operations	**VACD,** VT Pasture Network, UVM Ext, Vermont Horse Association	VAAFM	**ongoing**
47. Create programs to improve infiltration and water holding capacity of soils through addition of organic material, avoiding compaction	**NRCS,** VAAFM, UVM Coop Ext, Highfields Center for Composting	NRCS, VT VAAFM, UVM, VACD, SARE	**2011**

Objective: Protect and restore the equilibrium conditions of streams and rivers.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
48. Complete Phase 1 Stream Geomorphic Assessments (SGA) of all major streams in the Lake Memphremagog Watershed where this has not been completed and targeted smaller streams as identified in Figure 8.	**NorthWoods Stewardship Center**, VDEC, towns, environmental consultants	Ecosystem Restoration Grants	**2011**/ Largely completed. Barton, Black, Clyde, Johns Rivers completed. Some small tributaries have not been done.
49. Complete Phase 2 SGA for all stream reaches in the basin that were rated as in fair or poor condition in the Phase 1 assessment, stream reaches that towns would like to include in FEH zoning, or stream reaches that are of concern to local residents as shown in Figure 8.	**NorthWoods Stewardship Center**/ VDEC, towns, environmental consultants	Ecosystem Restoration Grants	**2013**/ Majority of Barton, Clyde, Johns Rivers completed. Black River in progress. Some small tributaries have not been done.
50. Work with towns to include protection for floodplains, FEH zones and buffer zones in local zoning.	**NorthWoods Stewardship Center**/ VDEC, MWA, NVDA towns	Town planning grants	**2014**
51. Promote BMPs for development adjacent to river corridors to protect river functions, such as maintaining setbacks and buffer strips, LID techniques.	**NorthWoods Stewardship Center**/ VDEC, OCNRCD, watershed groups	ERP	**ongoing**

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
52. Provide education programs to increase awareness of fluvial geomorphic principles and the many benefits of managing rivers for their equilibrium condition. Examples include demonstrating the flume at Derby days, the fisherman's breakfast or other events in the basin, involving volunteers in geomorphic assessments, and holding workshops.	**NorthWoods Stewardship Center**/ VDEC, towns, OCNRCD, watershed groups	Watershed Grants	**2013**
53. Protect riparian lands in Basin 17 which are identified as essential to maintaining stream equilibrium conditions (shown in Figure 10.)	**NorthWoods Stewardship Center**/ VDEC, Towns, Land Trust, OCNRCD, Environmental Consultants	ERP, VHCB,	**2014**
54. Establish a Trees for Streams Program in Basin 17 to increase natural vegetated buffers along streams.	**OCNRCD**/ VDFPR, Consulting Foresters, Lake Associations	**$10,000 per year /** 319 program, ERP	**2014 /** OCNRCD began trees for streams program in 2010 and continued in 2011.
55. Increase buffers on state lands including fish and wildlife access areas, riparian land ownership and South Bay and Willoughby Falls WMAs.	**VANR**/ NorthWoods Stewardship Center,	Lands Stewardship funds	**2012 /** Buffer plantings along a 1.5 miles of river in 2009 and 2010. Dunn property accepted by USFWD will have 100ft buffers.

GOAL: PREVENT THE SPREAD OF NON-NATIVE INVASIVE PLANTS AND ANIMALS TO WATERBODIES AND RIPARIAN LANDS IN THE BASIN AND TO CONTROL EXISTING POPULATIONS WHERE PRACTICAL TO SUPPORT RECREATION AND NATIVE BIOLOGICAL COMMUNITIES IN THE BASIN.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
56. Hold an annual Vermont Invasive Patrollers (VIP) training in the basin to support the establishment of VIP programs for lakes and ponds in the basin.	**VDEC**/ Lake and Watershed Groups	NA	**Yearly**/ workshops held in 2008 and 2009.
57. Support new and existing greeter programs for lakes and ponds. Encourage greeter programs on waters with invasives (e.g. Eurasian watermilfoil) to provide information to recreational users to encourage actions to prevent waterbody to waterbody transport	**VDEC**/ Lake and Watershed Groups Communities	ANC Grant-in-Aid, Watershed Grants	**2011**
58. Support participation in the Federation of Vermont Lakes and Ponds forum for lake and pond residents to discuss issues associated with aquatic invasive species spread prevention and control in addition to other lake and pond topics.	**Federation of Vermont Lakes and Ponds**/ Lake and Watershed Groups, VDEC	NA	**ongoing**

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
59. Support active invasive species control programs with priorities going to those which have the greatest chance of keeping an invasive species population in check.	V**DEC**/ Watershed Groups, Towns	ANS grants, Town funds, Local support	**ongoing**
60. Strengthen the enforcement of existing laws in regards to the transport of aquatic non-native invasive species.	**Enforcement programs**/ Legislature, VDEC, Watershed Groups	NA	Law passed to make transport of all aquatic plants illegal in 2010

GOAL: IMPROVE AQUATIC HABITAT CONDITIONS IN THE BASIN TO SUPPORT FISHERIES, AND AQUATIC, RIPARIAN AND WETLAND COMMUNITIES.

Objective: Protect and restore habitat and water quality of lakes and lakeshores.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
61. Hold a public meeting to discuss the importance of undeveloped lakeshore parcels and priorities for their protection.	**VDEC**/ UVM, Lake and Watershed Groups		**2011**
62. Working closely with local land trusts, lake associations, and towns, contact landowners of the highest priority undeveloped lakeshore parcels to determine interest in conservation and conserve at least one of the top priority parcels.	**VLT**/ NorthWoods Stewardship Center, VANR, Towns, Environmental Consultants	VHCB, Private funds	**2013 /** Dunn property accepted by US Fish and Wildlife with support from VANR.
63. Coordinate lake association comments on any lakeshore buffer legislation at the state level to increase the likelihood that any such an effort will be effective in protecting lakes in the basin.	**Federation of Vermont Lakes and Ponds**/ Lake and Watershed Groups	NA	**ongoing**
64. Contact all towns in the basin without existing buffer language for lakes in town zoning to offer support for the development of regulations such as those included in the VLCT *Model Lake Shoreland Protection District Bylaw.*	V**DEC**/ VLCT, NVDA, Watershed Groups, Conservation, zoning and planning commissions	Municipal planning grants, 604(b)	**ongoing**
65. Hold annual shoreland walks or paddles in the basin to discuss good shoreland practices and advertize these to all basin lake and watershed groups.	NorthWoods Stewardship Center, VDEC, OCNRCD, MWA, Watershed Groups	Watershed Grant	**2013/** Walks have been held in Newport and Morgan.
66. Continue to develop materials on good and poor lakeshore practices for distribution to lakeshore residents. Establish a program for getting these materials to new shoreland landowners in the basin and to the press.	**MWA**/ VDEC, Watershed Groups	Watershed Grant,	**2012/** MWA developed materials for folder and has distributed around Memphremagog and to other lake associations.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
67. Establish lakeshore buffer planting programs that continue through the early summer when lakeshore residents are in town.	**OCNRCD**/,VDEC, Watershed/ Lake groups	**$10,000 yr**/ 319 program, ERP,Watershed grant	**2012**/ Northeast Kingdom Lakeshore Buffering program established and extending season.
68. Hold a training for landscapers on landscaping to protect the lakeshore environment. Contact local nurseries to encourage them to provide local native trees and shrubs for shoreland plantings at reasonable prices.	**NorthWoods Stewardship Center**/ VDEC, OCNRCD, Watershed/lake Groups, Master Gardeners	Watershed Grant	**Ongoing**
69. Host and do outreach to promote project WET training workshops for teachers in the Memphremagog watershed customized to address water-related topics including, wetlands, watersheds, lake ecosystems, water quality monitoring, and phosphorus.	**VDEC**/ Local Schools and teachers, Watershed and lake groups		**Ongoing**

Objective: Protect the functions and values of existing wetlands and selectively restore human-altered wetlands.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
70. Increase opportunities for watershed residents to learn about the important functions and values of wetlands , and changes in the wetland rules that allow all significant wetlands, regardless of mapping, to be protected and considered class II, through events, public displays and the distribution of outreach materials.	**NorthWoods Stewardship Center**, VDEC, Lake and Watershed Groups, Beck Pond LLC	Watershed Grant	**2012**
71. Complete wetlands surveys for towns in the basin to identify wetlands not included on the Vermont Significant Wetlands Inventory maps and wetlands with exceptional functions and values that may be deserving of additional protections thorough conservation efforts, town zoning, or reclassification.	**Conservation Commissions**/ NorthWoods Stewardship Center, VDEC, Towns, environmental consultants, Beck Pond LLC	**$5,000-$10,000 per town** / 604(b), Watershed grant.	**2013**/
72. Develop specific wetland conservation priorities for high value wetlands in the basin for both habitat and phosphorus retention and use the priorities to focus the wetland conservation and restoration work of the many different partners involved in such work in the basin.	**VDEC**/ NVDA, Watershed Groups, NRCS, OCNRCD, VLT, Northern Rivers land trust, Beck Pond LLC	604(b), Watershed Grant	**Ongoing**/ Ecosystem System restoration grant received in 2011 to identify target wetlands for restoration.
73. Work with individual landowners to conserve wetlands with exceptional functions and values in the basin.	**VANR**/ Watershed Groups, OCNRCD, NorthWoods Stewardship Center, NRCS, Landowners, VLT, NRLT, Beck	VHCB, Private funds and donations, Ducks unlimited	**Ongoing**/ Dunn property accepted by US Fish and Wildlife with support from VANR and VLT.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
	Pond LLC		
74. Identify and prioritize sites of prior converted agricultural wetlands and wetland buffers in the basin for wildlife and phosphorus retention potential. Contact landowners to encourage enrollment in the Wetlands Reserve Program or CREP program to restore wetland functions and values.	**OCNRCD**/ VDEC, Lake and Watershed Groups, NRCS, Private landowners, Beck Pond LLC	WRP, WHIP, CREP, ERP, Partners for Fish and Wildlife	**2012/** Ecosystem System restoration grant received in 2010 to identify lands appropriate for WRP program.
75. Provide information to watershed residents about changes in the Current Use Program that allow for the enrollment of ecologically sensitive lands such as wetlands	**NorthWoods Stewardship Center**/ VANR, Consulting foresters		**2013**
76. Provide information to watershed residents on the benefits of beavers including their importance for creating wetland and wildlife habitat and for protecting water resources. Increase the awareness of programs available in some situations to assist landowners in dealing with human beaver conflicts while maintaining the benefits of beavers.	**VFWD**/ VDEC, Watershed groups	USFWS funding	**ongoing**
77. Increase protection for the Upper Clyde River / Pherrins Wetlands Complex, including, but not limited to, having these wetlands designated a Class One Wetland under the Vermont Wetlands Rules.	**NorthWoods Stewardship Center**/ Towns, VANR, Watershed groups, private landowners	Watershed Grant	**2012/** Upper Clyde River wetlands study initiated by NorthWoods Stewardship Center in 2011.

Objective: Assess barriers to aquatic species passage and replace or retrofit priority structures in the basin to increase stream continuity.

Action	**Lead**/Key Players	**Cost**/Funding	**Target Date**/Status
78. Complete bridge and culvert assessments using ANR protocols on streams in the basin targeting in the following order of priority: a. Black, Barton, Johns rivers and minor tributaries to Lake Memphremagog, and the Clyde River below Charleston Dam. b. Tributaries to Willoughby, Crystal, Salem, Echo, and Seymour lakes, Norton, Island and Great and Little Averill ponds. c. The rest of the watershed used by brook trout and other native species	**VDEC**/ VDFW, OCNRCD, Vtrans	**$5,000-$10,000** / 604(b), Ecosystem Restoration	**2014/** Assessments have been completed for the town of Coventry, and portions of the Black and Johns Rivers and Phase 2 assessment reaches.
79. Work with partners in the basin to replace stream crossings blocking aquatic species passage including those targeted in Table 3 as well as any identified through additional bridge and culvert assessments.	**VDEC**/ VDFW, OCNRCD, Vtrans, Towns, NRCS, VAST	WHIP, ERP, Partners for fish and wildlife, Eastern brook trout joint venture	**2014**

Chapter 5. Management Goals for Surface Waters in Basin 17

The protection or improvement of water quality and water-related uses can be promoted by establishing specific management goals for particular bodies or stretches of water. The management goals describe the values and uses of the surface water that are to be protected or achieved through appropriate management. In Chapter 2 of this plan, a number of waters were identified as being of notable high quality, and these, as well as other unique areas such as the upper Clyde River wetlands, may be candidates for establishing higher management goals through one of the following processes which are further described below:

- Classification of waters and designation of water management types.
- Identification of existing uses.
- Designation of waters as Outstanding Resource Waters.
- Designation of waters as warm and cold water fisheries.
- Classification of wetlands.

The Agency of Natural Resources is responsible for determining the presence of existing uses on a case by case basis or through basin planning and the Vermont Water Resources Panel is responsible for classification or other designations by rule. Once the Agency or the Panel establishes a management goal, the Agency manages state lands and issues permits to achieve all management goals established for the associated surface water. Before the Agency recommends, or the Panel establishes management goals through a classification or designation of surface waters as a rule, input from the public on any proposal is required and considered. The public is also able to present a proposal for establishing management goals for the Panel to consider at any time. When the public develops proposals regarding management goals, the increased community awareness can lead to protection of uses and values by the community and individuals.

Water Management Typing and Classification

Since the 1960s, Vermont has had a classification system for waters that establishes management goals. Setting water quality management goals is the responsibility of the Vermont Water Resources Panel. These goals describe the values and uses of surface waters that are to be protected or restored through appropriate management practices. The Agency works to implement activities that restore, maintain or protect the management goals. The current classification system includes three classes: A(1), A(2), and B.

Presently in all basins across Vermont, waters above 2,500 feet in elevation are classified A(1) by Vermont statute. In addition, the Water Resources Panel or members of the public can petition that high quality waters with significant ecological value below 2,500 feet be classified as A(1) based upon the public interest. In Basin 17, the only A(1) waters include those above 2,500 feet in elevation. The management objective for A(1) waters is to maintain their natural condition.

Waters used primarily as public water supplies may be classified A(2). The only class A(2) waters in Basin 17 that are actively used as a water supply are:

- Unnamed tributary to Island Pond

- Unnamed tributaries to unnamed tributary to Lightning Brook
- May Pond Brook watershed above water intake

The Cities of Sherbrooke and Magog use water from Lake Memphremagog as a water supply for approximately 160,000 people and similar to Lake Champlain which is used as a drinking water source in Vermont, Lake Memphremagog is classified as a Class B water. Management objectives for class B waters state that Class B waters shall be managed to achieve and maintain a level of quality that fully supports the designated use of the water as a public water supply and be suitable for use as a source for a public water supply with filtration and disinfection and so this classification is protective of the continued use of Lake Memphremagog as a drinking water supply. Most other municipalities and private individuals in the watershed use ground water wells for drinking water supplies.

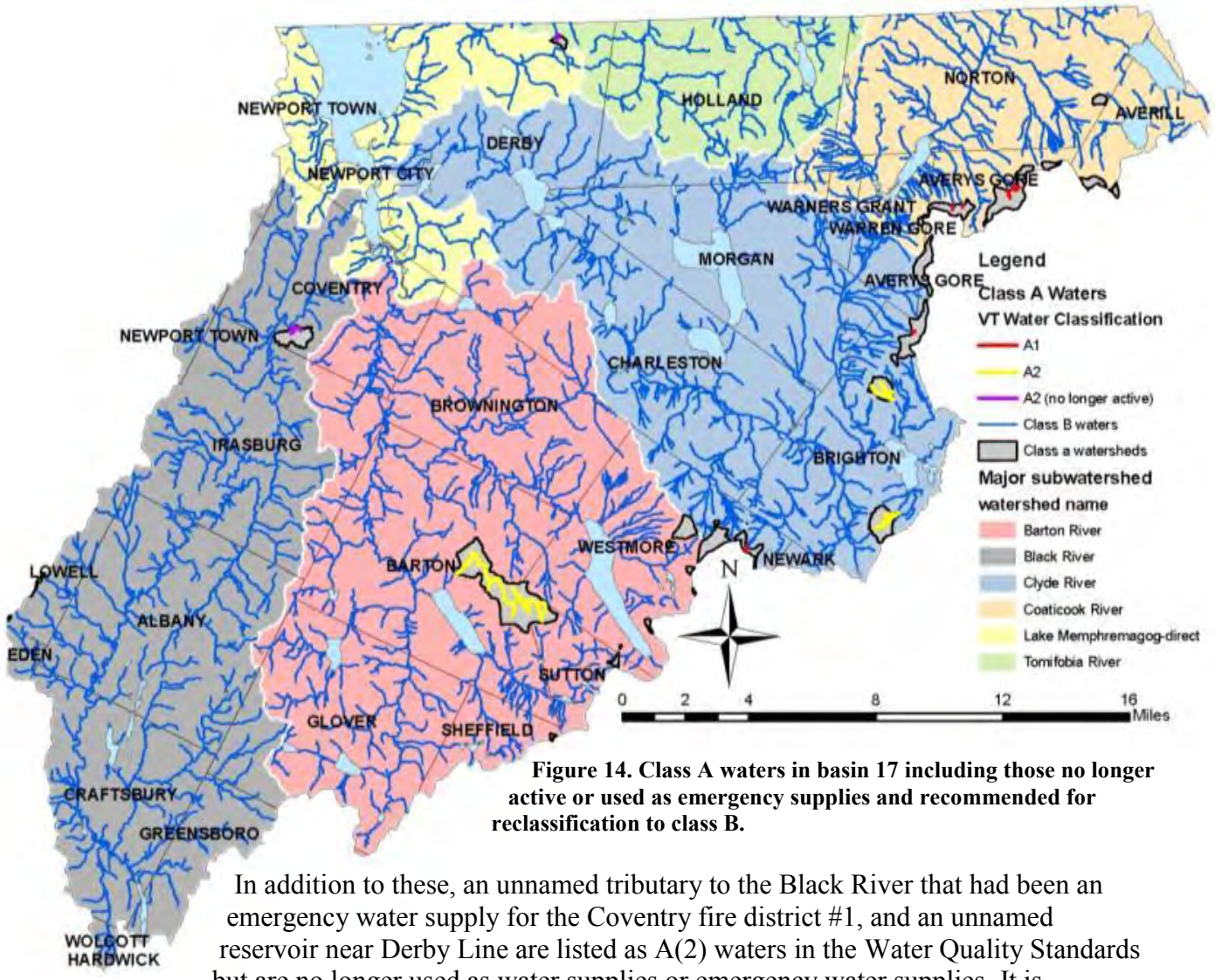


Figure 14. Class A waters in basin 17 including those no longer active or used as emergency supplies and recommended for reclassification to class B.

In addition to these, an unnamed tributary to the Black River that had been an emergency water supply for the Coventry fire district #1, and an unnamed reservoir near Derby Line are listed as A(2) waters in the Water Quality Standards but are no longer used as water supplies or emergency water supplies. It is recommended that these two A(2) waters be reclassified to Class B waters. All the remaining waters in the watershed below 2,500 feet in elevation are Class B waters.

As part of the Water Quality Standards revisions in 2000, the system was changed to allow Class B waters be divided into three management types: B1, B2 and B3. This change was made to furnish a greater level of protection to existing higher quality waters and to recognize attainable uses that could be supported by improvements to existing water quality. A simplification of the B1, B2 and B3 designations would be to say that the spectrum from B3 to B2 to B1 is described as representing "good," "better" and "best" aquatic conditions.

The revised Water Quality Standards require that all basin plans place Class B waters into one of the three water management types. However, considerable challenges over the past decade have limited ANR's ability to identify proposed water management types, and the Panel's ability to promulgate these designations. These challenges are listed in detail in VDEC's 2010 Report to the Vermont General Assembly on Basin Planning. Consequently, this basin plan contains no recommendations for any Class B water concerning water management types.

Existing uses

During the Basin 17 planning process, VDEC collected sufficient information to document and determine the presence of existing uses for swimming, boating, and fishing on flowing waters using current VDEC procedures. Waters used as active or emergency public drinking surface water supplies were also identified. The Agency presumes that all lakes and ponds that exist within the basin have existing uses of fishing, contact recreation and boating. This simplifying assumption is being used because of the well known and extensive use of these types of waters for these activities based upon their intrinsic qualities and, to avoid the production and presentation of exhaustive lists of all of these waterbodies across Basin 17. This presumption may be rebutted on a case-by-case basis during the Agency's consideration of a permit application which might be deemed to affect these types of uses.

The lists presented in tables 7 through 9 are not intended to represent an exhaustive list of all possible existing uses, but rather identify those existing uses per the Department's existing use identification procedure, as has been done for all Basin Plans issued by the Department in recent years. Additional existing uses of contact recreation, boating and fishing on/in flowing waters and additional public drinking water supplies may be identified during the Agency's consideration of a permit application or in the future during subsequent basin planning efforts.

Boating

The Appalachian Mountain Club (AMC) River Guide describes five boating segments on the Black River and one stretch to portage. The most boated stretch of the river however is flatwater in the lower reaches of the river from Coventry to Lake Memphremagog.

The AMC River Guide (2007) describes the boating on the Barton River in two segments. The first segment begins north or downstream of Glover village and goes to the confluence of the Willoughby River, which is approximately nine and a quarter miles. The second segment from the confluence of the Barton and Willoughby Rivers to Lake Memphremagog is about ten miles long to South Bay or twelve and a half miles to the U.S. Route 5 bridge across the top of South Bay. There are no obstructions in this stretch, which includes a few miles through the floodplain and swamp forests of the South Bay Wildlife Management Area and this is the more heavily boated stretch of the river.

There is an approximately 3 ½ mile stretch of the Clyde River described in The Whitewaters Report (1992) as a "highly important" stretch for whitewater boating. The run begins at Salem Lake where there is access at the town beach. Below Salem Lake, the river is Class II whitewater. The river is lined with cedar and this stretch was described as secluded and beautiful. After a mile in the cedar, the river goes under the Route 105 bridge, steepens and is possibly Class III at high water. It then goes into a ravine, crosses under Interstate 91, becomes another good Class II stretch before flattening out and flowing into Clyde Pond.

The AMC River Guide (2007) describes three "runnable sections" of the Clyde River including the Class II whitewater stretch described above. The other sections described are a 15-mile stretch of flatwater and quickwater from below Island Pond to Pensioner Pond and a three and a quarter stretch of mostly quickwater with some Class I and II rapids from West Charlestown to Little Salem Pond.

The Clyde River is also now part of the Northern Forest Canoe Trail that runs from Old Forge New York to Fort Kent Maine.

Table 7. Boating as an existing use of specific flowing waters in Basin 17.

Surface Water	Location of Use	Town	Documentation of Existing Use	Put In	Take Out
Black River	From Coventry to Lake Memphremagog	Coventry, Newport City	Appalachian Mountain Club (AMC) NH and VT paddlers guide (Fisk 2007)	Park in Coventry	South Bay VFWD Boat Launch
Barton River	From Willoughby River to Lake Memphremagog	Barton, Irasburg, Coventry	AMC	River Road Bridge	South Bay VFWD Boat Launch
Clyde River	From Five Square Mile Road to Pensioner Pond	Brighton, Charleston	AMC, Northern Forest Canoe Trail, Clyde River Paddling and Fishing Guide.	Five Square Mile Road	Pensioner Pond VFWD boat launch
Clyde River	From West Charleston to Salem Pond	Charleston, Derby	AMC, Northern Forest Canoe Trail, Clyde River Paddling and Fishing Guide.	Fontain Road Bridge	Hayward Road
Clyde River	From Lake Salem to Clyde Pond	Derby	AMC, Northern Forest Canoe Trail, Clyde River Paddling and Fishing Guide, White water rivers of VT (rated highly important)	Hayward Road	Clyde Pond Dam Access Area

Swimming

Most of the swimming in the basin takes places on the many lakes and ponds in the basin which have a presumed existing use of contact recreation. During the basin planning process no locations of swimming use on rivers were identified in accordance with the Vermont anti-degradation implementation procedure (see Appendix F).

Fishing

The basin is best known for its fishing opportunities associated with runs of Salmon and rainbow trout from Lake Memphremagog into major tributaries, as well as cold water fisheries in the

many deep oligotropic lakes in the basin. In particular, the Willoughby River is renowned for its spawning migration of steelhead from Lake Memphremagog. These fish leap a cascade in Orleans, attracting hundreds of dedicated anglers and spectators from far and wide during the months of April and May (VANR 2006). However, there are a diversity of fishing opportunities in the basin including warm water fisheries on many of the shallower lakes which include some of the larger northern pike in the state, walleye runs on the Clyde River as well as brook trout in many smaller brooks and ponds in the basin.

Table 8. Recreational fishing as an existing use of specific flowing waters in Basin 17

Surface Water	Location of Use	Town	Documentation
Clyde River	From mouth up to the "abandoned Mill Dam" at the Newport #1,2,3 powerhouse.	Derby	Special regulations
Clyde River	From 1/4 mile below Bridge Street to 1/4 mile above Route 105.	Derby	Stocking information
Clyde River	From 1/4 mile below Fontaine Road to West Charleston Dam.	Charleston	Stocking information
Clyde River	From Charleston Pond to Pensioner Pond Dam.	Charleston	Stocking information
Clyde River	From 1/4 mile above and below Center School Road.	Charleston	Stocking information
Clyde River	From 1/4 mile below Twin Bridges Road to 1/4 mile above Twin Bridges Road.	Charleston	Stocking information
Clyde River	From 1/4 mile above and below Route 105 at the crossing near Ten Square Mile Road.	Charleston	Stocking information
Clyde River	From .2 miles below Charleston/Brighton Town line to .3 miles below Webster Brook confluence.	Charleston/ Brighton	Stocking information
Clyde River	From 1/4 mile above and below access point on Gideon Mills Road.	Brighton	Stocking information
Clyde River	From .6 miles below to .8 miles above Five Square Mile Road.	Brighton	Stocking information
Barton River	From the mouth to the US Rte 5 closest to the Village of Barton.	Coventry Irasburg Barton	Special regulations
Willoughby River	From the Barton River to Lake Willoughby outlet.	Barton Brownington Westmore	Special regulations
Black River	From mouth to Route 14/58 bridge in Irasburg.	Coventry/ Irasburg	Special regulations
Black River	From 1/4 mile above and below Farm Road.	Irasburg	Stocking information
Black River	From 1/4 mile above and below Route 14 North near Griggs Pond.	Albany	Stocking information
Black River	From 1/4 mile above and below Wyllie Hill Road.	Albany	Stocking information
Black River	From 1/4 mile below Tanner Rd to 1/4 mile above North Craftsbury Road.	Craftsbury	Stocking information
Black River	From 1/4 mile above and below Post Road.	Craftsbury	Stocking information
Black River	From 1/4 mile above and below Black River Road.	Craftsbury	Stocking information
Black River	From 1/4 mile above and below Cemetery Road.	Craftsbury	Stocking information

Drinking Water Supplies

There are a number of public drinking waters supplies in Basin 17 including three systems that use surface waters and one that has a surface water listed as an emergency water supply. The Town of Brighton water supply receives water from a tributary to Island Pond and a tributary to

Table 9. Determination of existing uses of waters for pubic surface water supplies in Basin 17

Surface Water	Town	Documentation of Existing Use
Unnamed tributary to Island Pond	Brighton	Town of Brighton water supply (identified in the VWQS and source protection plan)
Unnamed tributaries to unnamed tributary to Lightning Brook	Brighton	Town of Brighton water supply (identified in the VWQS and source protection plan)
Derby Lake	Derby Center	Derby Center water supply (based on source protection plan)
Holland Pond	Holland, Norton	Emergency water supply
May Pond Brook watershed above water intake	Barton, Sutton	Town of Barton water supply (identified in the VWQS and source protection plan)

Lightening Brook. The Town of Barton water supply receives water from May Pond Brook, and the Derby Center water supply receives water from the Derby Pond watershed. Derby Line also maintains Holland Pond as an emergency water supply. Most other municipalities and private individuals in the watershed use ground water wells for drinking water supplies.

Outstanding Resource Waters

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.

At the present time there are no ORW designations in Basin 17. Although no other waters have been identified as ORW in this plan, there may be waters in the basin which merit this designation and for which ORW status should be pursued. Water quality on the Willoughby River and its exceptional recreational (primarily fishing) and scenic values make this a potential water for this designation. Similarly, Lake Willoughby is renowned for its exceptional scenic beauty and recreational values along with water quality and so may also merit ORW designation. The Agency will support the development of a petition by providing guidance and relevant information for ORW designation of these waters, should there be public support.

Warm Water and Cold Water Designations

In addition to the foregoing classifications and designations the following waters are designated for management as warm water fish habitat by the VWQS:
(a) Daniels Pond, Glover
(b) Lake Derby, Derby
(c) Long Pond, Sheffield
(d) Little Hosmer Pond, Craftsbury
(e) Mud Pond, Craftsbury
(f) Mud Pond, (North) Morgan
(g) Tildys Pond (Clark Pond), Glover
(h) Toad Pond, Charleston
(i) Turtle Pond, Holland

The remainder of surface waters in Basin 17 are designated as cold water fish habitat. Waters designated as warm water fish habitat have less stringent dissolved oxygen, temperature and turbidity criteria than waters designated as cold water fish habitat (Vermont Water Resources Board 2008). This water quality management plan does not recommend any changes in the designation of waters in the basin.

Acronyms

319	Federal section 319 grants for NPS pollution abatement
604(b)	Federal section 604b funds for regional planning commissions
AAP	Acceptable Agricultural Practices
Agency	Vermont Agency of Natural Resources
AMP	Acceptable Management Practices
ANS	Aquatic Nuisance Species Program
AOP	Aquatic Organism Passage
ARS	Agricultural Rresources Specialist
BMP	Best Management Practices
CREP	Conservation Reserve Enhancement Program
EQIP	Environmental Quality Incentives Program
ERP	Ecosystem Restoration Program
FEH	Fluvial Erosion Hazard
FEMA	Federal Emergency Management Agency
LaRosa	LaRosa Analytical Partnership Program
LEAP	Logger Education to Advance Professionalism
LMP	Lay Monitoring Program
MWA	Memphremagog Watershed Association
NFIP	National Flood Insurance Program
NMP	Nutrient Management Plan
NOFA	Northeast Organic Farming Association of Vermont
NPS	Nonpoint Source Pollution
NRCS	Natural Resource Conservation Service
NVDA	Northeastern Vermont Development Association
OCNRCD	Orleans County Natural Resources Conservation District
ORW	Outstanding Resource Water
PSB	Public Service Board
RMP	River Management Program (Agency of Natural Resources)
SARE	Sustainable Agriculture Research and Education
SEP	Supplemental Environmental Project
TMDL	Total Maximum Daily Load
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
UVM Ext	University of Vermont Extension
UVM WAgN	University of Vermont Women's Agricultural Network
VAAFM	Vermont Agency of Agriculture, Food and Markets
VACD	Vermont Association of Conservation Districts
VANR	Vermont Agency of Natural Resources
VAST	Vermont Association of Snow Travelers
VCGI	Vermont Center for Geographic Information
VDEC	Vermont Department of Environmental Conservation
VDFPR	Vermont Department of Forest Parks and Recreation
VFWD	Vermont Fish and Wildlife Department
VHCB	Vermont Housing and Conservation Board
VIP	Vermont Invasive Patrollers
VLCT	Vermont League of Cities and Towns
VLT	Vermont Land Trust
VSJF	Vermont Sustainable Jobs Fund
VTrans	Vermont Agency of Transportation
VRC	Vermont River Conservancy
VWQS	Vermont Water Quality Standards
VYCC	Vermont Youth Conservation Corps
WHIP	Wildlife Habitat Enhancement Program
WWTP	Waste Water Treatment Plant

Glossary

Please see http://www.anr.state.vt.us/dec/waterq/wqd_mgtplan/swms_glossary.htm#eco

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