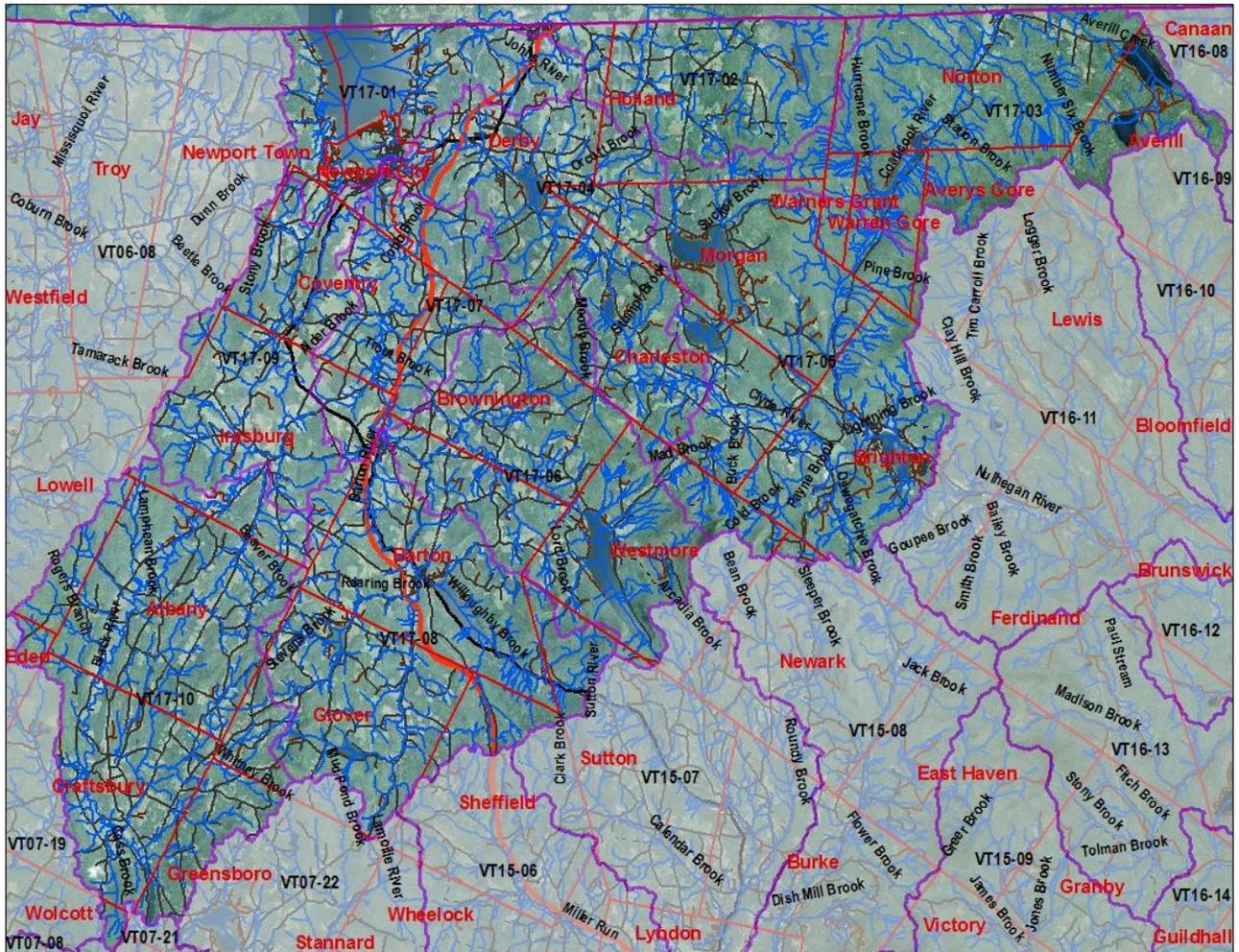


Lake Memphremagog Watershed

Including Barton, Black, and Clyde River Watersheds

Water Quality and Aquatic Life Assessment Update



Vermont Agency of Natural Resources
Department of Environmental Conservation
Monitoring, Assessment and Planning Program
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Memphremagog Watershed Summary of Segments with Impacts

The table below contains the segments of river or stream or portion of lakes or ponds that are either impaired or altered (do not meet some part of the Water Quality Standards) or stressed (still meeting standards as far as is known but a pollutant, activity, or condition is reducing the water quality or aquatic community or its habitat). These segments are from the draft 2016 303(d) Impaired Waters List, Other Priority Waters List, or the Stressed Waters list maintained by the Vermont DEC Watershed Management Division.

Table 1. Stream segments or lake sections with impacts

Stream or Lake Segment	Mileage & Status	Pollutant	Source	Other information
Lake Memphremagog (two segments)	5966 acres Impaired Part A list	phosphorus		Creation of a TMDL is underway.
Stearns Brook Tributary	0.5 miles Impaired Part A list	nutrients	agricultural activities	Projects to address nutrient-laden runoff have been identified
Turtle Pond (Holland)	27 acres Impaired Part D list	acid	Atmospheric deposition	EPA approved a TMDL on Sept. 30, 2003.
Duck Pond (Holland)	6 acres Impaired Part D list	acid	Atmospheric deposition	EPA approved a TMDL on Sept. 30, 2003.
Halfway Pond (Norton)	22 acres Impaired Part D list	acid	Atmospheric deposition	EPA approved a TMDL on Sept. 30, 2003.
Lake Salem (Derby)	150 acres Impaired Part D list	mercury	Atmospheric deposition	EPA approved a regional mercury TMDL Dec. 20, 2007
Roaring Brook	2.4 miles Impaired Part A	nutrients	Agricultural activities, pond	New listing in 2016
Lake Derby (Derby)	10 acres Altered Part E list	Eurasian water milfoil		
Brownington Pond (Brownington) (two segments)	30 acres Altered Part E list	Eurasian water milfoil		
Lake Elligo (Eligo Pond) (Craftsbury)	15 acres Altered Part E list	Eurasian water milfoil		
Great Hosmer (Craftsbury) (three segments)	140 acres Altered Part E list	Eurasian water milfoil		
Averill Creek, downstream from dam on Great Averill	5.4 mile Altered Part F list	low and fluctuating flows	Hydro-electric facility operation	Facility in Quebec
Averill Creek, downstream from dam on Little Averill	1.0 mile Altered Part F list	low and fluctuating flows	Hydro-electric facility operation	Facility in Quebec

Coaticook River below Norton Pond Dam	3.0 mile Altered Part F list	low and fluctuating flows	Hydro-electric facility operation	Facility in Quebec
Little Averill Pond (Averill)	467 acres Altered Part F list	water level fluctuation	Hydro-electric facility operation	Facility in Quebec
Great Averill Pond (Averill)	828 acres Altered Part F list	water level fluctuation	Hydro-electric facility operation	Facility in Quebec
Norton Pond (Norton)	583 acres Altered Part F list	water level fluctuation	Hydro-electric facility operation	Facility in Quebec
Tributaries to the Clyde River below Brighton water supply withdrawal	2.0 miles Altered Part F list	low & fluctuating flows		
Shadow Lake (Glover)	210 acres Altered Part F list	water level fluctuation	Town owned dam	Town can fluctuate water level by four to five feet
Johns River	2.5 miles Stressed	nutrients		
Lake Memphremagog (Newport)	5966 acres Stressed	mercury		
Lake Memphremagog littoral zone	Stressed	new invasive species		
South Bay (Newport)	470 acres Stressed	mercury, nutrients, sedimentation, Eurasian watermilfoil		
Stearns Brook	3.0 miles Stressed	sediment		
Clyde Pond (Derby)	149 acres Stressed	mercury		
Clyde Pond (Derby)	37 acres Stressed	Eurasian watermilfoil		
Walker Pond (Coventry)	Stressed	phosphorus		
Mud Pond (Craftsbury)	Stressed	phosphorus		
Barton River below Ethan Allen wetlands	0.5 miles Stressed	toxics		
Black River Trib #2	0.5 miles Stressed	nutrients	Ag activities	Macroinvertebrate sample fair in 2015

IDDE Investigation in the Memphremagog Watershed

An illicit discharge detection and elimination (IDDE) project was recently conducted in the Lake Memphregagog watershed and included the Town of Barton, Village of Orleans (in Barton), Town of Brighton, Newport City, Town of Derby and its villages Derby Line and Derby. A total of 375 stormwater drainage systems were assessed. Of the 375, 320 were assessed at the outfall and 55 were assessed “up-pipe from the mapped outfall location”. Some of these 55 were “inundated by the receiving waterbody.”

Among the 375 systems investigated, there were 73 suspected illicit discharges. Of the 73 suspected discharges, 13 had confirmed illicit discharges (although dye testing could not be done on two discharges in the suspected category and there is further assessment ongoing in Newport City). Of the thirteen confirmed, six were in Barton, none were in Brighton, four were in Derby (either the town or the villages), one was in Orleans Village, and two were in Newport City. Follow-up is needed and is happening on the confirmed discharges.

Tumors in Lake Memphremagog Fish

In 2013, the Vermont Department of Fish and Wildlife got reports from anglers of a “black tar substance” on brown bullhead from Lake Memphremagog and other locations. Fish with these raised black areas were found in Halls Creek, the Black River in Coventry, the Willoughby River, and the main lake of Lake Memphremagog.

In 2014, seventy-three brown bullhead were collected by Fish and Wildlife Department in Hospital Cove and 26% were found to have these lesions. The lesions seemed to show with fish over a certain length. Seven tissue samples were preserved and sent to the USGS National Fish Health Research Laboratory. The laboratory determined that “[t]he raised black lesions were diagnosed as invasive melanomas. Neoplastic melanocytes invaded into the hypodermis and in some cases in to the muscle of affected fish.” They also noted that “[t]o our knowledge this is the first report of a high prevalence of melanoma in a wild population.”

The USGS National Fish Health Research Laboratory and the West Virginia Cooperative Fish and Wildlife Unit are doing further study of the affected fish tissue plus reference samples of fish tissue. The study components include:

- Further verify the presence and microscopic pathology associated with observed pigmented lesions.
- Compare both skin and liver tissue microscopically in bullheads collected within Lake Memphremagog (with and without pigmented lesions) and the reference (Ticklenaked Pond) without the presence of pigmented lesions.
- Using Next Generation Sequencing of normal and pigmented skin to identify differences in gene expression that might provide evidence for the cause/risk factors associated with observed melanomas.

The Vermont Department of Environmental Conservation is assisting with attempts to determine the cause of these lesions and having fish tissue analyzed for a number of contaminants including PAHs, which have been associated with lesions and tumors in brown bullhead in some past studies.

Black River Watershed

General Description

The Black River is 26 miles in length and drains 134 square miles of land. The Black River watershed contains over 600 acres of lakes and ponds, the three largest being Elligo Pond, Little Hosmer Pond and Great Hosmer Pond.

The Black River, after beginning on the east side of Great Hosmer Pond with streams flowing off of Ames Hill in Albany, flows south-southwesterly through a relatively narrow valley. It continues in a generally southerly flow into the town of Craftsbury entering a wider valley east of Duck Pond. Whitney Brook, and then the drainage from Little Hosmer and Great Hosmer Ponds, join the river.

South of Craftsbury village, the river reverses course and flows northwesterly with Lake Elligo outlet stream joining the river from the east. The river twists and turns its way north through a broad valley, which contains many significant floodplain and wetland communities. The river flows the length of Craftsbury, south to north then into the town of Albany where it continues meandering in a more northeasterly fashion on the western side of Great Hosmer Pond now. It winds through Albany and into Irasburg east of Potters Pond. It continues its sinuous route northeast and then east to the village of Irasburg.

Just upstream of Irasburg, the meandering Lords Creek enters the Black River. Lords Creek is about ten miles long and drains a watershed that is 17 square miles.

Downstream of Irasburg, the Black River continues north in a narrower valley. It flows into the town of Coventry and continues in an east-northeasterly direction until it joins the South Bay of Lake Memphremagog in Newport. For about the last 4.7 miles, the river is part of the state's South Bay Wildlife Management Area.

Assessment Information for the Black River watershed

Biological Monitoring

Table 2. Biological Monitoring Site Locations

Stream	Rivermile	Description
Black River	11.4	Adjacent to Covered Bridge Road in Irasburg, at turn off below small farm
Black River	12.1	Below falls off Under the Hill Road below Irasburg village
Black River Trib1	0.1	Located adjacent to High Acres Road
Black River Trib2	0.5	Located off of Coventry Station Rd.
Brighton Brook	0.9	Off Route 58, above Gage Road
Brighton Brook Trib1	0.1	Below Route 58
Stony Brook	1.8	Just upstream of Spencer Hill & Route 14 junction off east side of Route 14 below gravel mining area
Stoney Brook	2.8	Upstream of Route 14 immediately below gravel mine
McCleary Brook	2.0	Up Dyer Road, above Albany/Lowell town line, upstream of confluence with unnamed tributary

Rogers Branch	1.0	Upstream of Bailey Hazen Road crossing
Shalney Branch	1.3	Upstream of Godard Lot and Larabee Hill Roads intersection

Table 3. Biological monitoring assessments 2006 – 2015 Black River watershed streams

WBID	Stream Name	River-mile	Date	Assessment - macroinvertebrates	Assessment - fish
VT17-09	Black River	11.4	09/15/2014	very good-good	---
VT17-09	Black River	12.1	09/14/2009	very good	---
VT17-09	Black River Trib 1	0.1	09/14/2014	very good-good	poor
VT17-09	Black River Trib 2	0.5	09/16/2015	fair	---
VT17-09	Brighton Brook	0.9	09/21/2004	---	ua ¹
VT17-09	Brighton Brook	0.9	09/15/2014	very good	ua ¹
VT17-09	Brighton Brook Trib 1	0.1	09/15/2014	very good	ua ¹
VT17-09	Stoney Brook	1.8	09/14/2009	poor	very good
VT17-09	Stoney Brook	1.8	09/17/2010	good	---
VT17-09	Stoney Brook	2.8	09/17/2010	exc-vgood	---
VT17-10	McCleary Brook	2.0	10/15/2010	fair	---
VT17-10	McCleary Brook	2.0	09/26/2011	good-fair	---
VT17-10	McCleary Brook	2.0	09/27/2012	good-fair	---
VT17-10	McCleary Brook	2.0	09/26/2013	very good-good	---
VT17-10	McCleary Brook	2.0	09/29/2014	excellent	---
VT17-10	McCleary Brook	2.0	09/28/2015	very good-good	not assessed yet
VT17-10	Rogers Branch	1.0	10/11/2010	excellent	---
VT17-10	Rogers Branch	1.0	09/26/2011	good	---
VT17-10	Rogers Branch	1.0	09/27/2012	very good	---
VT17-10	Rogers Branch	1.0	09/26/2013	exc-vgood	---
VT17-10	Rogers Branch	1.0	09/29/2014	very good	---
VT17-10	Shalney Branch	1.3	10/11/2010	excellent	---
VT17-10	Shalney Branch	1.3	09/26/2011	vgood-good	---
VT17-10	Shalney Branch	1.3	09/27/2012	very good	very good (9/14) ²
VT17-10	Shalney Branch	1.3	09/23/2013	very good	excellent (9/2)
VT17-10	Shalney Branch	1.3	09/29/2014	excellent	excellent (9/16)
VT17-10	Shalney Branch	1.3	09/28/2015	exc-very good	very good

1 unable to assess - site was sampled but IBI not calculated, database notes describe the findings

2 fish sampled at the same rivermile in the same season but different date for some reason

Table 4. Biological monitoring needed in the Black River watershed

Water-body id	Stream or river names	Location, number of sites	Comments
VT17-10	Black River, upper section	Rm 32.3 or rm 34.8	The upper Black River itself hasn't been sampled recently or often
VT17-09	Stony Brook	Rm 1.8 and rm 2.8	Last sampled in 2010 and there are huge gravel pits upstream and a lot of water quality monitoring

VT17-10	Whitney Brook	Any spot	Never been sampled
VT17-10	Lords Creek	Rm 2.4 & other site	Rm 2.4 hasn't been sampled since 2004 and another site farther upstream would be informative

Volunteer water quality monitoring on Black River streams

There has been water quality monitoring on the Black River and its tributaries since 2005 as part of an effort to identify what streams deliver the most phosphorus and nitrogen to Lake Memphremagog. There has also been water quality sampling associated with the biological monitoring in the watershed over the years. There are data from the Black River itself, Brighton Brook, Stony Brook, Shalney Branch, Airport Tributary, an unnamed tributary near the access road to River of Life camp, and other small tributaries. Some of the results are summarized below. More results can be found at the [Memphremagog Watershed Association website](#).

Black River Trib 1 (Airport Tributary)

This small tributary includes two branches: the northern branch drains the back side of the Coventry Airport and an eastern branch drains the south corner of the airport as well as wetlands, cornfields and hayfields, some of which were cleared in 2012. Water sampling on this tributary began in 2013 and identified elevated levels of phosphorus and turbidity. In 2015, sites were added on the northern and southern branches to further identify the source, and upon seeing extremely turbid water in the northern branch a series of gullies were identified that receive stormwater runoff from the southwest corner of the Airport.

Black River Tributary 2

A site visit and sampling was done by Vermont DEC in the fall of 2014 in response to a complaint about water quality in this small tributary. The field visit showed extensive growth of sewage fungus along at least 100 meters of the stream completely covering the bottom.

Two rounds of water quality sampling showed elevated levels of nitrogen and phosphorus from a northern branch of this stream adjacent to a barnyard. An issue with silage leachate was identified and was addressed in the fall of 2014 but LaRosa program began sampling the northern tributary in 2015 to evaluate ongoing nutrient contributions from this small stream. Average total phosphorus levels remained high, and while the flows from this stream are minor, the loading at these levels means that the total loading is still substantial even if slightly lower than in the fall of 2014. In the fall of 2015 a biological sample was collected and showed that at this time, the macroinvertebrate community was assessed as “fair”.

Stony Brook

Water sampling was done on Stony Brook from 2010 through 2013 and a site was added on a very small tributary in 2015 (Sunrise Farm). Generally upstream sites at Hancock Hill Road, and Alderbrook Road, which is below large gravel operations, were low with mean total phosphorus values of 34 and 30 respectively. Phosphorus values gradually increased to Blake Road (41 ug/l) and the mouth of Stony Brook (mean tp of 47).

Results from sampling the Sunrise Farm site in 2015 were very high for total phosphorus (mean of 492 ug/l) with total nitrogen values of 5.5 mg/l and turbidity of just over 5 NTU. However, flows from this small stream are very small so total loading from this site is less than these high values suggest alone.

Field observations during some of the sampling events have included wetland impacts on Stony Brook, which were addressed through an enforcement action, and runoff from manure on farm fields along a farm two-track that crosses the Brook.

Brighton Brook

Brighton Brook has been identified as having elevated total phosphorus levels in 2010 when sampling was first done on this tributary. A number of sites were added in 2011 to 2014 to identify source areas upstream. Collectively these data suggest source areas include barnyard areas and cornfields during rain events. A large mortality compost pile was identified as a source area and was moved in 2015 and so further monitoring will show if this lowers levels at the Upper Brighton Brook North Site.

Macroinvertebrate communities, however, were not affected by the phosphorus levels and were assessed as “very good” on Brighton Brook and Brighton Brook Trib 1 in 2014.

McCleary Brook, Rogers Brook, and Shalney Brook

McCleary, Rogers, and Shalney have been sampled each year for the last five years in a row as part of the water quality certification conditions for the Kingdom Community wind project. Below is information taken directly from one of the annual reports done by the consultants VHB for Green Mountain Power dated May 22, 2015.

The Lowell Wind Project consists of a 63 megawatt Wind Farm with 21 wind turbines and associated infrastructure located along an approximately three-mile ridge line of the Lowell Mountain range in Lowell, Vermont. Construction of the KCW Project was substantially completed by December of 2012, with minor stabilization work occurring through mid-2013. The construction phase stormwater discharge permit (6216-INDC) was terminated on June 17, 2013. During 2014, the Project was in its operational phase and Project construction was limited to postconstruction stabilization activities, such as a tree planting project on rock fill slopes along the accessroad and adjacent to certain turbine pads. Ongoing activity at the Project site is limited to general maintenance and is occurring under an operational phase stormwater discharge permit (6216-INDS).

As seen in Table 3 above, Shalney Brook has been very good to excellent (but for a very good-good in 2011) in all five years sampled for macroinvertebrates and in the three sampled for fish and looks to be a very high quality water.

Volunteer monitoring identified elevated levels of phosphorus in the Shalney Branch in 2009. Several barnyard and laneway improvement projects were implemented during 2009-2012 and seemingly as a result, total phosphorus concentrations in this stream dropped dramatically between 2009-2010 and 2012-2013 especially at the lowest stream flows.

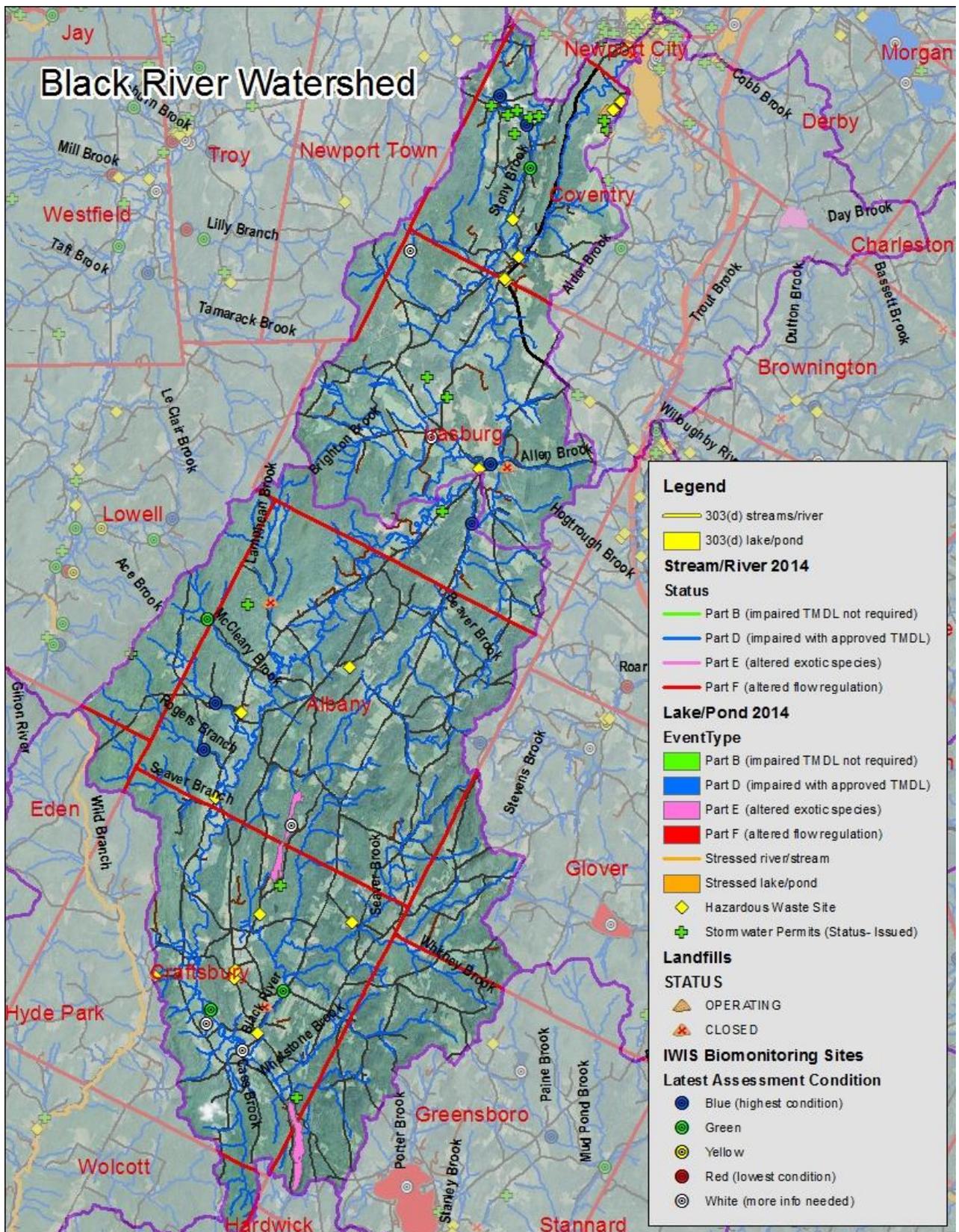


Figure 1. Black River Watershed with Assessment Information

Physical assessments

The Northwoods Stewardship Center completed Phase 1 assessments along the entire Black River (49 river miles) as well as Stony Brook, Ware Brook, Lords Creek, Lamphear Brook, McCleary Brook, Rogers Branch, and Whitney Brook (40 river miles). From these, Phase 2 assessment reaches that appeared most likely in need of restoration were selected. Phase 2 field assessments were completed along ten reaches of the Black River (14 river miles) and ten tributary reaches (totaling nine river miles) along Stony Brook, Ware Brook, Lords Creek, Lamphear Brook, McCleary Brook, Rogers Branch, and Whitney Brook. Information from their 2011 report follows:

Overall, the Phase 2 surveys along the mainstem found eleven miles (79%) in good condition, three miles (21%) in fair condition, and no reaches in poor condition. The tributary findings were nearly identical proportionately, with seven miles (78%) in good condition, two miles (22%) in fair condition, and no reaches in reference or poor condition.

Often the geomorphic state of a reach impacts the condition of the in-stream habitat, while land uses within the river corridor affect habitat along the adjacent riparian zone. During Phase 2 assessments, we evaluated habitats along each of the ten mainstem and ten tributary reaches. All of the mainstem assessed reaches had habitat conditions that were either good (eight miles - 57%) or fair (six miles - 43%). The assessed tributaries had slightly more degraded habitat conditions, with 4.1 miles (46%) being good, 4.7 miles (53%) fair, and 0.1 miles (1%) poor. Reaches rated as having fair or poor habitat condition exhibited higher bank instability and increased sediment deposition affecting the streambed, as well as decreased riparian vegetation. No reaches were in reference condition; in part because we prioritized reaches with impacted riparian zones for the Phase 2 assessments.

Located in a rural watershed, the Black River and its tributaries are relatively lightly influenced by development; one exception being gravel mining operations along Stony Brook. The primary impacts today are from agricultural use within the river corridor, which is much reduced from historic levels, and which is offset in many areas by vegetated riparian buffers. Still, a number of areas do require active restoration - and other intact wetlands and forest within the riparian corridor merit protection to maintain the outstanding habitat and water quality benefits that they provide. Along the mainstem, nearly six miles of river bank currently lack a minimal vegetated buffer (>25 feet wide), while over 15 miles of tributaries lack this minimal buffer. Areas where lack of buffer coincides with stream sensitivity should be prioritized for re-planting efforts. These occur in short sections along the Black River mainstem (reaches M05, M20, and M24), as well as the lower reaches of Ware Brook, McCleary Brook, Rogers Branch, and Whitney Brook, but more extensively in reach M29 and along Lords Creek and Stony Brook.

Hazardous Waste Sites

NEWS (Waste USA) & former Nadeau's Landfills in Coventry

The Nadeau Landfill was opened in 1970 and accepted municipal from Coventry town and Newport City. In 1978 and 1979, 217 55-gallon drums of urea formaldehyde glue were brought to the landfill and some of it was allegedly buried and some of it was stored above-ground. Later the above-ground drums were removed by a contractor, however, the remaining drums were presumably onsite (at the time of the Final Screening Inspection Report in 1989 from which this information comes). Other hazardous materials also were allegedly disposed of onsite including transformer oil potentially with PCBs and "metal treating solutions".

The Vermont ANR DEC Waste Management Division did a Preliminary Assessment of the site in 1986 and then in 1988, jointly with the NUS corporation consultants, did a reconnaissance of the site and on and off site sampling. Eleven soil samples and four sediment sediment samples, two from the Black River, were collected. The following contaminants were found in quantities from 3 to 14 times the background detection limit: arsenic, manganese, zinc, trichloroethene, benzene, 2-butanone, and endosulfan sulfate. A magnetometry reconnaissance was also done at this time to try to determine if there were buried drums onsite and this work did not find evidence of the drums.

In 1991, a consultant did sampling and a search for the metal drums possibly buried in the "old" portion of the landfill that had had a racetrack built over it. There was nothing found thorough this investigation either.

In 1996, a memorandum from a DEC environmental engineer to the chief of the Sites Management Section (SMS) summarized the known and alleged information with respect to hazardous waste at the Nadeau Landfill. The memorandum outlined three options for the Division (current waste management division) in terms of moving forward at the site.

In 1998, the SMS wrote a memorandum to New England Waste Services of Vermont (NEWSVT) notifying the company that the Department of Environmental Conservation had requested EPA to "archive the site from the CERCLIS database" and once that happened, DEC would SMAC (Site Management Activity Complete) the site. The site, as part of the NEWSVT landfill, would still be monitored and reviewed but as part of the solid waste program versus the hazardous waste program.

The NEWSVT facility has been issued a Solid Waste Management Program certification in 2004, then again in 2010, and most recently in June 2015 for a ten year period. Ongoing monitoring of a large number of groundwater wells, several surface water locations, and underdrains are part of the certification.

Surface water monitoring occurs every May and October at eight locations, two upstream locations and six downstream locations. The latest monitoring reviewed was from October 2015 where iron water quality standards were exceeded at one location and arsenic was exceeded at three locations. Some of the metals have detection limits above their water quality standard and so it is not clear if the standards are being met for those pollutants. The metals that have detection limits that are too high include cadmium, copper, chromium, copper, lead, nickel, and zinc.

Barton River Watershed

General Description

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. There are approximately 3,410 acres of lakes and ponds within the basin. The three largest are Lake Willoughby, Crystal Lake and Lake Parker.

As mentioned above, the Barton River begins in Glover at Runaway Pond, which is no longer a pond but a large wetland system, and flows downstream into Tildys Pond and then on downstream in a northerly direction. Shadow Lake outlet stream and an unnamed tributary join the Barton from the west in Glover. The river continues north into Barton and about a mile and a half downstream, Roaring Brook, the outlet stream from Lake Parker, comes into the river. The Barton River increases in size with the addition of this flow.

The river continues north flowing just west of the village of Barton where Crystal Lake's outlet stream comes in. Northwest of Barton village, the river drops rapidly, Hogtrough Brook comes in and then the Barton begins meandering through agricultural fields east of Route 5 deep within its banks in low water. The river flows through agricultural land until Orleans village where it flows adjacent to a wetland and then through the Ethan Allen furniture manufacturing complex built all around and over the river. As would be expected, the river is channelized through the village and this facility. Just north and downstream of Orleans village, the Willoughby River joins the Barton River.

The Willoughby River is the largest tributary to the Barton River beginning at Willoughby Lake in Westmore and flowing 9 miles generally in a northwestern direction through parts of Brownington and Barton. It drains a watershed of about 62 square miles. The Willoughby River begins its journey through a nice cedar swamp (described below) at the northern end of Lake Willoughby where it has clear water and a sandy channel bottom. In about two and a half miles, Lords Brook enters the Willoughby River. The river continues northwesterly through Evansville and then south of Brownington Center, the Brownington Branch joins it. As the river flows south along Center Road, it is flanked on one shore by very high, steep, and in some stretches, bare and eroding, banks. South still of this area, the river turns west and northwest and heads towards Orleans village. At the edge of the village are the dramatic Willoughby Falls described below and then the river flows through flatter agricultural land and joins the Barton River.

The Barton River, relatively large and slow now, meanders through agricultural fields and floodplain/wetlands from Orleans Village up to Lake Memphremagog. The last several miles before the lake, the river is an integral part of a large forested wetland complex protected as South Bay Wildlife Management Area.

Assessment Information for the Barton River watershed

Biological Monitoring

Table 5. Biological monitoring assessments 2006 – 2015 Barton River watershed streams

WBID	Stream Name	River-mile	Date	Assessment - macroinvertebrates	Assessment-fish
VT17-06	Brownington Branch	1.3	09/16/2009	excellent	very good
VT17-06	Brownington Branch	1.3	09/16/2015	excellent	---
VT17-06	Wheeler Mountain Brook	0.1	09/17/2014	excellent	very good
VT17-06	Wheeler Mountain Brook	0.1	09/15/2015	assessment not available yet	good
VT17-06	Willoughby R Trib 17	1.7	09/17/2014	very good	poor
VT17-06	Willoughby River	2.4	09/16/2015	not available yet	---
VT17-07	Alder Brook	1.0	09/14/2009	vgood-good	----
VT17-07	Trout Brook	1.6	09/16/2014	very good	poor
VT17-07	Trout Brook	1.6	09/15/2015	not available yet	poor
VT17-08	Annis Brook	0.1	09/17/2010	----	ua ¹
VT17-08	Annis Brook	0.1	09/13/2011	fair	----
VT17-08	Annis Brook	0.5	09/11/2012	very good	ua
VT17-08	Annis Brook	0.5	09/04/2013	good	ua
VT17-08	Annis Brook	0.7	10/12/2009	good-fair	----
VT17-08	Annis Brook	0.7	09/14/2010	exc-vgood	----
VT17-08	Annis Brook	0.7	09/13/2011	fair	----
VT17-08	Annis Brook	1.9	10/09/2006	good-fair	----
VT17-08	Roaring Brook	0.6	10/21/2009	exc-vgood	----
VT17-08	Roaring Brook	2.4	10/21/2009	fair	----
VT17-08	Roaring Brook	2.4	09/17/2014	fair	----
VT17-08	Roaring Brook	3.5	10/21/2009	good-fair	----
VT17-08	Roaring Brook	5.3	09/17/2014	exc-vgood	ua
VT17-08	Barton River	9.7	09/17/2009	good	---
VT17-08	Barton River	9.8	09/17/2009	very good-good	---
VT17-08	Barton River	14.5	09/17/2009	very good	---
VT17-08	Duck Pond Brk Trib 3	0.2	09/12/2009	exc-vgood	---
VT17-08	Duck Pond Brk Trib 3	0.2	09/11/2012	exc-vgood	---
VT17-08	Duck Pond Brk Trib 3	0.2	09/04/2013	exc-vgood	---
VT17-08	Stevens Brook	3.0	09/17/2009	excellent	----

1 ua = unable to assess, the site was sampled but an IBI not calculated, notes in the database describe the fish findings

Roaring Brook

The macroinvertebrate sampling results at rm 2.4 found a “fair” community in 2009 and again in 2014. The sample in 2009 was found to be “fair” due to enrichment. In 2014 enrichment was also indicated as well as possible toxic effects. The community was again extremely high in abundance >2,500/kn. Richness is good but lower than in 2009; EPT richness was very low with 10 fewer taxa than in 2009. The community is dominated by

Diptera 67%, in particular the Chironomidae. The functional group composition was also severely altered.

The sample location is about one mile below Parker Lake that is enriched likely related to a number of small farms, shoreland development and dirt roads in its watershed; however, it is also below a medium sized farm with a barnyard near Roaring Brook below the Lake Parker outlet.

Upstream at rm 3.5, which is just below Lake Parker, the macroinvertebrate community was sampled in 2009. The community was assessed as “good-fair” that year at that site.

Table 6. Biological Monitoring Site Locations in Barton River watershed

Stream	River-mile	Description
Brownington Branch	1.3	About 100 feet upstream of bridge on Schoolhouse Road.
Wheeler Mountain Brook	0.1	At bottom of Swift Lane, just upstream (about 100m) from Lake Willoughby.
Alder Brook	1.0	Upstream of culvert on Revoir Road
Trout Brook	1.6	In backyard of farm off Cleveland Rd, just below confluence with small tributary
Annis Brook	0.1	Began section about 10 meters above mouth
Annis Brook	0.5	At new security gate downstream of old 0.7 site.
Annis Brook	0.7	In a riffle section in a forested section above a silt fence.
Annis Brook	1.9	At 2200 feet, very small stream, maybe ephemeral.
Roaring Brook	0.6	Above first bridge crossing of Roaring Brk on Roaring Brk Rd
Roaring Brook	2.4	Above road fork of Roaring Brk Rd and East Albany Rd about 200 meters
Roaring Brook	3.5	Below snowmobile bridge, about 350 meters below Lake Parker
Roaring Brook	5.3	Adjacent to Parker Rd, just above confluence with small trib
Barton River	9.7	Just above confluence with the Willoughby River
Barton River	9.8	Above Orleans Village WWTF about 100 meters, in fast bouldery riffle.
Barton River	14.5	Above Route 5 bridge, nest to Pinecrest motel and cabins
Duck Pond BrkTrib 3	0.2	Above Duck Pond Rd, powerline, and I-91 & above confluence with Duck Pond Brook.
Stevens Brook	3.0	By intersection of County Rd and Holliday Rd (near King Neighborhood Rd)

Table 7. Monitoring needed in the Barton River watershed

Water-body id	Stream or river names	Location, number of sites	Comments
VT17-07	Cobb Brook	1 site, above Glen Road?	A lower named trib to the Barton, the stretch midway is channelized by the interstate
VT17-07	Trout Brook	Re-sample at rm 1.6	Why are bugs very good and fish poor in 2014?
VT17-08	Stevens Brook	at rm 3.0 again	Confirm vhf status from 2009
VT17-08	Willoughby River	1 location, rm 4.9	This site was last sampled in 2008.

VT17-08	Lord Brook, a trib to the Willoughby River	1 site	Never been sampled
VT17-06	Willoughby River Trib 7	At rm 1.7 again	Why are bugs very good and fish poor from 2104?

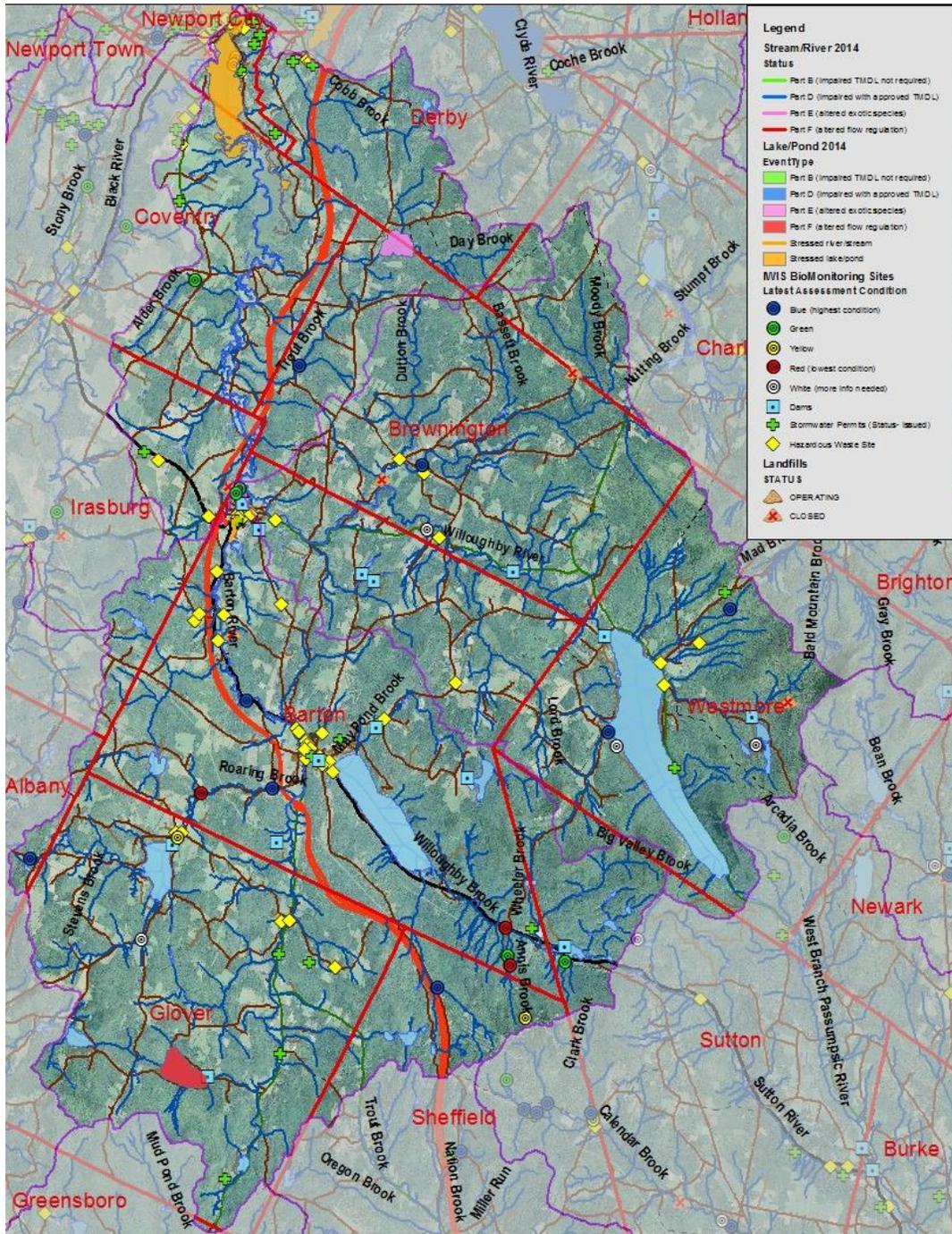


Figure 2. Barton River and watershed assessment information

Physical assessments

A river corridor plan was done for the Barton and Johns Rivers in December 2008 by the North Woods Stewardship Center.

Volunteer water quality monitoring on Barton River streams

There has been water quality monitoring on the Barton River and its tributaries since 2006 as part of an effort to identify which streams deliver the most phosphorus and nitrogen to Lake Memphremagog. A total of 30 sites have been sampled in the Barton River watershed. There has also been water quality sampling associated with the biological monitoring in the watershed over the years.

There are 4 subwatersheds in the Barton River watershed where water quality sampling has identified elevated levels of nutrient and sediment runoff: Hamel Tributary, which includes drainage from Cook Road and Route 5 in Coventry, and two of its tributaries that have mean phosphorus levels of 40 and 100; Rock Junkyard Tributary which includes runoff from Route 58 east out of Orleans and enters the Barton River close to the historical Rock Junkyard (the highest levels of phosphorus have been identified where this stream splits above Route 5); Roaring Branch, which also had a fair biological assessment; and finally, sections of the mainstem of the Barton River from Barton down to Webster road in Coventry. Results can be found at the [Memphremagog Watershed Association website](#).

Hazardous Waste Sites

E.M. Brown & Son

The E.M. Brown & Son/Crystal Lake Outlet Stream hazardous waste site (2004-3206) was sampled in November 2004 (monitoring wells installed October 2004) for VOCs. One well had three contaminants above standard, the other well had two. The site and wells are quite close to the outlet stream.

Surface water and groundwater samples were taken until October 2006 and then the two groundwater monitoring wells were sampled until April 2008 with one of the monitoring wells consistently having contaminants above the Vermont Groundwater Enforcement Standards (VGES). In their May 2008 report, Johnson Company recommended that the property owner pursue Sites Management Activity Closed (SMAC) status for the site as the contamination seems to be limited to the site. Vermont DEC did not agree with SMAC because there are still contaminants in MW3 above the VGES unless a notice is put on the land record with the town and the monitoring wells are closed, in which case the owners can apply for SMAC status.

Letters were exchanged in 2009 about the choices for site closure (i.e. SMAC) between lawyers for the property owners and Vermont DEC Waste Management Division. No action seemed to happen as Vermont DEC sent a letter in 2013 and in 2015 trying to find out what the owners planned to do as there has been no further monitoring and no other activity towards clean-up or closure.

Ethan Allen

The Ethan Allen hazardous waste site (#770016) is located just south of Orleans village with the Barton River along the western edge of the property and wetlands to the south. As of July 1998, the site contained 17 buildings - buildings numbered 3, 16 and 17 being used for chemical and hazardous waste storage. A former 2 ½ -acre drum disposal area in the southeastern corner of the property is just northeast of the wetlands. An intermittent stream flows northeast to southwest through the old drum disposal area into the wetland. During September 1997 Site Inspection Prioritization sampling, two drainage pipes with

water discharging into the Barton River, were observed north of Building Number 3 and "bright orange colored leachate was observed along the outflow drainage route of one of the pipes." In addition, a hole about 2 feet square was seen in a concrete wall just north of Building Number 3. Any stormwater from pavement flow north through this hole into the Barton River and is considered one of two "probable points of entry" (PPE) for contaminants. The second PPE is the intermittent stream in the southeast corner of the property.

Sediment samples were collected during the September 1997 site inspection. Four sediment samples were taken from the Barton River and five sediment samples were taken from the wetland south of the property (two river samples and two wetland samples were collected as background samples). In sediment sample SD-01 just downstream of the drainage pipes mentioned above, there were nine semivolatile organic compounds (SVOCs) found from 2.6 to 17.9 times the reference level. In sediment sample SD-02, just downstream of the wetland discharge to the Barton River, there were seven SVOCs found from 5.4 to 8.2 times the reference value. The PCB, Aroclor-1254, was detected in the sediment samples SD-06 and SD-07. Calcium and potassium were 4.7 to 6.1 times the reference value in both of these samples as well.

The conclusion of the contractors (Roy F. Weston, Inc. Superfund Technical Assessment and Response Team (START)) in the Final Site Inspection Prioritization Report in terms of the "Surface Water Pathway" was this: "Based on the START analytical results, a release of hazardous substances to the Barton River has been noted from on-site sources. As a result of the release, a Clean Water Act-protected water body and a fishery have been impacted. No other sensitive environments are known or suspected to have been impacted. To date, no known actions have been taken to address the release to the Barton River."

A Vermont Agency of Natural Resources environmental enforcement officer visited the Ethan Allen site in summer 2005, however, to follow-up on the above information and did not find the 2 foot hole or see any evidence of discharges or visible problems (orange coloring or other). The officer viewed the river and buildings from several locations.

In February 2009, The Johnson Company applied for designation for Site Management Activity Completed (SMAC) status for Ethan Allen to Vermont DEC. The letter and report outlined the history of the site and how it met SMAC criteria. Additional information to the above, is that the "storm water discharge pipe (Building Number 3, Outfall #2) associated with Weston Sample SD-01 is part of a combined municipal and private system. The system collects surface water from a small stream and storm water from both the Ethan Allen Property and public roads and right-of-ways of Orleans Township east of the plant. "

Barton Electric Department CERCLA site

The Barton Electric Department (BED) CERCLA site is located on High Street northeast of Barton village. There was illegal disposal of transformer oil contaminated with PCBs at this site and between 1985 and 1987, two companies hired by the Barton Electric Department to remove PCB oils. In 1987, BED personnel collected some samples as did Roy Weston for the EPA.

The most recent sampling in the hazardous waste files was from August 1992 and part of an EPA site investigation. Numerous contaminants were found in the soil samples at this site: 10 polycyclic aromatic hydrocarbons (PAHs) were found at concentrations exceeding reference values; one phthalate was found above reference values; 12 pesticides were found in concentrations exceeding reference values; Aroclor-1260 (a PCB) was in 4 samples exceeding reference values; and a number of inorganics were detected in all of the soil samples (copper, iron, cyanide, arsenic). There is a small pond and unnamed outlet stream south of the site. The stream flows to the Barton River (<1/2 mile).

The EPA determined that a "No Further Remedial Action Planned" (NFRAP) decision was suitable for this site and wrote a letter to Barton Village in April 1995 stating this despite the levels of contamination found. Since that time, Vermont DEC Waste Management Division has been in communications with the Village about following up from 1995, doing some testing on the site, and moving towards closing out the site from the State's perspective. The site was mapped during the IDDE process but the investigators for that work did not know about the hazardous materials on the town site that drains to the catch basin identified in that study.

Barton Landfill

The closed Barton Landfill on West Barton Road is sampled twice a year. This site, which had approximately 500,000 gallons of waste stain, lacquer and water were disposed here over a 10 year period, is upgradient from the Barton River. In the past, low concentrations of metals were found in the stream running through landfill. From the July 15, 2004 letter from the Johnson Company (the consultant) to Vermont DEC Waste Management Division: "Three surface water samples were collected at the Barton land on May 19, 2004. The locations sampled were SS-1 (upstream) and SS-2 (downstream), both on the stream that bisects the landfill site from east to west, and SWS-1, which is southwest of the wood waste area on an intermittent stream." At both sites on the bisecting stream, sodium, chloride, and iron were above detection limits but not above water quality standards. At SS-2, the downstream site, manganese was also above detection but not above standards. In the intermittent stream, total sodium, iron and manganese were above detection limits but not standards.

Rock Junkyard

The Rock junkyard on River Road was a source of concern and complaints for many years. It was once thought to be a potential problem for the Barton River. The Vermont Senate Institutions Committee held hearings in 2001 on the junkyard and heard the concerns of sportsmen, the game warden and a river guide. In May 2005, the investigation was with the Attorney General's office. DEC Solid Waste Division had sampled soil and water behind the junkyard and although they looked for evidence of hazardous waste spills, they didn't really find anything but the metal everywhere. Data from sampling did not turn up violations from where the samples were collected.

Now in 2015, the property is still owned by the Rocks but no one lives onsite and the house is collapsed. All the metal was removed from the site a number of years ago but there are a lot of tires there as well as garbage that people dump there because of the trash that was left onsite following the metal removal. Vegetation is growing where the stacks of metal were once.

Clyde River Watershed

General Description

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 and extensive swamps and marshes. Several dams and bypasses are along the river. The Clyde River drops 32 feet in its first 16 miles, 160 feet in the two miles below Pensioner Pond and 170 feet in less than one mile at Clyde Pond. It flows into Lake Memphremagog in Newport City.

From its source at Island Pond, the Clyde River begins a general westerly flow. Within a mile of the pond, the Pherrins River joins the Clyde from the north. The Pherrins River is ten miles long and drains a watershed of 19.1 square miles.

The Clyde River then winds southwesterly another few miles before the Oswegatchie Brook joins it from the south. Oswegatchie Brook and its steep tributaries drain a six square mile watershed. The brook itself is approximately three and a half miles long.

The Clyde River from this point meanders northwesterly for several more miles through the town of Brighton with the 4.5-mile long Cold Brook and the 6.5-mile long Webster Brook joining the Clyde from the south and the north respectively. As the Clyde flows through Brighton, it is surrounded by extensive forested, scrub-shrub, and emergent wetland communities.

The Clyde River continues its westerly/northwesterly flow into and through the town of Charleston. Here again, the river is part of an extensive forested/shrub/marsh wetland complex. In Charleston, as the river flows westerly, Mad Brook joins it and then the Seymour and Echo Lakes watersheds drain into it, and then another five to six miles downstream, the Clyde is dammed to form Pensioner Pond. Downstream of Pensioner Pond, the river is also dammed at West Charleston to form Charleston Pond.

From Charleston Pond, the river continues a northwesterly flow into Lake Salem, a very large lake. From Salem Lake, the Clyde flows generally northwest until it passes under Interstate 91 where it winds southerly into the dammed Clyde Pond. From Clyde Pond, it flows more directly west into Lake Memphremagog at Newport City.

Assessment Information for the Clyde River watershed

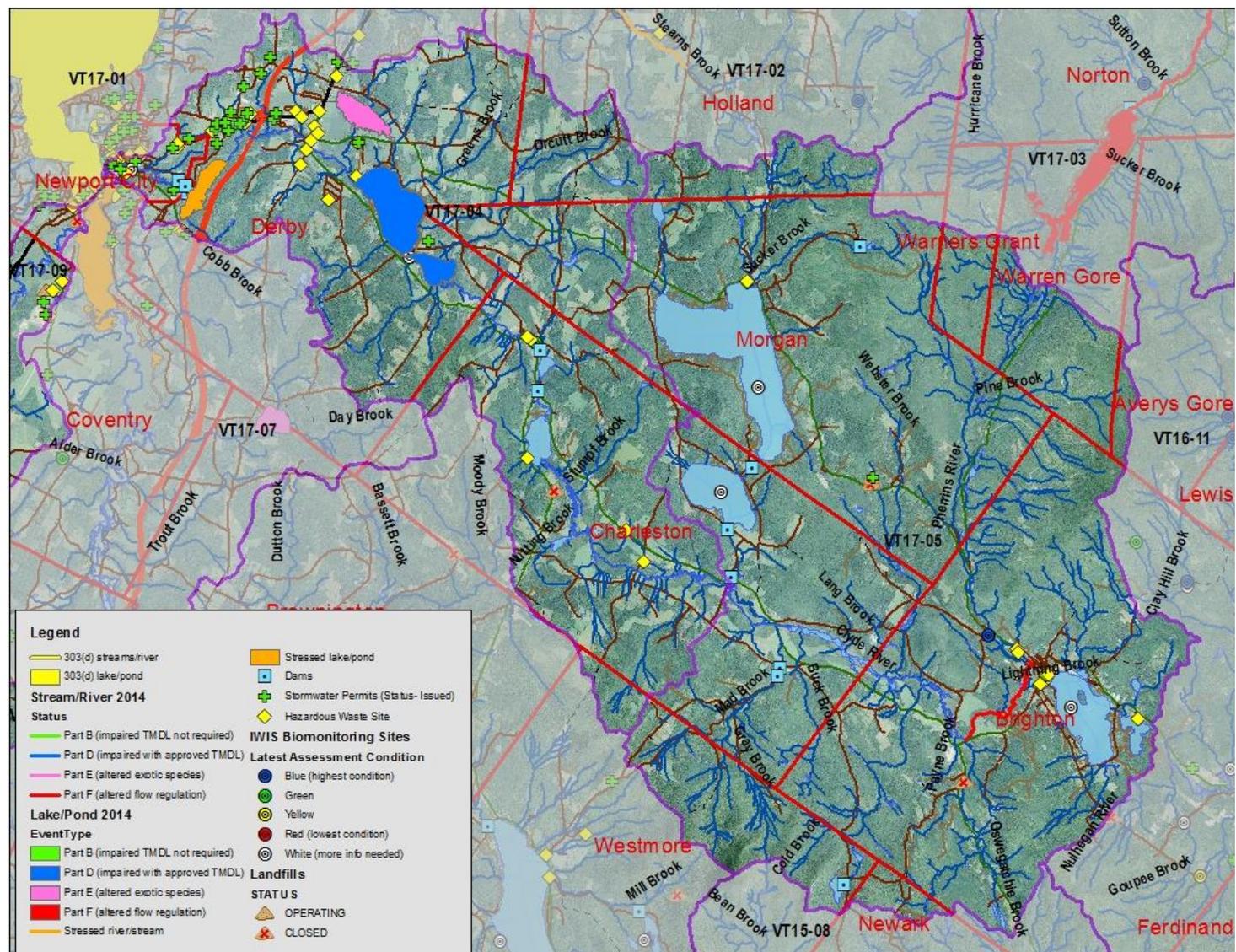


Figure 3. Clyde River watershed and assessment information

Biological Monitoring

The Clyde River watershed has very few recent biological monitoring sites that have been sampled and assessed and thus there is a need to add a number of potential biomonitoring sites to future sampling efforts.

Table 8. Biological monitoring in the Clyde River watershed 2006 - 2014

WBID	Stream name	River-mile	Date	Assessment-macroinvertebrates	Assessment - fish
VT17-04	Clyde River Trib #1	0.1	09/16/2014	good	poor
VT17-05	Webster Brook	4.6	09/15/2014	very good	ua
VT17-05	Pherrins River	3.1	09/15/2014	excellent	----

Table 9. Biological Monitoring Site Locations in Clyde River watershed

Stream	River-mile	Description
Clyde River Trib #1	0.1	100 meters above the confluence with the Clyde River
Webster Brook	0.6	Off of Bear Mtn Rd, follow game trail to stream

Table 10. Monitoring needed in the Clyde River watershed

Water-body id	Stream or river names	Number of sites, location	Comments
VT17-05	Pherrins River	3 sites, rm 3.1, rm 1.9 & another site downstream of rm 1.9	Rm 3.1 was sampled in 2014, was excellent and another sampled is needed to confirm. Rm 1.9 was last sampled in 2003 and was also excellent - need a more recent sample. Downstream there is flow alteration potential and a sample in this stretch would be valuable.
VT17-05	Oswegatchie Brook	1 site	This named stream has not been sampled.
VT17-05	Cold Brook	1 or 2 sites	This named stream has not been sampled. Has a largely forested watershed although extensive logging in one portion of watershed. Also fair amount of mapped wetland.
VT17-05	Mad Brook	1 site	There has been no sampling on this named tributary.
VT17-04	Trib 1 to Clyde River	1 site	Sample below Route 5. Walmart and other significant development upstream.
VT17-04	Clyde River itself	1 site	West or downstream of Route 105

Hazardous Waste Sites

Newport Plastics

This hazardous waste site near a tributary to the Clyde River in Newport was owned by Newport Plastics (site # 770059). The tributary is less than 500 feet west and downgradient of the site. At least 28,000 gallons of solvents were dumped in an evaporation pit of this site up until 1979. The pit was then filled in. In the early 1990s, GEI Consultants did borings to re-establish the location of the pit and put in four groundwater (GW) monitoring wells. In the process of doing the borings, two 55 gallon drums were uncovered. Volatile organic compounds (VOCs) were detected in three of the four groundwater samples and two VOCs detected exceeded primary groundwater standards. Dichloromethane was above standard in the GW sample from MW3 (745 ppb) and MW4S (5.8 ppb); tetrachloroethylene was high in the GW sample from MW4S (12.2 ppb).

Monitoring occurred in May 1991, August 1997, November 1997, May 2005, May 2007, May 2008, May 2013, May 2014, and May 2015. In the latest round done by Horizons Engineering, there were no constituents found above the Vermont Groundwater Quality Enforcement Standards. Tetrachlorethene was found in MW-105D at 4 ug/L below the enforcement standard but above the preventative action level. Other compounds that had been detected historically were not detected in this May 2015 round of sampling. Three of the six monitoring wells have not been sampled since 2008 as during the 2013, 2014, and 2015 sampling events, the wells were dry. The consultant recommends closing these more shallow wells but to continue monitoring the deeper ones that produce results.

Special Values, Uses, Features of the Clyde River Watershed

High biological diversity associated with water and wetland features

The areas that contribute the “greatest” to the biological diversity in the Clyde River watershed are: the upper Clyde River itself and the adjacent wetland communities; the upper Pherrins River;

several lakes and ponds including Seymour Lake, Echo Lake, Pensioner Pond, Charleston, and Island Pond (see the deep purple below). The components that make up that diversity include a number of rare species of plants, extensive significant wetland communities, a few rare animal species, and good riparian connectivity.

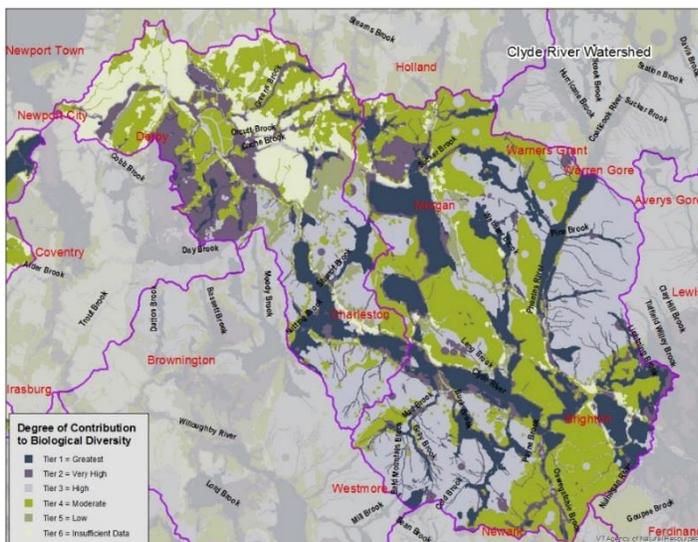


Figure 4. The contribution to biological diversity in the Clyde River watershed.

Clyde River Marshes

The extensive, significant, and diverse wetland communities associated with the Clyde River are a major contributor to the Clyde River biological diversity and a candidate for Class 1 wetland status. These wetlands and the rare species and significant natural communities are shown in the map below. The area's contribution to biological diversity is shown in the map above.

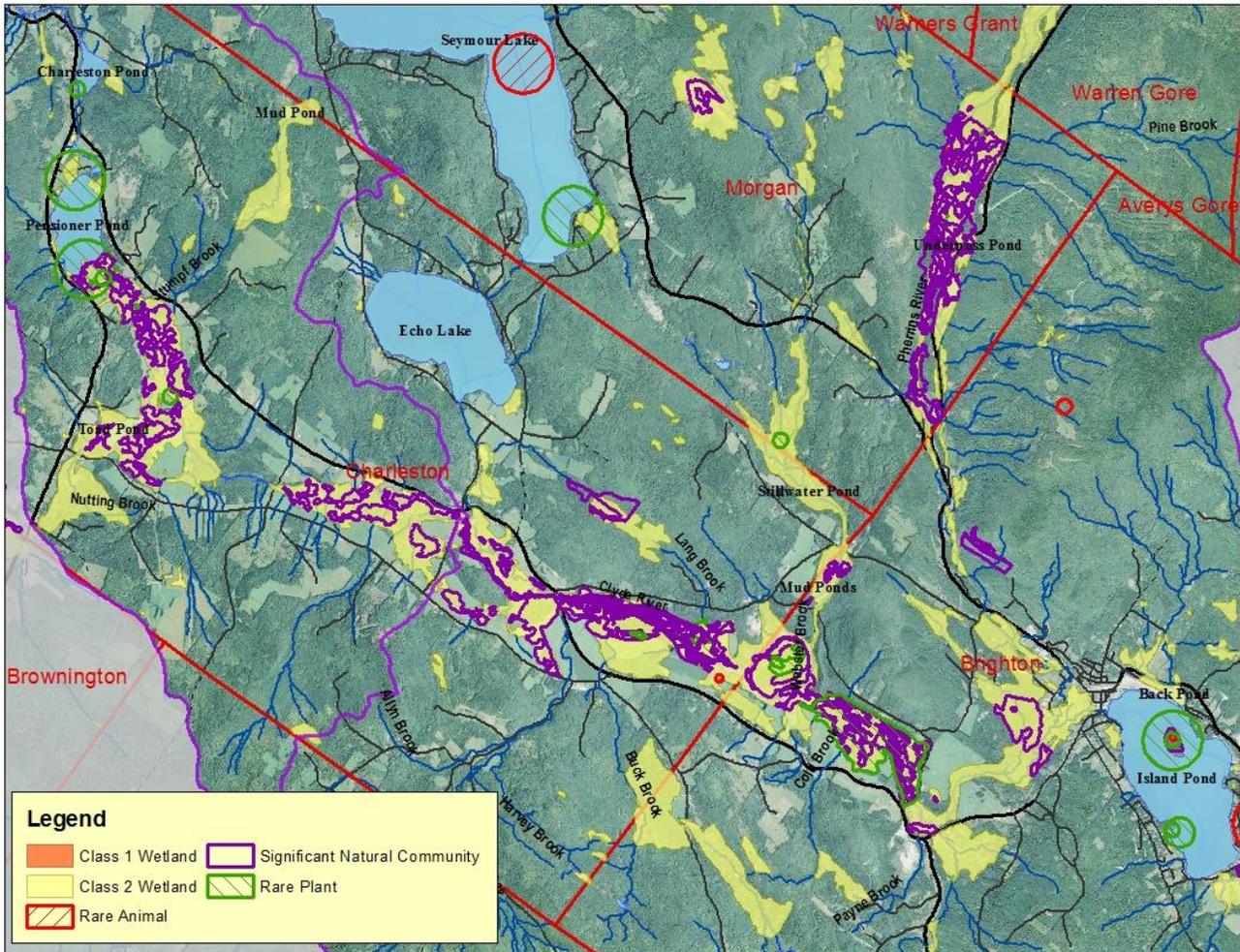


Figure 5. Clyde River wetlands, rare species, significant natural communities

Other Memphremagog Rivers and Streams Johns River, Tomifobia River, Coaticook River and tributaries

General Descriptions

Johns River watershed

The Johns River originates in Derby west of Nelson Hill. It flows northwesterly from its headwaters to the Canadian border. Northwest of Interstate 91 and in the area where Crystal Brook joins the Johns, there is a large forested wetland and shrub swamp. The river flows through Canada for a short distance and then re-enters the United States with a southwesterly flow. From the Canadian border to Derby Bay of Lake Memphremagog, the river is part of a large forested, scrub/shrub, and emergent wetland complex.

Not a tributary to the Johns River, but a stream that flows directly to Lake Memphremagog north of the Johns, is the Ruiss Arnold or Hall's Creek (one name is the Quebec name and one is the Vermont name). The stream is largely a Quebec water but it flows for almost two miles from the Quebec/Vermont border to a cove in the lake. It flows through diverse wetlands communities.

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. 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.

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, Moster Meadow Brook, Number 5 and Number 6 Brooks.

Assessment Information for Johns, Tomifobia, Coaticook watersheds

Biological Monitoring

Table 11. Biological monitoring assessments 2006 – 2014 Shared Canada/US Streams

WBID	Stream Name	River-mile	Date	Assessment - macroinvertebrates	Assessment-fish
VT17-01	Crystal Brook	0.3	09/07/2006	poor	----
VT17-01	Crystal Brook	0.3	09/16/2009	good-fair	ua ¹
VT17-01	Crystal Brook	0.3	09/16/2010	exc-vgood	ua
VT17-01	Crystal Brook	0.3	09/16/2014	good	poor
VT17-01	Crystal Brook	0.3	09/15/2015	very good	good
VT17-01	Crystal Brook	1.4	09/16/2014	very good	----
VT17-01	Darling Hill Brook	0.1	09/16/2009	exc-very good	fair
VT17-01	Johns River	1.6	09/16/2009	good-fair	fair
VT17-01	Johns River	3.1	09/16/2009	very good	poor
VT17-01	Johns River	4.8	09/16/2009	excellent	---
VT17-01	Lake Memphremagog Trib #9	1.1	09/16/2014	excellent	poor
VT17-01	Sunset Acres Brook	0.5	09/16/2009	excellent	good
VT17-02	Holland Pond Trib 3	0.5	09/16/2009	exc-vgood	----
VT17-02	Stearns Brook	2.3	09/18/2012	very good	good
VT17-02	Stearns Brook Trib	0.1	09/16/2009	fair-poor	good
VT17-02	Stearns Brook Trib	0.1	10/03/2012	good-fair	fair
VT17-02	Stearns Brook Trib	0.1	09/16/2014	fair	good
VT17-03	Number Six Brook	0.5	09/17/2009	vgood-good	good
VT17-03	Beaver Meadow Brk	0.1	10/03/2014	exc-vgood	----
VT17-03	Hurricane Brook	0.5	09/15/2014	exc-vgood	excellent
VT17-03	Coaticook River	40.0	09/15/2014	very good	----

¹ ua = unable to assess, the site was sampled but an IBI not calculated usually due to just one species present, notes in the database describe the fish findings

Table 12. Biological monitoring site locations for the Shared Canada/US streams

Stream	River-mile	Description
Crystal Brook	0.3	About 100 meters below Route 5 and about a ¼ mile north of I-91 overpass
Crystal Brook	1.4	About 50 meters above Aldredge Road
Darling Hill Brook	0.1	Adjacent to Darling Hill Road
Johns River	1.6	Above North Derby Road, just below Canadian border
Johns River	3.1	Off of Beebe Plain Road, ¼ mile south of intersection with Elm St
Johns River	4.8	Below Route 5 culvert/bridge
Trib #9 Lake Memphremagog	1.1	Located below Route 105
Sunset Acres Brook	0.5	Above culvert at North Derby Road
Holland Pond Trib 3	0.5	Access by Trucott Road (intersect with Page Road)

Stream	River-mile	Description
Stearns Brook	2.3	Above Stearns Brook Rd about 300 meters, just below small tributary from the north
Stearns Brook Trib	0.1	Trib is 40 meters upstream from last bridge in the U.S.
Number Six Brook	0.5	Off Route 114 near Black turn Brook Road
Beaver Meadow Brook	0.1	Approximately 100 meters downstream of Route 104A
Hurricane Brook	0.5	
Coaticook River	40.0	Downstream of Gagnon Road bridge about 100 meters, 40 miles from its mouth in Quebec but 3.1 miles up from the US/Canadian border

Table 13. Monitoring needed in the Shared Canada/US streams

Water-body id	Stream or river name	Location, number of sites	Comments
VT17-03	Hurricane Brook	Rm 0.5	Sample again to confirm vhf
VT17-03	Gaudette Brook	1 site	Never been sampled
VT17-03	Number 5 Brook	1 or 2 sites	Never been sampled

Crystal Brook

Macroinvertebrate sampling on Crystal Brook in Derby prior to 2006 got “fair” and “poor” at rivermile 0.3 on three different years; a “good” at rm 0.4 back in 1997; and “good” in 1997 and “exc-very good” in 2004 at rm 1.4. The fish community was sampled back in 1997 also and only 7 brook trout were found in an 85 meter stretch.

There was a large manure pit failure and fish kill on Crystal Brook in the late 1980s. There has not been anything since that time that ANR knows about. An April 2005 memorandum documents an agricultural investigation of a farm and manure pit adjacent to Crystal Brook. No signs of runoff from the farm were noted during the investigation but the manure pit was empty at the time and there is the possibility it could leak.

In 2007, the pit was replaced with a larger sealed lagoon better able to accommodate the volume and type of animal waste being generated. In addition, runoff from the silage area was captured by a new drainage system beginning with the summer of 2009. These actions helped to significantly reduce nutrient loading to Crystal Brook. In 2012, Crystal Brook was de-listed due to improvements in the aquatic community and reductions in the nutrients that were having an impact on the brook.

Crystal Brook’s condition unfortunately declined since its de-listing and 2014 biological monitoring. Sampling in fall 2014 found: the macroinvertebrate richness and EPT high (at or above all previous values for this site); the community composition had shifted since the site was last sampled in 2010, and showed a significant decline in biological condition; site

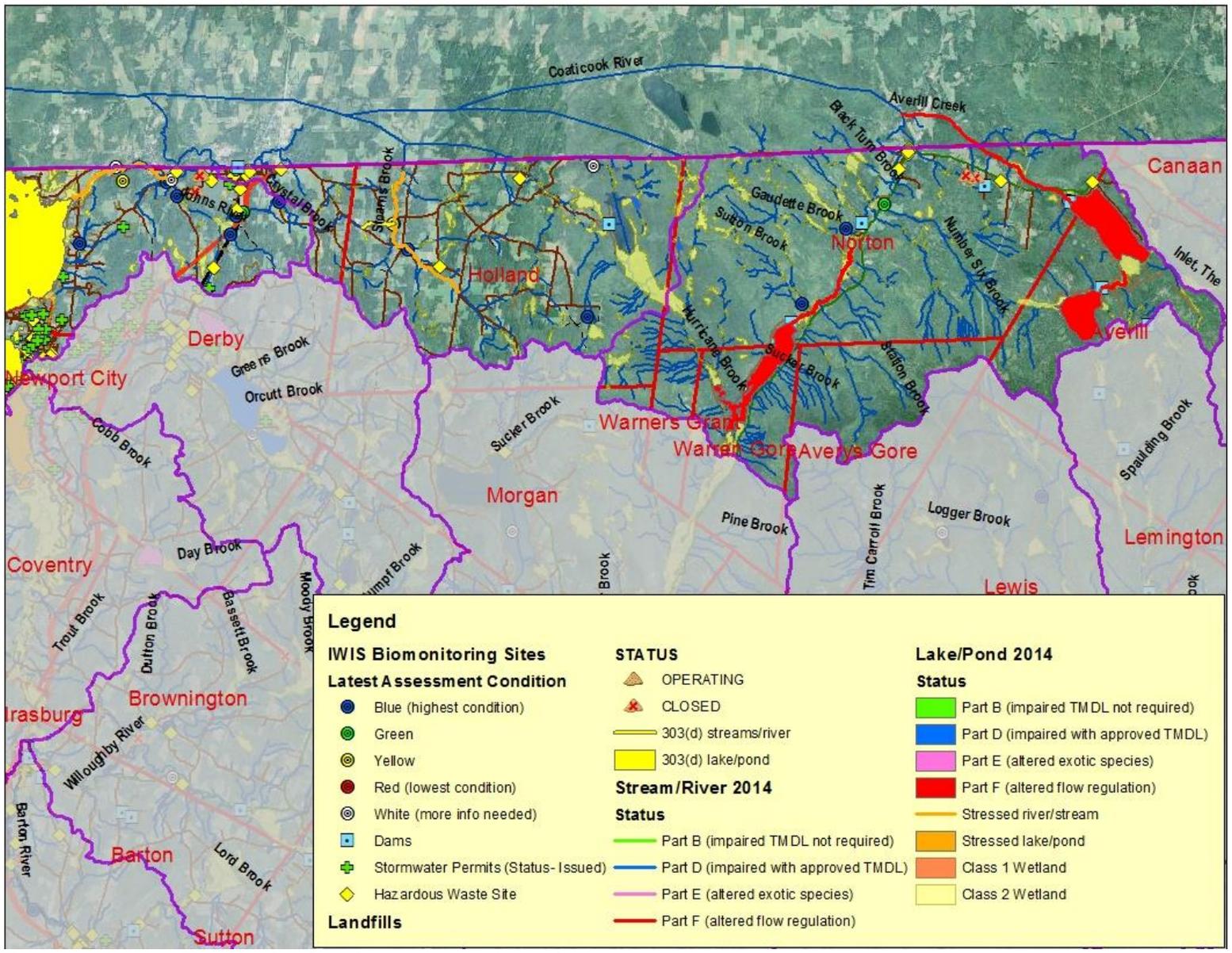


Figure 6. Johns, Tomifobia, Coaticook watersheds in Vermont and assessment status

observations indicated that the site was turbid (36.8 NTU) and smelled of decay; silt rating was high (4/5); and while the substrate did not show significant macro algae growth or thick periphyton cover (probably due to light limitation), concentrations of total nitrogen (5.25 mg/l) and total phosphorus (752 ug/l) were also very high. The macroinvertebrate community passed with a “good” rating but the fish community was “poor” with only two fish present. This was again thought to be barnyard and manure issues.

A number of metals were detected at this location including copper, cobalt, aluminum, arsenic, iron and nickel. Copper, cobalt and nickel are not normally detected in natural surface waters. Copper at 49.9 ug/l and iron 1339 ug/l concentrations are above the ALS criteria for these metals at a hardness of 223. The higher levels of iron may be tied to the elevated turbidity and suspended sediment, however copper is not a common element in soils and not usually detected at these high levels even in turbid conditions.

However in 2015, the macroinvertebrate community had recovered to “very good” and the fish community to “good”.

Volunteer water quality monitoring on Lake Memphremagog Direct streams

There has been water quality monitoring on direct drainages to Lake Memphremagog and its tributaries since 2006 as part of an effort to identify which streams deliver the most phosphorus and nitrogen to Lake Memphremagog. This monitoring included 16 sample sites on smaller drainages and 21 in the Johns River watershed. There has also been water quality sampling associated with the biological monitoring in the watershed over the years.

This water quality monitoring has identified elevated levels of nutrients on a number of these tributaries. Elevated levels of nitrogen were found in the Johns River watershed and in a direct tributary called Sunset Acres Brook (which drains from Darling Hill Road down to the lake). However, biological monitoring showed that aquatic life conditions in this brook were good as also was the case in the Johns River suggesting nitrogen was not having a major impact on biota at this time. Phosphorus loading was identified as elevated for tributaries to the Johns River including the Darling Hill Tributary and Crystal Brook. Nutrient levels on Crystal Brook have dropped over time and especially under low flow conditions, however, likely as a result of a manure pit replacement and other barnyard improvements.

Another very small drainage that enters the lake adjacent to Landing Street was sampled and had slightly elevated levels, which is unsurprising due to the fact that this drainage is over 80% developed land.

Finally three tributaries on the western side of Lake Memphremagog, Wishing Well tributary (Trib #9 in the table above), Strawberry Acres tributary, and Holbrook Tributary, were sampled and found to have elevated levels of phosphorus and, at times, turbidity. So-called Wishing Well tributary primarily drains large areas of pasture lands and a barnyard complex. The Sunset Acres tributary includes a small dairy farm at its headwaters. A site sampled below this farm had elevated levels of phosphorus but farmstead improvements in 2014 appear to have reduced these levels significantly. Finally the northern most tributary that was sampled was called the Holbrook Bay Tributary. Loading in this stream

may be related to release of nutrients from an onstream pond. More results can be found at the [Memphremagog Watershed Association website](#).

Volunteer Water quality monitoring on Stearns Brook Tributary

Stearns Brook is a tributary of the Tomifobia River, which flows north into Lac Massawippi, rather than into Lake Memphremagog. A small tributary of Stearns Brook is impaired and in need of a TMDL due to nutrients and sediment from agricultural runoff. Beginning in 2014, Beck Pond LLC and the Memphremagog Watershed Association analyzed water quality conditions at four sites along the main stem, two smaller tributaries and two drainages in order to pinpoint and assess possible nutrient and sediment sources along this tributary. In 2015, two more sites were added to sample ditches where runoff was observed.

This assessment was able to confirm that phosphorus levels increased dramatically downstream of Upper Stearns Tributary and Stearns Tributary Falls (see map below) and upstream of the next site down - Middle Stearns Tributary. In addition, phosphorus levels were consistently high in one of the two small tributaries (Valley Road South) and extremely high during rainfall events in the other small tributary (Twin Bridges Road). On many sample dates, extremely high phosphorus and nitrogen levels were measured in the water flowing from the two culverts and two ditches draining the farmstead upstream of the Middle Stearns Tributary site. The farm installed a number of practices to address runoff from the barnyard areas in late 2015 and water sampling is planned in 2016 to determine if these efforts were successful in reducing nutrient loading to the stream.

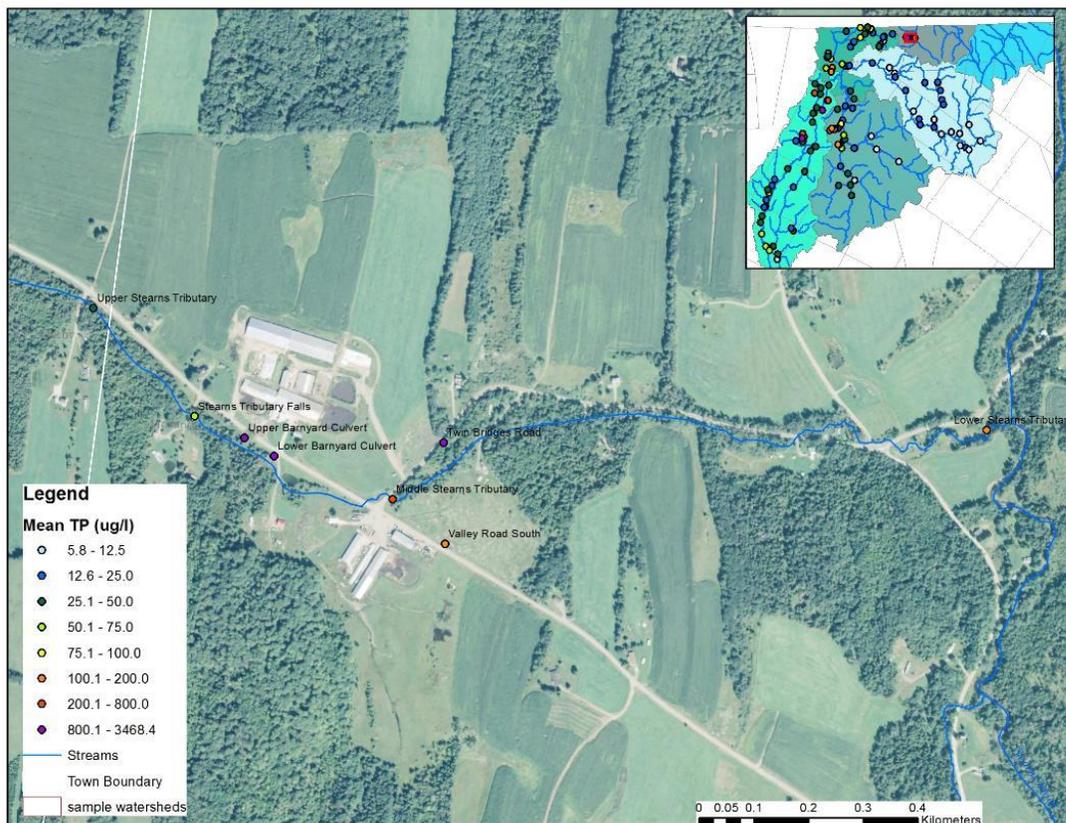


Figure 7. Mean total phosphorus levels at sampling sites on the Tributary to Stearns Brook and tributaries in 2014 and 2015.

Hazardous Waste Sites

Cumberland Farms Newport

Hazardous waste site 97-2329, Cumberland Farms in Newport, has been monitored for many years with both groundwater monitoring wells and a surface water monitoring site. The groundwater wells have shown levels of one or more volatile organic compounds (including MTBE, benzene, toluene, naphthalene and others) above the Vermont Groundwater Enforcement Standard (VGES) over the years. The number of wells sampled and the number showing exceedences of the VGES have varied over time.

In addition, the surface water sampling site at the head of an unnamed tributary to Lake Memphremagog has had levels of benzene above the water quality criteria for the protection of human health and aquatic biota from at least 2002 through 2006. The VOCs have been below standards since August 2007 based on an ENSR report (ENSR took over the site consulting in October 2006). Other VOCs had been elevated in the surface water samples too in the earlier years.

An AS/SVE remediation system was put into place in late summer 2004 and got underway in fall 2004 and was operated until March 2006. It was then shut down until May 2007 when a new consultant suggested it be re-activated. This second time, it ran from May 2007 until January 2008 and it was de-commissioned in July 2010.

Up through July 2015, the annual monitoring events were finding VOCs above the VGES in some of the onsite wells and the plume was expected to still be migrating offsite as the highest VOC concentrations were in the well at the downgradient portion of the site. The map below shows the location of the site in relation to an unnamed tributary to Lake Memphremagog.



Figure 8. Cumberland Farms Hazardous Site In Newport near Lake Tributary

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