Northern Connecticut River and Direct Tributaries
~Basin 16~
Water Resources, Water Quality, and Aquatic Habitat Assessment Report

Connecticut River in Bloomfield, Vermont

March 2011

Upper Connecticut River Watershed – Basin 16

Basin 16 is one of four basins that are atypical basins or planning units in Vermont. Thirteen of the seventeen basins are comprised of one or more major watersheds in the state. Basin 13 and Basin 16 consist of Connecticut River mainstem segments and mostly relatively small drainages that go directly to the Connecticut River. Basins 4 and 5 are mainly small drainages going directly to Lake Champlain.

Basin 16 consists of the northern Connecticut River and direct drainages to it from the Canadian border down to White River Junction. It includes the Nulhegan River watershed and the Paul Stream watershed among others. It does not include the Passumpsic River watershed (Basin 15) nor the Stevens, Wells, and Waits Rivers watersheds (these are part of Basin 14).

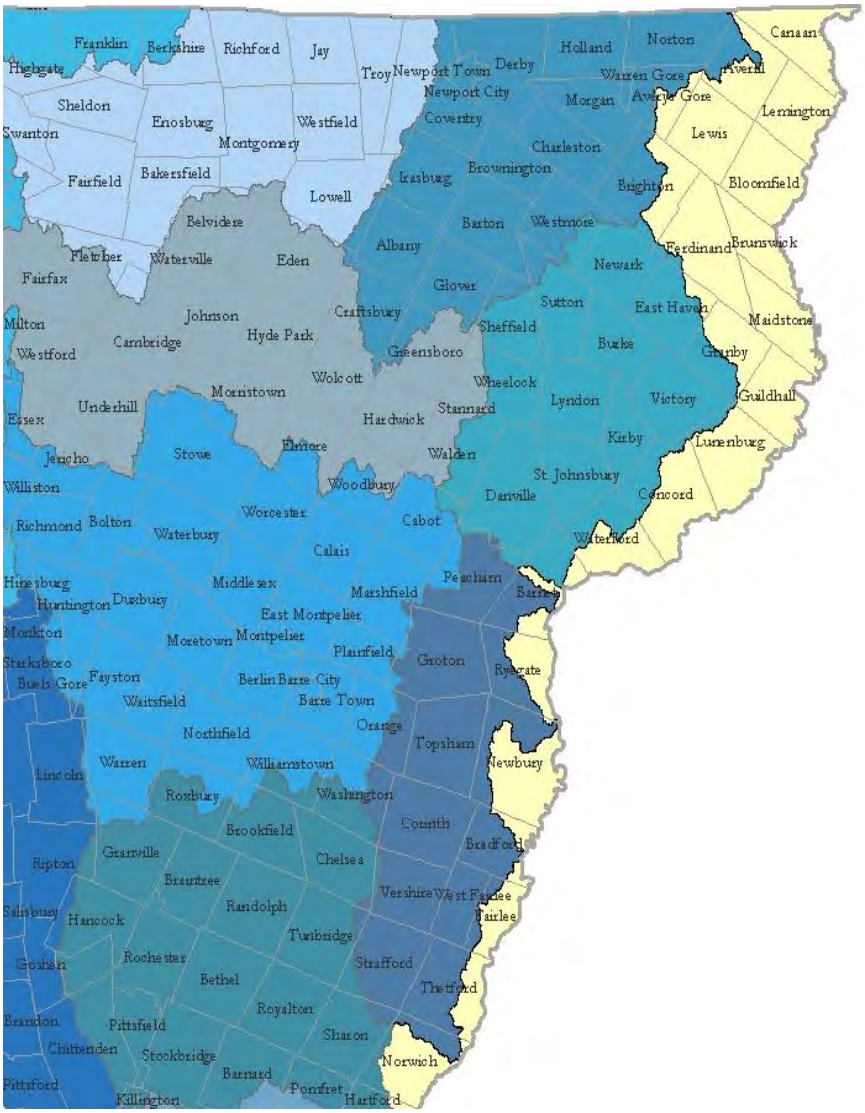


Figure 1: Basin 16 Northern Connecticut River (yellow)

For this report, Basin 16 is divided into seven sub-basins with each sub-basin having its own chapter. The seven drainage areas, from north to south, are as follows:

1) Canaan, Lemington, Bloomfield streams flowing to the Connecticut River plus the Connecticut mainstem itself;
2) Nulhegan River watershed, which is the Nulhegan River and its many branches;
3) Paul Stream, Wheeler Pond, Dennis Pond watersheds and the Connecticut River stretch to which these watersheds drain;
4) Maidstone, Guildhall, Lunenburg streams draining to the Connecticut River plus the Connecticut mainstem to which they flow;
5) Concord and Waterford streams to the Connecticut River plus the two reservoirs in this segment;
6) Barnet, Ryegate, Newbury, Bradford streams to the Connecticut River plus the stretch of Connecticut River to which they flow;
7) Fairlee, Thetford, Norwich streams to the Connecticut River and the adjacent mainstem.

As might be expected, Basin 16 is predominantly forested with over three quarters of the land area in forest. Wetlands make up a relatively large percentage of the basin"s land use as compared to other basins in Vermont. Forested land and wetland cover together, which are important for good water quality and aquatic habitat, account for almost 85% of the land area of this basin. Agricultural land uses, taking advantage of the river valley soils, accounts for 6.7% of the land use. Surface water covers almost 4% as does transportation uses. Developed land, in addition to transportation, makes up only 0.5% of the basin land area. Table 1 below gives the acres in each land use and the percent of the total area occupied by that land use or land cover.

Table 1. Land Use and Land Cover for Basin 16[1]

Land Use	Acres	% of Total
Forested	310,056.4	77.6
Wetlands	29,295.5	7.3
Agriculture	26,672.0	6.7
Surface Water	15,562.5	3.9
Transportation	15,386.2	3.9
Developed Land[2]	2,139.8	0.5
Old Field & Barren	246.2	0.1
Total:	399,358.6	100.0

1 Vermont Land Cover Classification Project, 1997 (based on satellite photographs from 1991 - 1993).
2 Developed land = residential, commercial, industrial but not transportation, which is listed separately.

Basin 16 Use Support and Causes & Sources of Impacts

Use Support for Rivers and Streams

Table 2. Use Support for River or Streams Uses in Miles for Basin 16

Use	Full support	Stressed	Altered	Impaired	Not assessed
Overall	309.3	5.4	30.0	0	180.9
Aquatic life	309.3	5.4	30.0	0	180.9
Swimming	330.0	0	0	0	195.6
Aesthetics	313.3	1.4	30.0	0	180.9
Fishing and/or boating	330.0	0	0	0	195.6
Fish consumption	0	525.6	0	0	0

Causes of Impacts or Stress to Basin Rivers and Streams

These are the pollutants or activities that have been documented to have an impact or stress on some miles of river or stream. Details on the streams with these impacts are given in the sections following in this report.

Table 3. Miles affected by causes of impact or stress to Basin 16 streams

Pollutant or Activity	Magnitude (S=stress, H=high impact)	Miles Affected
Flow alterations	H	30.0
Sedimentation	S	34.8
Turbidity	S	30.8
Nutrients	S	15.0
Other habitat alterations	S	4.0
Metals	S	0.6

Sources of Impacts or Stress to Basin Rivers and Streams

Sources are the land uses or land activity that is responsible for the pollutants causing the impact or stress shown above.

Table 4. Miles affected by sources of impact or stress on Basin 16 streams

Source	Magnitude	Miles Affected
Hydroelectric power production	H	30.0
Streambank modification or de-stabilization	H	30.0
Agriculture	S	15.0
Logging	S	4.0
Surface mining	S	0.8
Hazardous waste site	S	0.6

Use Support for Lakes and Ponds

Table 5. Use Support for Lake or Pond Uses in Acres for Basin 16

Use	Fully Supporting	Stressed	Altered	Impaired	Unassessed
Aesthetics	4217	928	127	0	27
Aquatic Biota/Habitat	3059	2067	127	19	27
Boating and Fishing	4217	928	127	0	27
Fish consumption	0	3287	0	2012	0
Swimming	4217	928	127	0	27

Causes of Impacts or Stress to Basin Lakes and Ponds

Table 6. Acres affected by causes of impact or stress to Basin 16 lakes or ponds

Cause of Alteration	Aesthetics	Aquatic Biota/Habitat	Boating and Fishing	Fish Consumption	Swimming
Eurasian Water Milfoil	127	127	127		127
Exotic Species	17	17	17		17
Cause of Impairment					
Mercury in Fish Tissue	0	0	0	2012	0
pH	0	19	0	0	0
Cause of Stress					
Eurasian Water Milfoil	35	61	35	0	35
Mercury in Fish Tissue	0	0	0	3287	0
Noxious Aquatic Plants - Algae	617	617	617	0	617
Noxious Aquatic Plants - Native	91	91	91	0	91
Nutrients	890	890	890	0	890
Organic Enrichment - DO	0	20	0	0	0
pH	0	1164	0	0	0
Phosphorus	890	890	890	0	890
Sedimentation/Siltation	346	447	376	0	376

Sources of Impacts to Basin Lakes and Ponds

Table 7. Acres affected by sources of impact or stress to Basin 16 lakes or ponds

Source of Alteration	Aesthetics	Aquatic Biota/Habitat	Boating and Fishing	Fish Consumption	Swimming
Other Marina/Boating On-vessel Discharges	144	144	144	0	144
Source of Impairment					
Atmospheric Depositon - Acidity	0	19	0	0	0
Atmospheric Depositon - Toxics	0	0	0	2012	0
Flow Alterations from Water Diversions	0	0	0	2012	0

Special Uses, Values, and Significant Features of the Northern Connecticut Watershed

Public Conservation Lands

The Northern Connecticut Watershed that is Basin 16 is home to vast areas of federal and state public land valuable for its ecological richness and the numerous recreation opportunities they provide including birding, fishing, tracking, hunting, hiking, botanizing, boating, and photography. The Conte National Wildlife Refuge, the State wildlife management areas, and the state forests that are a significant part of this basin are described in the appropriate sections below.

Natural Communities

Extensive high qualtiy plant communities are also found on both public and private land in Basin 16. Black spruce swamp, poor fen, northern white cedar swamp, black spruce woodland bog, alluvial shrub swamp and many other natural communities are found in this basin. Conant Swamp in Thetford is one of the largest red maple-black ash seepage swamps in the Vermont-New Hampshire portion of the Connecticut River Valley. More information on some of these communities can be found in sections below.

Waterfalls, Cascades, and Gorges

Sutton Brook Falls in Barnet and Glen Falls in Fairlee are the two cascades and falls listed in the *Waterfalls, Cascades and Gorges of Vermont* book. Sutton Brook flows from the western edge of Barnet in an easterly direction and meets the Connecticut River just downstream of the mouth of the Passumpsic River at Nine Island. The waterfall/cascade site includes 20-foot high cascades above Interstate 91 and then some low cascades and a seven foot waterfall below the interstate. The Glen Falls site includes a 110-foot long gorge with 20-30 foot walls and a steep cascade that is about 25 feet high. The falls are located close to the western shore of Lake Morey.

Boating

The Connecticut River is a gem for boating with its wide variety of conditions and put-in and take-out opportunities. From Canaan down to White River Junction, there are at least twenty places where a canoe can be launched in Vermont with other locations just over the river in New Hampshire. A subset of all the launch areas has the set-up for motorboats to put in – these are largely on the impounded portions of the river such as on Moore Reservoir among others.

Several tributaries to the Northern Connecticut are also excellent boating runs including whitewater on Paul Stream and the East Branch Nulhegan and calm paddling and wildlife viewing on the Nulhegan mainstem.

Canaan–Lemington–Bloomfield Streams and the portion of the Connecticut River to which they flow

General Description

The streams that flow from Canaan, Lemington, and Bloomfield into the northern Connecticut River from the Quebec/Vermont border down to the confluence of the Nulhegan River at North Stratford, New Hampshire comprise this section of the assessment report. These rivers and streams are waterbodies VT16-01, VT16-08, and VT16-09 in the River Assessment database. The major lakes and ponds in these towns are Wallace Pond, which is partly in the U.S. and partly in Canada, and Forest Lake.

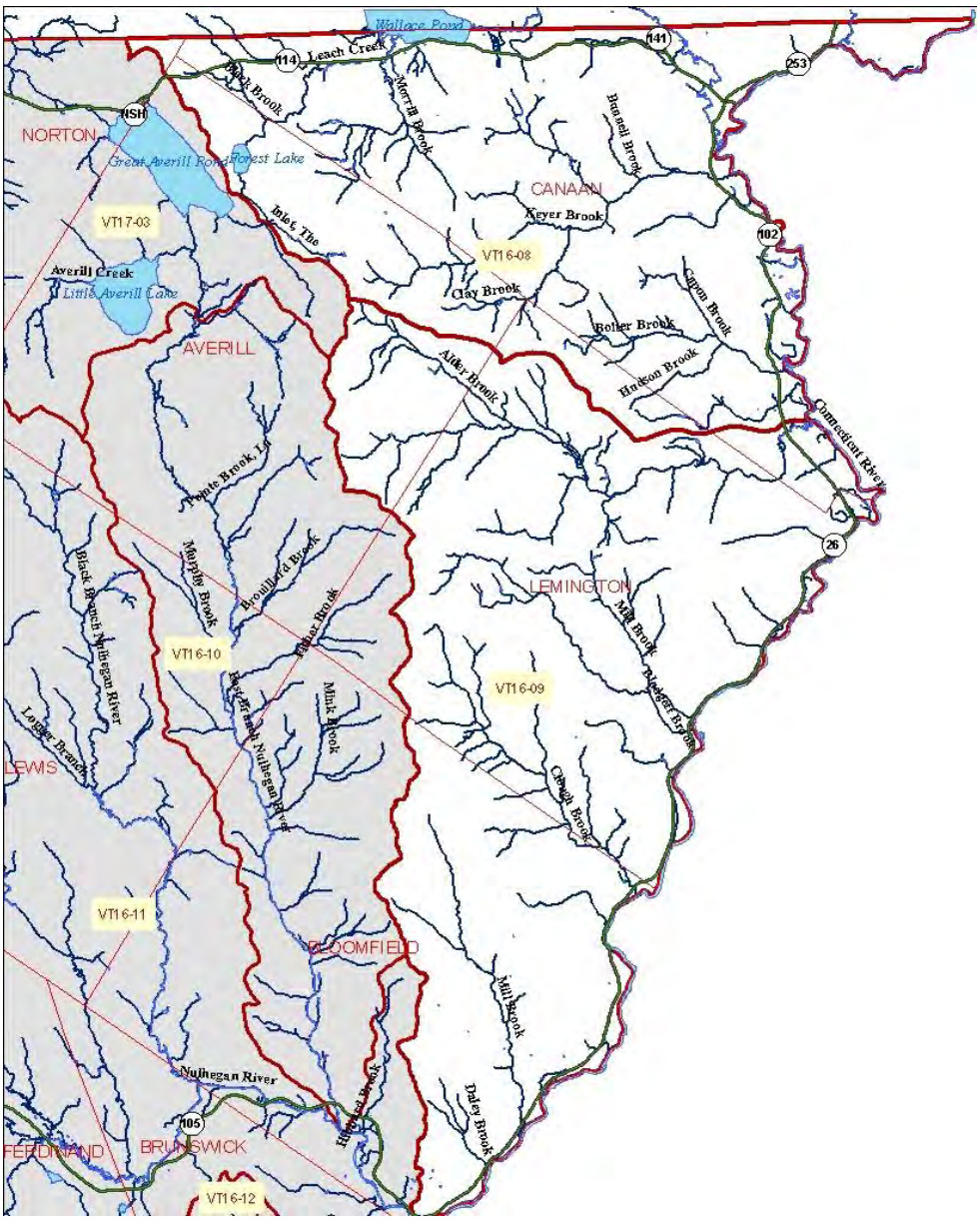


Figure 2. Canaan,Lemington, and Bloomfield Streams to the Connecticut River

Canaan Streams

The streams in Canaan that flow indirectly or directly to the Connecticut River include Halls Stream, Leach Creek with its tributaries Black Branch and Morrill Brook; Keyer Brook with its tributaries Jacobs Chopping Brook, Schoolhouse Brook, and Clay Brook; and Capon Brook with its tributary Hudson Brook.

Halls Stream flows into Beechers Falls, Canaan from Canada where it has been twisting and winding through extensive agricultural land and patches of forest land. In the United States, the stream flows between the Ethan Allen industrial site and a residential road on its way to the Connecticut River.

Leach Creek is first named as such as it drains Forest Lake in Averill. It flows northeasterly and Black Branch joins it just before Leach flows into the town of Canaan. Leach Brook continues through Canaan generally in a northeasterly direction to Wallace Pond. Unnamed tributaries from the north and Canada, as well as Morrill Brook from the south, join Leach Brook before it enters Wallace Pond. From Wallace Pond, Leach Brook flows through a portion of Quebec before re-entering Vermont now flowing in a southeasterly direction. Several unnamed tributaries join Leach before it enters the Connecticut River just south of the village of Canaan. Leach Creek is approximately six miles long and drains about 17 square miles within Vermont.

Keyer Brook originates in the eastern corner of Averill and flows easterly and northeasterly through Canaan to the Connecticut River. First the 1.2 mile long Schoolhouse Brook joins Keyer from the north, then the 2.3 mile long Clay Brook joins from the south and the 2.4 mile long Jacobs Chopping Brook joins from the north before Keyer meets the Connecticut River. There are also several unnamed tributaries to Keyer Brook. Keyer Brook is approximately six miles long and drains a 12 square mile watershed.

The 2.5-mile long Capon Brook originates on the eastern slopes of Kemp Hill in Canaan and flows southeasterly to the Connecticut River. It drains a 4.7 square mile watershed. Capon Brook has a tributary, Hudson Brook, which joins it from the south.

Lemington Streams

The streams from Lemington that flow directly or indirectly to the Connecticut River include Willard Stream (which actually flows north into Canaan where it joins the Connecticut but most of its length and watershed are in Lemington) with its two tributaries, West Branch and Alder Brook; Blodgett Brook with its tributary Mill Brook; and Clough Brook.
Willard Stream is formed when Alder Brook, which originates in a huge wetland in the eastern portion of Averill, and the West Branch, which also begins in eastern Averill join in the town of Lemington. Willard Stream then flows southeasterly through a portion of a large swamp. It turns northeasterly to follow the base of the slope of Monadnock Mountain and, for its final stretch, turns northerly flowing into Canaan and into the Connecticut River. Willard Stream is nine miles long and drains a 15 square mile watershed.

Blodgett Brook begins west of Meacham Swamp in Lemington and flows for about 5.6 miles southeasterly until it joins the Connecticut River just upstream of Columbia bridge and Lemington. Mill Brook is a 3.6 mile long tributary to Blodgett, which also flows through Meacham Swamp almost paralleling Blodgett until they join near Sims Hill Road.

Clough Brook begins in the southwestern portion Lemington and flows southeasterly for 5.5 miles before joining the Connecticut River in the northeastern corner of Bloomfield. Its watershed is nine square miles.

Bloomfield Streams

Mill Brook and Daley Brook are the two named streams that flow from Bloomfield to the Connecticut River.

Mill Brook flows on the eastern side of Bloomfield Ridge in a southerly direction for about six miles before it enters the Connecticut River. It drains a seven square mile watershed.

Daley Brook flows out of a large wetland south of Bloomfield Ridge and flows southeasterly for 1.7 miles to the Connecticut.

Uses, Values, Special Features or Conditions

Boating

A 24.5 mile section of quickwater and Class I – II whitewater from Canaan to North Stratford on the Connecticut River mainstem is described in the Appalachian Mountain Club (AMC) River Guide for New Hampshire and Vermont. This section includes a pretty pastoral stretch, the slopes of Monadnock Mountain, a covered bridge, and some whitewater at the remains of Lyman Dam, which needs scouting due to continually changing conditions.

Stream Sampling Results and Assessment Information

Halls Stream and the Ethan Allen Beecher Falls Hazardous Waste Site

According to a Site Inspection Report dated February 6, 1987, from 1970 to 1981, Ethan Allen dumped approximately 12-14,000 gallons of wastewater and sludge from lacquer and stain wash spray booths associated with the furniture finishing into an unlined lagoon near Halls Stream. The unlined lagoon was discontinued and covered with woodchips and soil. Halls Stream sediment samples upstream and downstream of the lagoon contained low levels of semi-volatile organics. Groundwater and soil samples from the lagoon area itself had low to moderate levels of volatile and semivolatile organic compounds.

Over the years there have been a number of other investigations at this same site. In addition to an investigation of the lagoon, there was an investigation into an onsite dipping tank; into a subsurface release of gasoline, which created a contaminant plume in the groundwater; and into two releases of heating oil, which resulted in some removal of contaminated soil.

Semi-annual groundwater sampling has occurred over the years and the last sampling was in June 2004. After that, the monitoring wells were abandoned per agreement between Vermont DEC Waste Management Division and Ethan Allen. The site was "closed" (SMAC). There were still wells on the site that had levels of organic compounds above the Vermont Groundwater Enforcement Standards (VGES) - monitoring well 2 had high levels of 1,3,5 trimethylbenzene, 1,2,4 trimethylbenzene, benzene, and naphthalene; monitoring wells 3 and 4 also had these four compounds in concentrations above the groundwater standards. The "SMAC" letter states that the contamination onsite will stay onsite and will decrease over time.

Stream biological sampling for macroinvertebrates took place on Halls Stream 2011 with an overall assessment of “very good” at rivermile 0.5 . The community abundance was high as was richness and EPT. The reach is likely slightly altered by nutrient enrichment reflected in a slight increase in BI indicating a compositional shift to more nutrient tolerant taxa. Macro algae is dominant with a significant presence, while micro algae was not thick. Moss not observed. All functional groups are presentand shredder herbaceous taxa are not elevated. While the substrate composition was low in sand, the embeddedness was rated as just above the fair threshold at 55%. Silt was also rated as moderate at 3/5. The substrate was dominated by coarse gravel at 69%, the riffle sampled was short with a lower gradient reach above and below. Iron seeps were noted from west bank. The stream is mid pH with a moderate alkalinity. Nutrients are slightly elevated: TP more than DP. Chloride is also slightly elevated from background. The only metals detected were iron, manganese, and aluminum, but all well were below ALS criteria.

A field visit to Halls Stream in July 2010 viewed the stream channel, banks, and water from Halls Stream Road. There is an iron seep along the base of bank right, which is the border of the Ethan Allen property and that goes for at least a couple hundred feet. There is a Stormwater Pollution Prevention Plan for this site from 2003 that describes stormwater from possibly contaminated places on the site going through piping or swales to Halls Stream.

There is reportedly a swimming spot in the bend of the stream before it goes under the road and to the Connecticut River and this needs confirmation.

Biological Assessments - Macroinvertebrate and Fish Community Integrity

Morrill Brook was sampled in 2003 and the macroinvertebrate community at rivermile 0.1 was assessed as "excellent-very good". The fish community was also sampled in Morrill Brook at rivermile 0.1 and it was assessed as "very good". While small in watershed area, the stream is influenced by upstream ponds and wetlands, and as a result functionally it resembles more of a medium high gradient stream type. Overall, however, numerous dominant macroinvertebrate taxa are water quality sensitive. The macroinvertebrate community is moderate in density, and high in both richness and EPT taxa. The fish community is also very high quality but is influenced by its close proximity to Leach Creek. As a result, small tesselated darter and smallmouth bass are present, but brook trout and longnose sucker are also still present. The Morrill Brook watershed is almost entirely forested except for down near its junction with Leach Creek.

Macroinvertebrate sampling on Keyer Brook found the following: at rivermile 1.0, a community assessment of "good" in 1992 and "excellent" in 1997. The macroinvertebrate community of the brook was sampled in September 2010 again and the assessment of the community was still "excellent". The macroinvertebrate abundance was moderate with richness and EPT species present high. EPT nutrient-sensitive species dominate the community and Oligochaetes, which could indicate sediment stress, are low. Embeddedness was only rated good (50%) but the silt rating was low (2/5).

The fish community was also sampled on Keyer Brook at rivermile 1.0. In 1992, the community was assessed as “excellent” and in 2010, it was assessed as “very good”. The stream was also inspected in mid-July 2010. The water was very clear and the stream channel looked good. There are a number of threats to the brook including road maintenance along Canaan Hill Road, which follows the brook for over two miles; erosion from a new snowmobile bridge's sitework and adjacent road erosion and runoff; and potentially changed watershed hydrology from a large logging job.

A tributary to Leach Brook was also sampled and the macroinvertebrate community at rivermile 0.5 was in "good" health and integrity in 1997. A high percent Oligochaeta indicates sediment is potentially a significant stress. No followup sampling has occurred. .

Mill Brook in Bloomfield was seen in July 2010 in two locations where Mill Brook Road crosses it. It is a very clear and beautiful little stream. At the two locations where observed, it is mostly boulder-cobble with some gravel. The boulders have moss on them or are golden in color from diatoms. The stream is well-shaded with a mix of hardwoods and softwoods. Macroinvertebrate community sampling in 2010 found an “excellent” community at rivermile 1.6. The top ten taxa are water quality sensitive. The substrate composition was very low in sand; the embeddedness was very good; the silt rating was low. The fish community indicated a very high quality water too but for brook trout having been replaced by nonnative brown and rainbow trout. East of Route 102, Mill Brook is part of a Class 2 wetland before it joins the Connecticut River.

Mill Brook in Lemington was sampled at rivermile 2.2 in 1992, 1993, and 1997. The macroinvertebrate community was "good" each of those years. It would be good to resample this stream over the next rotational period.

Blodgett Brook in Lemington, where Mill Brook Road crosses, is a bedrock and boulder stream with small steps. The water is clear and the stream pretty as seen in July 2010. The last biological assessment was in 1993. The stream at that time was of very high macroinvertebrate community integrity. The fish community was also also very good, however, again since no brook trout were present, it was assessed as “good”. This should be followed up with a more current assessment.

Willard Stream was seen from Route 102 in July 2010. There is a lot of cobble and gravel deposited in this area through which the stream has to find a way. This is where the stream's gradient lessens, however, orthophotos do show a gravel pit up higher in the stream's watershed and potential impacts from this activity are unknown. There are hundreds of acres of Christmas tree farm land in the Willard Stream watershed. There has been no fish or macroinvertebrate community sampling on this stream.

Stream Assessment Status

Stressed Miles

Halls Stream: 0.6 - from Canadian border down to Connecticut River - aquatic habitat and aesthetics at least stressed due to iron staining along bank right. Not known is the sediment condition due to the former hazardous waste site and any impacts of stormwater runoff or leaching on the stream.

Very High Quality Miles

Mill Brook in Bloomfield: 6.0 – from its mouth upstream it its headwaters – very high quality aquatic biota due to an undeveloped, forested watershed.

Unassessed Miles

A number of streams in Canaan are considered unassessed and these include: Capon Brook, Bolter Brook and a tributary, Hudson Brook, the upper 4 miles of Keyer Brook, Schoolhouse Brook, Clay Brook, Jacobs Chopping Block, Bunnell Brook, and Leach Creek. Although this area of the state is not developed, it underwent heavy logging in the 1980s particularly, and is still logged, mined, and farmed today so a presumption of full compliance is not possible.

Several streams in Lemington and Bloomfield are also considered unassessed. These include the West Branch Willard Stream, Alder Brook, Clough Brook, and Daley Brook.

Lakes and Ponds in Canaan, Lemington, Bloomfield

There are two lakes and ponds in the lake inventory and lake assessment database maintained by the Vermont DEC Water Quality Division in this portion of the watershed and some characteristics of these are shown in the table below.

Table 8. Lakes and ponds in Basin 16 in Canaan, Lemington, Bloomfield

Lake or Pond	Town	Waterbody ID	Lake Acres	Watershed Acres	Outlet Type	Trophic Status[1]	Monitoring Data[2]
FOREST (AVERLL)	Averill	VT16-08L01	62	1379	natural w/ artificial control	M	SpP
WALLACE	Canaan	VT16-08L02	532	19382	natural w/ artificial control	M	SpP

1 - O=oligotrophic; M=mesotrophic; E = eutrophic; D = Dystrophic; U = unknown
2 - LMP=lay monitoring program data (Secchi, chorophyll a,phosphorus); SpP = spring phosphorus data

Wallace Pond

Stressed Acres

30 acres due to sedimentation with aquatic life, secondary contact recreation, and swimming uses stressed.
532 acres due to periodic algae blooms and a decline in water quality with aesthetics, aquatic life, secondary contact recreation, and swimming uses stressed.
2010 Assessment Notes: Review of recent data reveals that there may be a slight increase in total spring phosphorus (mean now 11.9 ug/l).

Nulhegan River Watershed

General Description

The Nulhegan River originates east of Spectacle Pond in the town of Brighton. It flows in an easterly/southeasterly direction through a wide, flat valley of shrub swamp for much of its 16 mile length. The drainage area of the Nulhegan is 151 square miles. The four major tributaries to the Nulhegan are the East Branch, the Black Branch, the Yellow Branch, and the North Branch.

The East Branch of the Nulhegan River arises in Averill north of Sable Mountain and flows generally south through the southern half of Averill; the eastern edge of Lewis; and the western portion of Bloomfield until it joins the Nulhegan River mainstem a few miles upstream of its mouth at the Connecticut River. Tributaries to the East Branch include La Pointe Brook, Spaulding Brook, Brouillard Brook, Murphy Brook, Fisher Brook, and Mink Brook. The 13-mile long East Branch drains a watershed of just over 35 square miles.

The Black Branch of the Nulhegan River is located to the west of the East Branch and arises on the eastern slope of Round Mountain in Averys Gore. It flows south-southeasterly through the town of Lewis and then the western corner of Bloomfield before it reaches the Nulhegan near the Bloomfield/Brunswick town line. The 12-mile long Black Branch drains a watershed of 27 square miles. The main tributary to the Black Branch is Logger Branch, which arises on the eastern slopes of Lewis Mountain. Logger Branch flows southeasterly to meet the Black Branch in the Yellow Bogs, a huge wetland complex.

The 10-mile long Yellow Branch of the Nulhegan River is located west of the Black Branch. It begins just south of Lewis Pond and flows southeast and south overall through much of Lewis and into Brunswick down to meet the Nulhegan mainstem. Much of the Yellow Branch is associated with extensive wetlands including the vast Yellow Bogs. It drains 12.6 square miles and has no named tributaries.

The North Branch of the Nulhegan River has its origin in Unknown Pond in Avery"s Gore and from here it flows southeast. After the river enters the town of Lewis, Tim Carroll Brook joins it from the north. The North Branch continues on a southerly and southeasterly course, with Whiskey Brook joining it from the west, until it reaches the Nulhegan River mainstem. The North Branch is about 12 miles long and drains a 20 square mile watershed. Several long stretches of the North Branch are associated with wetlands.

Other tributaries to the Nulhegan River either directly or indirectly include Murphy Brook, Paul John Brook, Clay Hill Brook, and Tuffield Willey Brook. The ponds of the Nulhegan River watershed include McConnell Pond, Nulhegan Pond, Mile Pond, and Lewis Pond.

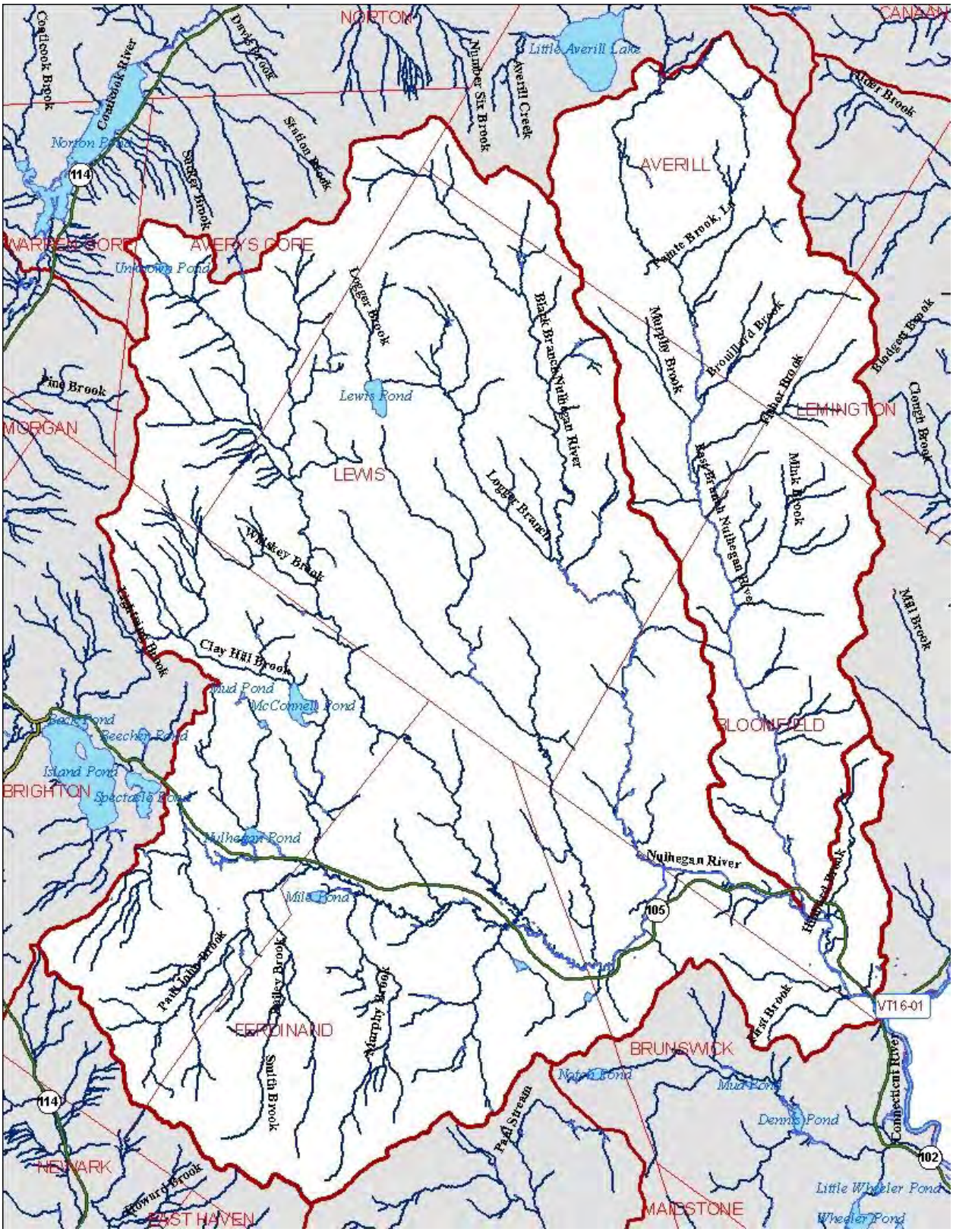


Figure 3. Nulhegan River Watershed.

Uses, Values, Special Features and Conditions

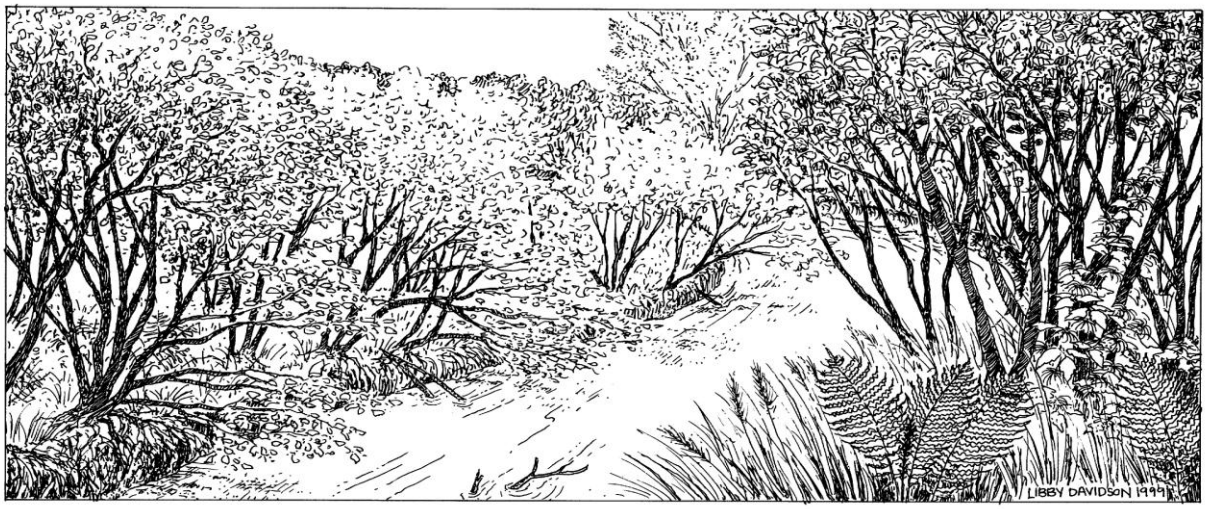
Public lands and natural communities

The Nulhegan River watershed is home to the 26,000 acre Nulhegan Basin Division of the Silvio O. Conte National Fish and Wildlife Refuge, which was formed from the former Champion International Paper Company lands in 1998. A portion of the Nulhegan River mainstem and some of its watershed including Moose Bog are part of the 1,993 acre state Wenlock Wildlife Management Area.

An extensive inventory and compilation of natural community and rare plant information was done in 2000 and 2001 for the Conte National Fish and Wildlife Refuge and West Mountain Wildlife Management Area (see also the Paul Stream watershed section of this report). Six natural community types found in the Conte Refuge are considered rare in Vermont and another ten types are classified as uncommon. All the rare community types are wetland or riverine communities including dwarf shrub bog, poor fen, and river cobble shore. There are 46 rare or uncommon plant species also found on the Refuge.

The following text on this unique and ecologically valuable part of Vermont is taken directly from the report produced following the inventory.

"Within the Refuge, the Nulhegan Basin is an area where hydrology and glacial deposits create a complex, fine-scale mosaic of upland and wetland natural communities – lowland spruce-fir forests… are intermingled with spruce-fir-tamarack swamp, black spruce swamp, northern white cedar swamp, a variety of open or shrubby peatlands, and riparian and beaver wetlands. Cloaking the slopes of the basin rim are extensive northern hardwood forests and its variants, plus restricted montane natural communities. Although much of the lowland conifer-dominated area, known as Yellow Bogs, has been heavily logged, it remains unparalleled in Vermont an example of a northern lowland ecosystem. Of equal ecological significance in the Refuge and adjacent ownerships are the high-quality alluvial shrublands and associated floodplain natural communities along the Nulhegan River and its branches."



"*Without a doubt the Nulhegan River floodplain is one of the most remarkable ecosystems in the project area, and in the whole Nulhegan Basin. This is really the heart of the Nulhegan Basin, where both the Yellow Branch and North Branch.. join the mainstem. The river in this flat area of the basin bottom cuts through sandy kame and what appears to be a narrow outwash plain...In the floodplain ecosystem, the natural hydrogeomorphic process of flooding leads to fresh sediment deposition, while at the same time the river erodes portions of the alluvial sediments as it winds its way across the floodplain... Alluvial shrubland is the predominant natural community in the complex. Imbedded in the shrubland are two other floodplain natural communities: alluvial grassland/meadow and alder swamp."* The endangered auricle twayblade (*Listera auriculata*) is found in the meadows of the floodplain.

The State of Vermont Wenlock Wildlife Management Area is a 1,993 acre piece of land wholly within the Nulhegan River watershed. A portion of the Nulhegan River mainstem, the lowest section of the North Branch Nulhegan River, and Moose Bog among other streams and wetlands are in the WMA. Two rare plant species were found on the Nulhegan floodplain in the Wenlock WMA during the Conte Refuge and Wenlock WMA natural community/rare plant inventory.

Nesting and migrating waterfowl use the river as well as beaver and bog ponds in the WMA. Northern spring salamanders, northern two-lined salamanders, red-backed salamanders, pickerel and wood frogs, and red-spotted newts are amphibians also found here. Moose, beaver, mink, river otter, and other mammals also use the wetlands and uplands of this WMA. The threatened Eastern pearlshell mussel is found in the Nulhegan River below the Black Branch confluence.

Stream Sampling Results and Assessment Information

Biological and Habitat Monitoring

Ambient Data

The streams that were sampled in the Nulhegan River watershed in summer 2000 had a total variation in pH among the sites of 5.45-7.68. The three sites on the Yellow Branch of the Nulhegan River had the lowest pH values and alkalinities (pH 5.45 - 5.83 and alkalinity 2- 4.5mg/l). These values represent summer flows and likely are considerably lower during spring snow melt events, which often bring the highest acidities of the year. As a result, the pH values and alkalinity in the Yellow Branch will be limiting to sensitive fish and macroinvertebrate taxa. Other stream reaches that also had low alkalinity and therefore probably undergo a period of low pH in the spring are: Tuffield-Willey and Bluff Mountain Brooks. The low pH and alkalinity of these two streams indicates that other very high elevation (>600m) streams with small watersheds most likely undergo a period of very low pH and alkalinity.

Macroinvertebrate Assemblages

A total of 223 taxa were identified from the 17 stream sites sampled within the Silvio Conte lands of the Nulhegan River watershed. Aquatic insects were the dominant macro-invertebrate class with 195 taxa broken down by insect order as follows: 81 Diptera (58

Chironomidae), 44 Trichoptera, 19 Coleoptera, 18 Ephemeroptera, 17 Plecoptera, 9 Odonata, 2 Megaloptera, and 4 Hemiptera. The remaining taxa were mainly from the class Mollusca, Gastropoda (8), and Bivalvia (6). This is not a complete taxa list of the macro-invertebrate species from streams within the Silvio Conte lands of the Nulhegan watershed, but does represent the taxa groups found in these streams in late summer.

None of the taxa collected are listed as threatened or endangered in Vermont or the United States. Most of the taxa collected are common in Vermont running waters, and all of the taxa collected are considered native to Vermont. The Trichopteran or caddis fly, *Palaegapetus celsus,* is uncommon as it is found from only 17 other locations in Vermont. It is highly associated with small acidic montane streams with liverwort present, which it uses to build its case. The Coleopteran or beetle, *Ancyronyx variegata,* has only been collected from six other stream sites by Vermont DEC. This may be due however to its habitat of burrowing under bark of decaying logs making it difficult to collect.

Eight of the 12 stream reaches were rated as either “very good” or “excellent”. These streams are considered very near reference condition compared to other streams from a similar category in Vermont. The four other streams were rated “good” condition; moderately altered from the natural condition, but still meeting their Class B water quality management designation. Overall, all the stream reaches were of good quality or better with no impaired reaches identified within the Silvio Conte National Refuge.

Table 9 . Macroinvertebrate Sampling Results 1999-2009

Wbid	River or stream	Town	Station	Date	Assessment
VT16-10	East Branch Nulhegan	Bloomfield	0.7	8/31/2000	Very good
VT16-10	East Branch Nulhegan	Bloomfield	2.9	9/09/2005	Excellent
VT16-10	East Branch Nulhegan	Averill	9.9	8/31/2000	Excellent
VT16-10	Mink Brook	Bloomfield	0.3	8/31/2000	Good
VT16-10	Brouillard Brook	Averill	0.1	8/31/2000	Good
VT16-11	Black Branch Nulhegan	Bloomfield	2.3	8/31/2000	Very good
VT16-11	Black Branch Nulhegan	Bloomfield	2.6	9/15/2009	Exc-Very good
VT16-11	Black Branch Nulhegan	Lewis	13.2	9/06/2000	Excellent
VT16-11	Logger Branch	Lewis	1.4	9/06/2000	Excellent
VT16-11	„Yellow Alder‟ Brook	Lewis	0.4	9/06/2000	Good
VT16-11	Yellow Branch Nulhegan	Bloomfield	0.1	9/06/2000	Excellent
VT16-11	Yellow Branch Nulhegan	Lewis	7.6	9/06/2000	Good
VT16-11	„Bluff Mountain‟ Brook	Averys Gore	0.1	8/30/2000	Very good
VT16-11	„Palaeagapetus‟ Brook	Lewis	1.6	8/30/2000	Excellent
VT16-11	North Branch Nulhegan	Ferdinand	4.4	9/12/2009	Excellent
VT16-11	North Branch Nulhegan	Lewis	10.5	8/30/2000	Good
VT16-11	Nulhegan River	Bloomfield	0.2	8/30/2000	Excellent
VT16-11	Nulhegan River	Bloomfield	0.3	9/15/2009	Excellent
VT16-11	Nulhegan River	Bloomfield	4.5	8/31/2000	Excellent
VT16-11	Nulhegan River	Ferdinand	15.1	9/08/2006	Exc-Very good
VT16-11	Nulhegan River	Bloomfield	0.2	10/16/2008	Excellent
VT16-11	Clay Hill Brook	Brighton	6.2	8/30/2000	Very good
VT16-11	Tuffield Willey Brook	Brighton	1.6	8/30/2000	Good
VT16-11	Goupee Brook	Brighton	1.5	9/06/2000	Very good
VT16-11	Paul John Brook	Brighton	2.8	9/06/2000	Excellent

Fish Assemblages

The fish communities were sampled from twelve sites on eight streams and rivers within the Silvio Conte lands of the Nulhegan drainage in 2000 to fill help fill the gap in aquatic biological information. A total of 450 fish from 16 species were collected by Vermont DEC. The Vermont Department of Fish & Wildlife collected an additional two species and a total of 31 Atlantic salmon, two brook trout, one brown trout and one rainbow trout at river mile 1.8 of the Nulhegan. The 18 species collected during this survey had already been recorded in Vermont waters of the Connecticut drainage. There were no state or federally-listed species collected during 2000, nor have any been reported in past surveys. Sixteen of the species collected were classified with "common" or "widespread" distributions. The burbot and lake chub have "uncommon" distributions across the Vermont. Only two species collected, rainbow and brown trout, are non-native to Vermont.

Table 10. Fish Community Sampling Results 1999-2008

Wbid	River or stream	Station	Date	Assessment
VT16-10	Mink Brook	0.3	8/31/2000	Very good
VT16-10	Brouillard Brook	0.1	8/31/2000	Excellent
VT16-11	Black Branch Nulhegan	0.1	8/29/2000	Fair
VT16-11	Logger Branch	1.4	8/27/2000	Good
VT16-11	Yellow Branch Nulhegan	7.6	8/21/2000	Poor
VT16-11	North Branch Nulhegan	12.5	8/21/2000	Very good
VT16-11	Nulhegan River	15.1	9/07/2006	Good

A stream walk on Murphy Brook in Ferdinand in summer 2000 found sandy point bars and sand mid-channel bars with dead alder branches emerging from the sand. Even in the steeper, more rapidly flowing stretches of stream, the boulders are embedded. Widening appears to be occurring with undercut banks, leaning trees, and recent tipovers. The habitat observations seemed to indicate that the brook has not recovered from past sedimentation events from logging.

There were a number of impacts described in earlier assessments on the East Branch of the Nulhegan River from the late 1980s and early 1990s because of extensive and intensive logging. However, the aquatic macroinvertebrate communities are healthy now where sampled and there appears to be at least some recovery of the river. There should be further investigation of the East Branch and some of its tributaries because washouts from logging and other gravel roads are still threats and the large scale clearcutting in the relatively recent past appears to have affected hydrology and the stream channel stability to a degree (mid-channel bars, new point bars, undercut banks, and other observations were made in a summer 2000 field survey). In addition, the East Branch watershed is still owned by a timber company - it is not part of the Conte NWR that includes the rest of the Nulhegan River watershed.

Stream Assessment Status

Stressed Miles

Murphy Brook: 4.0 - in Ferdinand - aquatic biota/habitat stressed due to sedimentation from logging practices. Steep logging road washout. Spawning habitat removed and physical habitat alterations as stream attempts to move sand through.

Unassessed Miles
The unassessed streams in the Nulhegan watershed include: unnamed tributaries 1,2,3; the unnamed tributaries off Bloomfield Ridge; Mink Brook above rivermile 0.5; Fisher Brook; Spaulding Brook; LaPointe Brook; and Brouillard Brook above rivermile 0.5.

Very High Quality Miles
East Branch Nulhegan River: 13.0 – mouth to headwaters – very high quality aquatic biota due a watershed that is dominated by forest land and wetland.

Black Branch Nulhegan River: 12.0 – mouth to headwaters – very high quality aquatic biota due to forested watershed within Conte National Wildlife Refuge.

Nulhegan River: 16.0 – very high quality aquatic biota, wildlife habitat, and boating due to a watershed and river corridor with diverse wetland and other natural communities.

Lakes and Ponds of the Nulhegan Watershed

There are eight lakes and ponds in the lake inventory and lake assessment database maintained by the Vermont DEC Water Quality Division in this portion of the watershed and some characteristics of these are shown in the table below.

Table 11. Lakes and Ponds in the Nulhegan River Watershed of Basin 16

Lake or Pond	Town	Waterbody ID	Lake Acres	Watershed Acres	Outlet Type	Trophic Status[1]	Monitoring Data[2]
FERDINAND-E;	Ferdinand	no	7	310	unknown	U	none
FERDINAND-NE;	Ferdinand	no	13	689	unknown	U	none
LEWIS	Lewis	VT16-11L02	68	1254	natural	U	SpP
MCCONNELL	Brighton	VT16-11L03	87	3621	natural	D	SpP
MILE	Ferdinand	VT16-11L05	26	156	natural	U	SpP
MUD (BRIGTN)-E	Brighton	no	4	19	unknown	U	none
NULHEGAN	Brighton	VT16-11L04	37	5421	natural	M	SpP
UNKNOWN (AVYGOR)	Avery's Gore	VT16-11L01	19	296	natural	D	none

1 - O=oligotrophic; M=mesotrophic; E = eutrophic; D = Dystrophic; U = unknown
2 - LMP=lay monitoring program data (Secchi, chorophyll a,phosphorus); SpP = spring phosphorus data

Note that the use of a semi-colon (;) after the pond name denotes a water for which Vermont DEC has established a name based on USGS topographic map features. These names were established for tracking purposes, and may not reflect local pond names.

Ferdinand-E; (Buxtons Pond)
Notes from a Nongame and Natural Heritage Program Report:
Buxtons Pond is a small, tannic-water pond surrounded by a lowland bog mat that is encroaching on the open water. 2001: A rare plant is associated with the pond"s wetland edge.

Lewis Pond
Stressed Acres
68 acres due to acid precipitation – aquatic life use stressed.

Notes from a Nongame and Natural Heritage Program Report:
The Lewis Pond Basin is a medium to high elevation (1800 feet), small, and exceptionally seepy basin that is separated from the Nulhegan Basin by a series of small hills. Lewis Pond, a wilderness-like dystrophic pond, lies in the deepest part of the basin. At 69 acres, it is the largest body of water within the Conte Refuge. There are meadows and small ponds created by beavers along the Tim Carroll and Logger Brooks, which feed Lewis Pond from the mountains to the north.

McConnell Pond
Stressed Acres
87 acres due to acid precipitation – aquatic life use stressed.

Mile Pond
Stressed Acres
26 acres due to acid deposition – aquatic life use stressed.
26 acres due to siltation, nutrients, and algae - aesthetics, aquatic life, secondary contact recreation and swimming uses stressed.

Nulhegan Pond
Stressed Acres
37 acres threatened due to acid deposition – aquatic life use stressed.

Unknown Pond (Avery's Gore)
Impaired Acres
19 acres due to extreme acid sensitivity – aquatic life use impaired.

Notes from Nongame and Natural Heritage Program Report:
Unknown Pond is a deep wilderness pond about 25 acres in size. It has a good coldwater fishery and a shoreline population of a rare aster.

Wheeler Stream watershed and Paul Stream watershed

General Description

Wheeler Stream watershed

More than half of the Wheeler Stream watershed is Notch Pond, Notch Pond Brook, Dennis Pond, and Dennis Pond Brook, which meets Wheeler Stream less than a mile before Wheeler meets the Connecticut River. Notch Pond Brook begins at the base of the southern slopes of Notch Pond Mountain and flows generally east through Notch Pond and into the extensive bog, sedge meadow, shrub swamp wetlands surrounding Dennis Pond. From there the stream leaving the wetland complex is Dennis Pond Brook which makes its way southeast and east to Wheeler Stream.

The other less-than- half portion of Wheeler Stream watershed is comprised of the drainages that are West Mountain Brook going into and out of West Mountain Pond, which flows into Wheeler Stream. Wheeler Stream flows into and out of Wheeler Pond and Little Wheeler Pond before joining the Connecticut River. Wheeler Stream is five miles long and drains a 17 square mile watershed.

A dominant characteristic of the Wheeler Stream watershed is the number of ponds and the amount of wetland surrounding most of the ponds and along the streams. Many interesting wetland natural communities can be found here including black spruce swamp, intermediate fen, sweet gale shoreline swamp and others.

Paul Stream watershed

The 15-mile long Paul Stream originates on the north side of West Mountain in Ferdinand and flows first northwest then west and then south and southeast about 180 degrees around the base of West Mountain. After shifting southeast, the stream soon flows into the extensive and ecologically diverse Ferdinand Bog. Stevens Branch and North Branch enter Paul Stream upstream of the bog, however, the outlet brook of South America Pond and Madison Brook join Paul Stream in the heart of the bog. Paul Stream continues southeasterly out of Ferdinand Bog.

Further downstream, as Paul Stream makes a wide bend to the northeast, Granby Stream flows into Paul Stream from the south. Wilke Brook, Tolman Brook, Stony Brook, and Fitch Brook are all tributaries to Granby Stream.

Paul Stream continues its northeasterly flow and a few miles downstream of the mouth of Granby, the outlet stream of Maidstone Lake enters from the south. Maidstone is a large lake of 745 acres with a watershed area of over 3000 acres. Paul Stream continues northeasterly still, the outlet from the small Pauls Pond enters, and then in about a mile Paul Stream reaches the Connecticut River. Paul Stream drains a watershed that is 43.9 square miles.

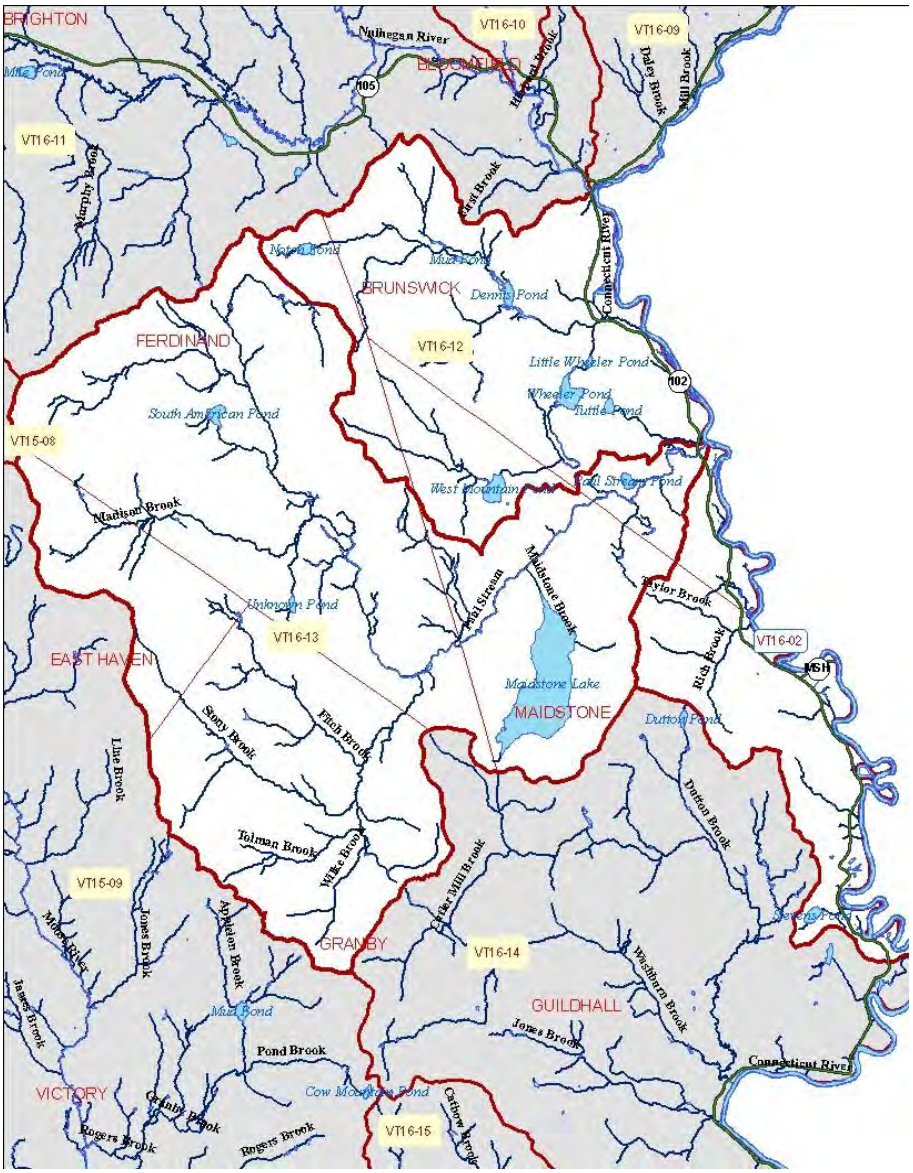


Figure 4. Wheeler and Paul Streams Watersheds

Uses, Values, Special Features or Conditions

<u>Public lands and natural communities</u>

The West Mountain Wildlife Management Area (WMA) is 22,971-acre piece of land owned by the State and managed by the Department of Fish and Wildlife. The WMA contains nine major ponds and over 75 miles of streams. A natural communities and rare plant inventory was done on the West Mountain WMA when one was also done on the Conte National Fish and Wildlife Refuge (see the Nulhegan Watershed chapter). Seven natural community types considered rare in Vermont and ten natural community types that are uncommon occur on the WMA. Forty-six plant species that are rare or uncommon are also on the WMA. All the rare natural community types are wetland or riverine-related natural communities including black spruce woodland bog, intermediate fen, river cobble shore, and northern conifer floodplain forest among others.

Stream Sampling Results and Assessment Information

Biological Monitoring

The biological communities were sampled from eleven sites on seven streams and rivers within the West Mountain WMA in 2000 to fill help fill the gap in aquatic biological information. The stream sites from the Paul Stream watershed and the Wheeler Stream watershed at which the biological communities were sampled ranged in watershed size from 3.5 to 113 km^2 and at elevations from 286 to 628 meters. The data indicate that the waters of these drainages are somewhat soft with specific conductances ranging from 26-41 Φmhos and alkalinities from 6.2- 21.3 mg/l. The pHs were near circumneutral ranging between 6.51-7.52. Within the Paul Stream watershed, the smaller streams generally had lower alkalinities (<10mg/l). Dennis and Notch Pond brooks had significantly higher alkalinity then all the other stream sites.

Fish Assemblages

A total of 1,763 fish from 20 species were collected from the ten stream sites. In addition to this, a collection conducted by the Vermont Department of Fish & Wildlife on lower Paul Stream (river mile 3.1) tallied 124 Atlantic salmon, 10 brook trout and an undetermined number of nongame species. All twenty species collected in 2000 had already been recorded in the Connecticut drainage. Species richness per site ranged from 1 to13.

Three non-native species were recorded: two brown trout from two sites and a single bluntnose minnow from one site. For all collections made in 2000, blacknose dace, white sucker and brook trout were the most common species with other common species including longnose dace and creek chub. There were no state or federally listed species collected in the West Mountain WMA. No listed species have been historically reported from this drainage. Species statewide occurrence is categorized here as ″abundant", "common", "uncommon" or "rare" based on the 9000-record Vermont ANR database. No rare fishes were collected. Finescale dace and burbot were the least common species, being rated as "uncommon". Ten species were regarded as "common" and nine were considered as having a "widespread" state distribution.

Macroinvertebrate Assemblages

A total of 147 taxa were identified from the seven stream sites sampled within the West Mountain WMA. Aquatic insects were the dominant macroinvertebrate class with 131 taxa broken down by insect order as follows: 52 Diptera (flies), 31 Trichoptera (caddis flies), 16 Ephemeroptera (mayflies), 15 Plecoptera (stone flies), 7 Coleoptera (beetles), 6 Odonata (dragonflies or damselflies), 2 Megaloptera (dobsonflies), and 2 Hemiptera (true bugs). The remaining taxa were mainly from the Gastropoda (snails) and Bivalvia. This is far from a complete taxa list of the running waters from the West Mountain WMA. It is however, a good representation of the taxa groups found in these streams during the late summer. None of the taxa collected are listed as threatened or endangered in Vermont or the United States. Most of the taxa collected are common in Vermont running waters, and all of the taxa collected are considered native to Vermont. The Coleopteran, *Microcylloepus pusillus*, is somewhat uncommon being found in only seven rivers identified in the Vermont DEC Biomonitoring database. It was found in Dennis Pond Brook and may be connected to streams below ponds or wetlands.

Some macroinvertebrate sampling on Paul Stream got the following results. In 2000, at rivermile 4.8, the community was assessed as "excellent"; and at rm 7.8, the community was again assessed as "excellent". In 2009, at rm 8.8 and at rm 15.9, the macroinvertebrate communities were "excellent". The community was rated "excellent" as well back in 1992 and 1993 at rm 0.1. Fish community sampling on Paul Stream in 2000 found a community in "fair" condition at rm 12.8 and "good" condition at rm 14.5.

The macroinvertebrate community was sampled in the North Branch Paul Stream at rm 2.7 in 2000 and the community there was in "excellent" condition.

The macroinvertebrate community in Madison Brook around rm 0.8 was also sampled in 2000 and the community there was in "very good" health.

The biological communities were sampled in Granby Stream in 2000 around rm 0.1. The bug community was in "excellent" health and the fish community in "very good" health.

Lakes and Ponds of the Wheeler Stream and Paul Stream Watersheds

There are twelve lakes and ponds in the lake inventory and lake assessment database maintained by the Vermont DEC Water Quality Division in this portion of the watershed and some characteristics of these are shown in the table below.

Table 12. Lakes and ponds in the Wheeler and Paul Streams Watersheds of Basin 16

Lake or Pond	Town	Waterbody ID	Lake Acres	Wshed Acres	Outlet Type	Trophic Status[1]	Monitoring Data[2]
BRUNSWICK SPRINGS	Brunswick	no	16	140	unknown	U	none
DENNIS	Brunswick	VT16-12L03	49	5337	natural	D	SpP
LITTLE WHEELER	Brunswick	VT16-12L07	9	4224	unknown	U	none
MAIDSTONE	Maidstone	VT16-13L02	745	3103	natural w/ artificial control	O	LMP, SpP
MUD (BRUNWK)	Brunswick	no	5	320	unknown	U	none
NOTCH	Ferdinand	VT16-12L01	22	500	natural	D	SpP
PAUL STREAM	Brunswick	VT16-13L03	20	151	natural	U	SpP
SOUTH AMERICA	Ferdinand	VT16-13L01	29	509	natural	D	SpP
TUTTLE (BRUNWK)	Brunswick	VT16-12L05	14	176	unknown	U	none
UNKNOWN (FERDND)	Ferdinand	VT16-13L04	12	186	unknown	U	none
WEST MOUNTAIN	Maidstone	VT16-12L02	60	2311	natural	D	SpP
WHEELER (BRUNWK)	Brunswick	VT16-12L04	66	4159	natural	D	SpP

1 - O=oligotrophic; M=mesotrophic; E = eutrophic; D = Dystrophic; U = unknown
2 - LMP=lay monitoring program data (Secchi, chorophyll a,phosphorus); SpP = spring phosphorus data

Maidstone Lake
Stressed Acres
745 acres due to acid precipitation – aquatic life use stressed.

2007 Assessment Notes: Visited as a study lake in the National Lakes Survey in 7/2007, and again in 10/2007 to cut a sediment core for analysis at the EPA Region 1 Lab.

Mud Pond (Brunswick)
Notes from a Nongame and Natural Heritage Program Report:
Mud Pond is a shallow, tannic pond with a peaty bottom, surrounded by a bog and upland spruce-fir forest. A threatened plant species occurs at the wet, boggy inlet to the pond.

Notch Pond
Stressed Acres
22 acres due to acid precipitation – aquatic life use stressed.

Paul Stream Pond
Stressed Acres
20 acres due to acid precipitation – aquatic life use stressed.

South America Pond
Stressed Acres
29 acres due to acid precipitation – aquatic life use stressed.

Notes from a Nongame and Natural Heritage Program Report:
South American Pond is a clear, softwater pond with a sandy bottom and angular boulders scattered along the shoreline. A rare rose grows here.

Tuttle Pond (Brunswick)
Notes from a Nongame and Natural Heritage Program Report:
Tuttle Pond is a shallow, tannic-water pond surrounded by a narrow shrub and forested bog mat. A spring fed, cold stream originates north of the pond and feeds into it.

West Mountain Pond
Stressed Acres
60 acres due to acid precipitation – aquatic life use stressed.
20 acres due to sedimentation – aquatic life, aesthetics, secondary contact recreation, and swimming uses stressed.

Wheeler Pond (Brunswick)
Stressed Acres
66 acres due to acid precipitation – aquatic life use stressed.

Dennis, Paul Stream, Little Wheeler and Tuttle Ponds are shallow ponds with warmwater fish such as brown bullhead, chain pickerel, and yellow perch. South America, Notch, West Mountain, Unknown and Wheeler Ponds are deeper ponds containing brook trout. Paul, Granby, and Wheeler Streams all support wild brook trout, slimy sculpin, burbot, longnose dace, blacknose dace, and creek chubs.

Maidstone-Guildhall-Lunenburg Streams to Connecticut and the Connecticut River itself

General Description

The streams that flow to the northern Connecticut River from these three towns range in size from the two mile long Mad Brook in Waterford to the 11 mile long Cutler Mill Brook in Maidstone and Guildhall. Each named stream is briefly described below beginning in Maidstone and going south, or downstream, on the Connecticut River.

The one and a half mile long Taylor Brook with its unnamed tributary flows into the Connecticut near the northern border of Maidstone. No more named tributaries enter the Connecticut River in the town of Maidstone.

Cutler Mill Brook, originating in Granby and flowing northerly then easterly -southeasterly through Maidstone and southerly into Guildhall, joins the Connecticut River at a large meander. Cutler Mill Brook is about 15.3 miles long and drains a 26 square mile watershed. After its 12 plus mile passage through the mountains of Granby and Maidstone, the brook twists and winds its last three miles through a flatter area mostly in Guildhall before it reaches the Connecticut. It passes through several very large wetlands in its journey.

Named tributaries to Cutler Mill Brook include Sable Mountain Brook, Dutton Brook, and, shortly before the Connecticut River, Washburn Brook. Sable Mountain Brook is about 0.8 miles long; Dutton Brook flowing from Dutton Pond is about 2.1 miles long; and Washburn Brook is 4.3 miles long and drains a 4.5 square mile watershed.

Jones Brook in Guildhall originates in the notch between Burnside Mountain and Stone Mountain and flows for approximately three miles east-southeast to the Connecticut River. It has several unnamed tributaries and one named tributary, Emery Brook.

Sheridan Brook, also in Guildhall, begins on the northeast slope of Sheridan Mountain and flows southeasterly for about 3.3 miles until it reaches first an old oxbow, and then a more recent oxbow, of the Connecticut River. The older oxbow is a Class 2 wetland.

The three-mile long Hudson Brook begins on the southeast slope of Sheridan Mountain in Guildhall and twists its way southerly overall down to the Connecticut River in Lunenburg. There are a handful of Class 2 wetlands associated with this brook, which also has at least four small unnamed tributaries.

Catbow Brook originates between Stone Mountain and Adden Mountain in Guildhall and flows six and a half miles south-southeasterly to the Connecticut River draining a nine and a half square mile watershed. A very large wetland complex, which is largely softwood swamp, occupies the basin formed by the ring of Adden, Stone, Halibut, Sheridan, and Colby Mountains through which Catbow Brook flows. Turner Brook is a tributary to Catbow Brook near the Connecticut River.

Neal Brook in Lunenburg is an eight and a half mile long brook that includes the 185 acre Neal Pond in its course. Neal Brook and its tributaries drain a 21 square mile watershed. The brook begins in the western corner of Guildhall in a valley below Adden Mountain. It flows southerly into the town of Lunenburg and about two miles downstream from the Guildhall/Lunenburg border, Halls Brook joins Neal Brook. Soon after this, the brook"s flow becomes part of Neal Pond. Exiting Neal Pond, the brook continues south through Lunenburg until it meets the Connecticut River. The six mile long Mink Brook joins Neal Brook in an area of wetland just before the Connecticut. Mink Brook drains a nine square mile watershed.

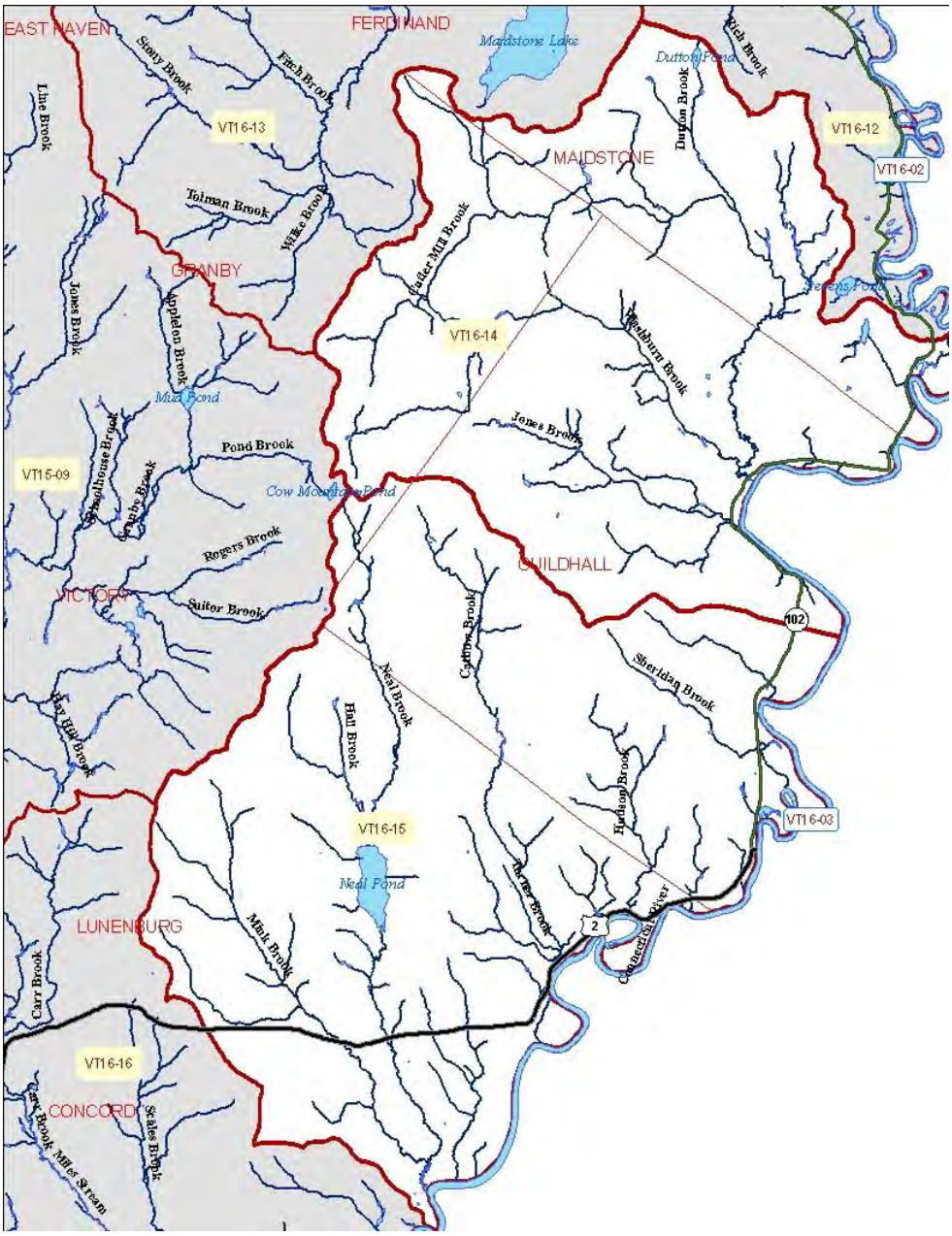


Figure 5. Maidstone, Guildhall, Lunenburg Streams to Connecticut River

Stream Sampling Results and Assessment Information

Monitoring and Assessment

A field visit to Washburn Brook in July 2010 found that the water was cloudy in this brook - a grey-green turbid color and the channel bottom was covered with algae. This was below the gravel operation, which was posted so an inspection of the stream where it goes through the gravel yard was not possible. Past assessments have noted gravel pit lagoon overflows. The macroinvertebrate community was sampled at rivermile 0.3 in September 2010 and was assessed as “excellent”. No macro algae was observed and micro algae and moss dominated the periphyton community. This indicates that primary productivity is not enhanced. All of the functional groups are well represented and 5 of 9 dominant taxa are water quality sensitive species. While substrate observations showed the stream to be low in sand, embeddedness was only rated as good (50% embedded), and the silt rating was high (4/5). Iron and manganese were moderately elevated but below the aquatic life use support criteria. However the values do indicate significant soil disturbance within the immediate watershed. A gravel mining operations is located immediately upstream, and small iron seeps were evident above the reach near this operation. The fish community was also rated “excellent” dominated by brook trout and sculpin, with cold water sensitive burbot and longnosed sucker also present.

Orthophotos of Cutler Mill Brook show it to be a very sinuous stream with many wetlands in areas along its length. An area north of Round Mountain in Granby and Maidstone looks to be logged fairly extensively, however, this was not seen in the field but shows up on 2009 orthophotographs.

The macroinvertebrate community was sampled on Mink Brook at rivermile 2.7 in Lunenburg in September 2000. The assessment of the community was "very good".

The macroinvertebrate community of Neal Brook was sampled in 2005 at rivermile 0.3. The assessment of the community from the DEC biologist describes the brook as a "low gradient stream with low density [of macroinvertebrates] but very high richness and EPT taxa." It is a "possible reference" stream for this type. "Community assessment of very good with low density."

Hudson Brook macroinvertebrate community was also assessed in 2005 but at rivermile 0.1. The comments include: "Low gradient stream possible reference. Density low, richness high, 5 *Odonata* species present.." Water chemistry results: low alkalinity, low chloride, low TP and TN, very tannic, moderately high iron. "Overall assessment based on best professional judgement is very good biological integrity for low gradient stream type."

Stream Assessment Status

Stressed Miles

Washburn Brook: 0.8 - above confluence with Cutler Mill Brook - aquatic biota/habitat, aesthetics at least stressed by turbidity, sedimentation, algae from activities at the Caulkins Sand & Gravel Pit.

Not assessed
The following streams in these towns were not assessed: Jones Brook; Cutler Mill Brook; Dutton Brook; and Taylor Stream.

Lakes and Ponds in Maidstone, Guildhall, and Lunenburg

There are four lakes and ponds in the lake inventory and lake assessment database maintained by the Vermont DEC Water Quality Division in this portion of the watershed and some characteristics of these are shown in the table below.

Table 13. Lakes and ponds in Maidstone, Guildhall, Lunenburg towns in Basin 16

Lake or Pond	Town	Waterbody ID	Lake Acres	Watershed Acres	Outlet Type	Trophic Status[1]	Monitoring Data[2]
DUTTON	Maidstone	VT16-14L01	12	115	unknown	U	none
LITTLE MUD (GRANBY)	Granby	no	2	3	unknown	U	none
NEAL	Lunenburg	VT16-15L01	185	5720	natural w/ artificial control	M	SpP
STEVENS	Maidstone	VT16-12L06	26	178	artificial	U	SpP

1 - O=oligotrophic; M=mesotrophic; E = eutrophic; D = Dystrophic; U = unknown
2 - LMP=lay monitoring program data (Secchi, chorophyll a,phosphorus); SpP = spring phosphorus data

Little Mud Pond (Granby)
Notes from a Nongame and Natural Heritage Program Report:
Little Mud Pond in Granby is a small shallow remote pond with a lowland bog mat on three sides. The bog extends north along a drainage for a short distance and the bog is fringed by larch, spruce, winterberry, and sweet gale.

Neal Pond
2007 Assessment Notes: Based on 2006 analysis, the trophic trend is declining.

2010 Assessment Notes: Visited as part of the National Lakes Survey on 8/1/2008.

A Nongame and Natural Heritage Program Report notes that Neal Pond has bottom sediments that are very muddy to sandy to very rocky. *Eriocaulon septangulare* growth is found along most of the shoreline. It also has a rare equisetum present.

Stevens Pond
Stressed Acres
26 acres due to acid precipitation – aquatic life use stressed.
26 acres due to excess nutrients - aesthetics, aquatic life, secondary contact recreation, and swimming uses stressed.

A Nongame and Natural Heritage Program Report notes that Stevens Pond in Maidstone is a tannic water pond with a boggy perimeter at the south end and marshy at the north end. The east and west shores are forested with mixed hardwoods and softwoods. The west end has steep hemlock slopes.

Concord-Waterford Streams to Connecticut and the Connecticut River itself

General Description

Miles Stream in Concord begins upstream and northwest of Miles Pond in a wetland at the drainage divide with the Moose River watershed. The stream flows southeasterly to the 215-acre Miles Pond and then out of the pond through wetland communties. The very branched Carr Brook joins Miles Stream from the north about a mile downstream of the pond. Miles Stream continues southeasterly to the village of East Concord where it makes a bend and flows south-southwesterly to the Connecticut River. At the bend, Scales Brook enters from the east.

Roaring Brook in Concord is a two and a half mile long stream that drains a 4.2-square mile watershed. It enters the Connecticut River in an arm of Moore Reservoir.

The 3.5-mile Mink Brook in Concord also flows into Moore Reservoir draining an eight-square mile watershed. Cutting Brook is a tributary to Mink Brook.

Halls Brook in Concord flows into and then from the 128-acre Shadow Lake heading southeasterly and southerly into an arm of Moore Reservoir. Halls Brook is about four miles long and it drains a 7.5 square mile watershed.

Mad Brook in Waterford is two miles long and drains a 4.2 square mile watershed.

Chandler Brook originates near the center of the town of Waterford and flows south for over four miles to the Connecticut River. Many mapped wetlands as well as gravel pits are along the length of this brook. Chandler drains a seven-square-mile watershed.

Stream Sampling Results and Assessment Information

Miles Stream in Concord was sampled in September 2003 and the macroinvertebrate community at rivermile 0.6 was assessed as "excellent". The assessment for the macroinvertebrate community notes that the density was moderate while the richness and EPT high. Both the Bio Index and the ratio of EPT to EPTc are very good indicating little to no enrichment. Mayflies dominate with caddis flies next in numbers. Stoneflies are well represented also. The fish community was also sampled in 2003 (August) and was assessed as "good".

The macroinvertebrate community of Carr Brook was sampled in September 2005 at rivermile 0.4 and was assessed as "good". The density of the community was low in part perhaps due to the limited riffle habitat - most of the reach was low gradient sand/gravel bottom. The richness and EPT were high however. The Bio Index was also slightly high although again perhaps due to stream type. There are two warmwater caddisflies (family

Hydropshychidae) present due possibly to the tannic, dark-colored water and canopy cover only about 50%. There appears to have been a lot of logging and some gravel mining in the watershed that may have affected instream macroinvertebrate habitat.

The fish community was sampled in First Brook at rm 0.1 in September 1999 and was assessed as "fair".

Portions of Chandler Brook were seen in September 2009. Much of this brook flows through wetland communities including shrub willow swamp. There are also a number of large gravel pits in the stream corridor. Two dams impound Chandler Brook into two small ponds above the Waterford Sand & Gravel pit entrance.

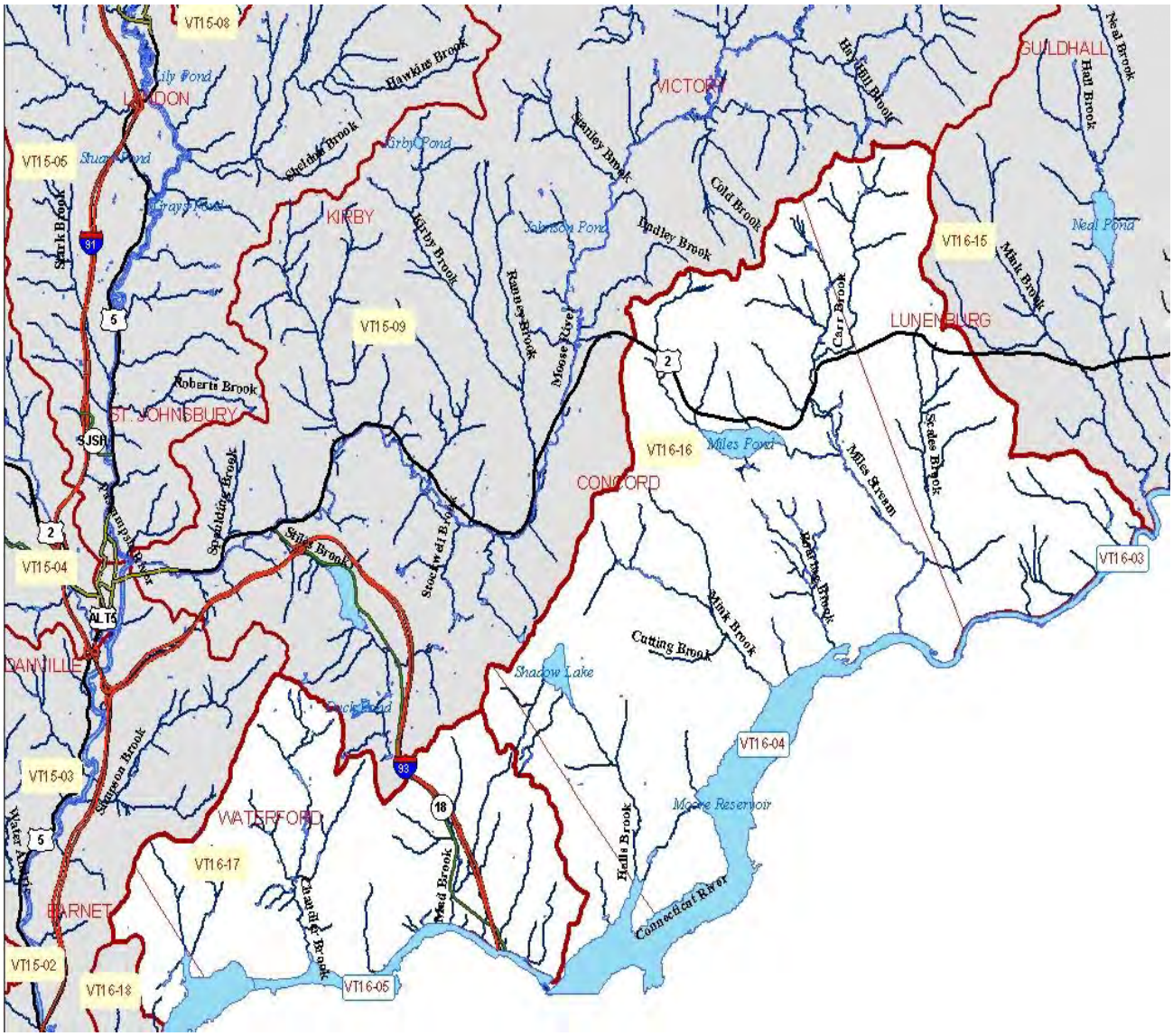


Figure 6. Waterford and Concord Streams to Connecticut River

Lakes and Ponds in Concord and Waterford

There are eight lakes and ponds in the lake inventory and lake assessment database maintained by the Vermont DEC Water Quality Division in this portion of the watershed and some characteristics of these are shown in the table below.

Table 14. Lakes and ponds in Concord and Waterford towns in Basin 16

Lake or Pond	Town	Waterbody ID	Lake Acres	Watershed Acres	Outlet Type	Trophic Status[1]	Monitoring Data[2]
CHANDLER;	Waterford	VT16-05L02	6	1313	unknown	U	none
COMERFORD	Barnet	VT16-05L01	777	307121	artificial	U	none
CONCORD;	Concord	no	2	unknown	unknown	U	none
COPENHAGEN;	Waterford	no	2	2315	unknown	U	none
JOSLIN TURN;	Concord	no	10	165	unknown	U	none
MILES	Concord	VT16-16L01	215	4158	natural w/ artificial control	M	LMP, SpP
MOORE	Waterford	VT16-04L01	1235	293580	artificial	U	none
SHADOW (CONCRD)	Concord	VT16-16L02	128	1649	natural	M	SpP

1 - O=oligotrophic; M=mesotrophic; E = eutrophic; D = Dystrophic; U = unknown
2 - LMP=lay monitoring program data (Secchi, chorophyll a,phosphorus); SpP = spring phosphorus data

Note that the use of a semi-colon (;) after the pond name denotes a water for which Vermont DEC has established a name based on USGS topographic map features. These names were established for tracking purposes, and may not reflect local pond names.

Comerford Reservoir

Impaired Acres

777 acres due to mercury – fish consumption use impaired.

2007 Assessment Notes: Mercury TMDL completed and submitted to EPA for approval 10/2007.

2008 Assessment Notes: Fish mercury monitoring by Biodiversity Research Institute conducted in fulfillment of the 401 license agreements for this facility suggest declining tissue mercury concentrations in response to reductions in water level fluctuations. This is most evident in smaller, prey-sized fishes, but there is a non-significant decrease in larger consumption-sized smallmouth bass as well.

Miles Pond

Stressed Acres

215 acres due to nutrients and sedimentation - aesthetics, aquatic life, secondary contact recreation, and swimming uses stressed.

2007 Assessment Notes: Visited as part of the National Lakes Survey in 8/2007.

Moore Reservoir

Impaired Acres

1235 acres due to mercury – fish consumption use impaired.
There are two discharges regulated under NPDES which discharge up to 3.076MGD to the Connecticut River upstream of this impoundment. These are:
Lunenberg VT WWTF - NPDES # VT0101061. Permitted flow = 0.076 MGD
Simpson Paper Mill - NPDES # VT0000116. Permitted flow 3.0 MGD

2007 Assessment Notes: Mercury TMDL completed and submitted to EPA for approval 10/2007.

2008 Assessment Notes: Fish mercury monitoring by Biodiversity Research Institute conducted in fulfillment of the 401 license agreements for this facility suggest declining tissue mercury concentrations in response to reductions in water level fluctuations. This is most evident in smaller, prey-sized fishes, but there is a non-significant decrease in larger consumption-sized smallmouth bass as well.

Barnet-Ryegate-Newbury-Bradford Streams to the Connecticut River

General Description

The streams that flow from Barnet, Ryegate, Newbury, and Bradford are the focus of this chapter. This section does not include the Passumpsic River watershed, which meets the Connecticut in East Barnet. The discussion also does not include the Stevens, Wells, and Waits Rivers, which meet the Connecticut in Barnet, Newbury, and Bradford respectively. It does include Sutton Brook in Barnet; Manchester Brook in Rye-gate; Harriman, Peach, and Halls Brooks in Newbury; and Roaring Brook in Bradford. Warden, Upper and Lower Symes, Harriman and Round Ponds, and Halls Lake are also in these towns.

Figure 7. Barnet, Ryegate, and Newbury Streams to Connecticut River

Barnet Streams

Sutton Brook begins on the western side of Barnet and flows east/southeast into Warden Pond. After Warden Pond, it flows a short stretch into the small Sarah Moores and then on easterly to the Connecticut River. Its length is 2.5 miles and its watershed is 3.5 square miles.

Ryegate Streams
Wormwood Brook flows into Upper Symes Pond, which flows into Lower Symes Pond, the outlet of which is Manchester Brook. Manchester Brook flows southeasterly for 5.5 miles before joining the Connecticut River just upstream of East Ryegate.

Newbury Streams
Harriman Brook begins at Harriman Pond, flows through a wetland and field, then tumbles southeasterly down to the Connecticut passing through the village of Newbury on its way. Scotch Hollow Road follows the brook too closely and crosses it several times.

Halls Brook originates at the 85 acre Halls Lake and flows southeasterly overall down to the Connecticut River. From the lake down, Halls Brook: goes under Interstate 91; winds through an alder swamp; cascades along Snake Road; has a pool behind an old dam for swimming and fishing; is fast below the dam for a stretch; passes through agricultural land; goes under Route 5; and meets the Connecticut. Its length is six miles and it drains a 26.5 square mile watershed.

Peach Brook is a very significant tributary to Halls Brook. It starts up in Scotch Hollow, with Eygpt Brook as an early tributary to it, and flows southeasterly 8.5 miles before it joins Halls Brook. It is a clear, healthy, intact stream with either wetland vegetation or forest adjacent to it for much of its length. There are nice cascades and moss-covered boulders downstream of Moore Hill Road.

Bradford Stream
Roaring Brook begins in Newbury but then flows south into Bradford then easterly and southeasterly through a wetland; under I-91; through Blodgett Pond; and into the Connecticut River. It is about 5.5 miles long and drains a five square mile watershed.

Uses, Values, Special Features and Conditions

Halls Brook in Newbury has a steep section along Snake Road that is a nice set of cascades that end in a pool above an old dam. People swim and fish in the pool and also boat and float below the dam where there is a stretch of rapids in medium to higher flows.

Stream Sampling Results and Assessment Information

Roaring Brook in Bradford was visited in July 2010. The brook was accessed at four locations along its length. A large area south of Rabbit Track (road) is a beautiful, diverse wetland that is not currently mapped. Where seen, the water was clear and the stream well-shaded (outside of the wetland areas).

Vermont DEC WQ BASS returned to Roaring Brook in October 2010. It was evident that this brook in addition to Zebedee (below) had seen very high flows from the huge precipitation event on October 1,2010. Only chemistry was taken here.

A macroinvertebrate sample was taken on McIndoe Falls tributary at rm 0.1 in September 2007 and the community was assessed as "good-fair".

Peach Brook was sampled in September 2003 and the macroinvertebrate community was assessed as "excellent-very good" at rm 4.2 and rm 4.3 in Newbury. The fish community was sampled in June of 2003 at rm 4.2 and it was assessed as "very good".

There are seven dams listed on the State Dam Inventory in Newbury: three on Halls Brook, one on Halls Brook tributary, and three on unnamed tributaries to the Connecticut River. Halls Lake dam is at the outlet of Halls Lake, Cole Dam is also at the outlet of a small pond and is on an unnamed tributary to Halls Brook; and Fish Pond Dam is at the head of a tributary to Harriman Brook. Old Stone dam is a former mill dam and more recently a former hydro-electric dam on Halls Brook. The last time it was used as a hydro dam was in 1999 but the dam is intact and the mill building still stands just below the dam. People swim and fish in the pool that is above the dam and at the end of a nice cascades. People boat and float below the dam when there is whitewater. Information is needed on Twin Flower Dam on Halls Brook. Two dams impound water on an unnamed tributary for the Newbury Water Supply.

Halls Brook is a six mile long stream that winds through alder swamp in some sections and agricultural fields in its lowest section among other areas. It also has steeper sections with beautiful cascades, a pool behind a dam, and falls over a dam before some more rapids. No known or seen problems.

Lakes and Ponds in Barnet, Ryegate, Newbury, Bradford

There are thirteen lakes and ponds in the lake inventory and lake assessment database maintained by the Vermont DEC Water Quality Division in this portion of the watershed and some characteristics of these are shown in the table below.

Table 15. Lakes and ponds in Barnet, Ryegate, Newbury, Bradford towns of Basin 16

Lake or Pond	Town	Waterbody ID	Lake Acres	Watershed Acres	Outlet Type	Trophic Status[1]	Monitoring Data[2]
BLODGETT;	Bradford	VT16-09L01	15	2964	unknown	U	none
COBURN	Ryegate	VT16-18L05	5	64	unknown	U	none
HALLS	Newbury	VT16-19L03	85	561	natural w/ artificial control	M	LMP, SpP
HARRIMAN (NEWBRY)	Newbury	VT16-19L02	20	1438	natural	E	SpP
LEIGHTON HILL;	Newbury	VT16-07L01	6	213	unknown	U	none
LONG (NEWBRY)	Newbury	no	15	242	unknown	U	none
LOWER SYMES	Ryegate	VT16-18L03	57	2636	natural	M	SpP
MUDDY (NEWBRY)	Newbury	no	3	152	unknown	U	none

ROUND (NEWBRY)	Newbury	VT16-19L01	30	260	natural	U	SpP
SARAH MOORES	Barnet	VT16-18L04	13	288	unknown	U	none
THE FISH	Newbury	no	6	380	unknown	U	none
UPPER SYMES	Ryegate	VT16-18L02	20	2035	natural	U	SpP
WARDEN	Barnet	VT16-18L01	46	1085	natural	M	SpP

1 - O=oligotrophic; M=mesotrophic; E = eutrophic; D = Dystrophic; U = unknown
2 - LMP=lay monitoring program data (Secchi, chorophyll a,phosphorus); SpP = spring phosphorus data

Note that the use of a semi-colon (;) after the pond name denotes a water for which Vermont DEC has established a name based on USGS topographic map features. These names were established for tracking purposes, and may not reflect local pond names.

Halls Lake

Altered Acres

17 acres due to Eurasian milfoil growth - aesthetics, aquatic life, secondary contact recreation, and swimming uses altered.

Stressed Acres

85 acres due to nutrients, siltation and weed growth – aesthetics, aquatic life, secondary contact recreation, and swimming uses stressed.

2008 Assessment Notes: VTDEC Lakes staff recently initiated rapid response protocols in Halls Lake in Newbury in eastern Vermont after confirming the presence of the invasive aquatic plant variable-leaved watermilfoil (*Myriophyllum heterophyllum*). This is the first confirmed population of variable-leaved watermilfoil in a Vermont water.

Harriman Pond (Newbury)

Stressed Acres

5 acres due to the proximity of a Eurasian milfoil-infested waterbody - aesthetics, aquatic life, secondary contact recreation, and swimming uses stressed.

Leighton Hill;

Stressed Acres

6 acres due to weeds - aesthetics, aquatic life, secondary contact recreation, and swimming uses stressed.

Round Pond (Newbury)

Stressed Acres

30 acres due to light Eurasian milfoil infestation - aesthetics, aquatic life, secondary contact recreation, and swimming uses stressed.

Warden Pond

Stressed Acres

20 acres due to low hypolimnetic dissolved oxygen – aquatic life use stressed.
5 acres due to sediment accumulation at inlet – aquatic life use stressed.

Fairlee-Thetford-Norwich Streams to the Connecticut River

General Description

Fairlee Streams
Bog Pond Brook begins in the northern portion of the town of Fairlee. It flows northeasterly and easterly in Fairlee then northeasterly again into the town of Bradford where it continues on into the Connecticut River. The brook is culverted under the Maurice Roberts Highway and then Interstate 91 in Fairlee and then it is culverted and ditched through a farm in Bradford before reaching the Connecticut River.

Several streams drain into Lake Morey and then the Lake Morey outlet stream flows south into the Connecticut River. Big Brook begins to the east and north of May Hill (1626 feet) and flows east/southeast to the wetlands at the northern end of Lake Morey. Glen Falls Brook begins to the west of Lake Morey and flows east/southeast into the lake. An unnamed tributary also originating west of Lake Morey flows easterly into the southern end of the lake. At least three unnamed tributaries also join the Lake Morey outlet stream as it flows south under the interstate and through wetlands.

An unnamed tributary originates on the north side of Ely Mountain and flows north before turning east and southeast to flow into the Connecticut River near the village of Ely. Route 244 follows much of its length west of the interstate.

Thetford Streams
There are at least five streams flowing from the town of Thetford into the Connecticut River. Two of these are named streams, Roaring Brook and Zebedee Brook, and three are unnamed streams although one goes by the name North Thetford Brook.

Zebedee Brook begins on the eastern side of Thetford Hill and makes its way with many changes in direction down to the Connecticut River. A very forked tributary enters Zebedee just west of Interstate 91. Zebedee Brook is 4.5 miles long and drains a 5.2 square mile watershed.

The so-called North Thetford Brook is also a brook with many forks or branches. It begins in Childs Pond, which is quite near the Connecticut River itself, then flows northwest and then northeast and joins the Connecticut in North Thetford.

Roaring Brook begins in the drainage between High Peak and some hills to the north and flows down a steep valley to the Connecticut River.

Figure 8. Fairlee and Thetford Streams to Connecticut River

Norwich Streams

The watershed of Bloody Brook and its tributaries is the largest watershed feeding to the Connecticut River in Norwich. Bloody Brook originates east of Gile Mountain up near the Sharon/Norwich town line. It flows generally southerly, but at times, southeasterly, for 7.5 miles to the Connecticut River. The upper two-thirds of the watershed is forest land and rural residential while the lower third includes the village area of Norwich as well as the Interstate 91 interchange 13. Turnpike Road follows Bloody Brook fairly closely for much of its length. Bloody Brook drains an 18 square mile watershed. Named tributaries to Blood Brook include New Boston Brook, Charles Brown Brook, and Bragg Brook.

New Boston Brook originates near the drainage divide with the Ompompanoosuc River watershed. It flows south-southwesterly in a small valley for 3.4 miles before reaching Bloody Brook. A large area of wetland surrounds the brook in its middle section.

Charles Brown Brook is a significant tributary to Bloody Brook. It originates south of Stone Hill near the drainage divide with the White River watershed. It flows south then southeasterly for approximately 4.5 miles until it joins Bloody Brook just upstream of Moore Road. Beaver Meadow Road follows the brook for much of its length. Charles Brown Brook drains a 5.7 square mile watershed.

Figure 9. Norwich Streams to Connecticut River

Uses, Values, Special Features and Conditions

The so-called “Grand Canyon of Norwich” is a beautiful series of cascades through a narrow, somewhat steep valley on a tributary to Charles Brown Brook. A town trail, the Bill Ballard trail, takes hikers to the top of the cascades.

Two waterfalls, both on Charles Brown Brook, were identified on a map in a Bloody Brook Watershed Study done by the regional planning commission of the time – no descriptions were given.

Stream Sampling Results and Assessment Information

Monitoring and Assessment Results

Zebedee Brook was visited in October 2010. Water chemistry was taken upstream of Stevens Road (downstream of the interstate highway crossing) but no macroinvertebrates were sampled at the time. The stream showed the disruption from the very large amounts of rain on October 1, 2010 - some places got 5 inches in 24 hours - and it didn't make sense to sample at this time because the results only show that there had been scour,which is already know. Overall given the volume of water, the stream was not in bad shape - it had plenty of places where the flow could jump the bank and spread out. Woody debris was present and nice pools were seen. A very good stream to sample next year for bugs and fish.

Bloody Brook macroinvertebrate and fish communities were sampled at rm 1.6 (above Huntley Street bridge) in September 2006. The macroinvertebrate community was assessed as "very good". The comments about the sample and community note the density is very high, the richness and EPT high, the Bio Index is moderately elevated and the EPT ratio is very good. Two taxa present (one a dipteran and one a mayfly) indicate a slight level of enrichment to the stream. The substrate was low in sand and embeddedness. The water quality sample showed an alkaline stream with mid 7s pH, nutrients low, and metals non-detect. The chloride was significantly elevated at 71 mg/liter resulting in high conductivity of over 300. The fish community was assessed as "good" at the same location and date.

Geomorphic assessment work was done in the Bloody Brook watershed from 2006 to 2008. Phase 1 geomorphic assessment (map and other desk analysis) was done in the summer of 2006; Phase 2 assessment work (field measurements and observations) was done on seven Bloody Brook mainstem reaches and seven tributary reaches in fall 2006; and a corridor plan (which includes project recommendations) was produced in March 2008. The Phase 2 assessment work on Bloody Brook and its tributaries identified specifically locations of rip-rap, bank erosion, road and development encroachment into the stream corridor, recent dredging activity, waterfall and ledge locations, bridges and culverts, and numerous other pieces of information to contribute to problem then solution identification.

Bloody Brook was investigated in the field in September 2010. Observations include the numerous road and driveway crossings of Bloody Brook (at least 23 bridges or culverts); the lack of water instream at Birch Hill Lane crossing but small flows below at #1470 driveway; some streamside vegetation removal up at an extensive cleared area upstream, under the powerlines that cross the brook, along some lawns, and at Huntley Field owned by the town of Norwich; water very clear; some fish and water striders seen.

The Norwich Conservation Commission sampled Blood Brook in 2004, 2005, and 2007. There is a summary of the results from sampling on Blood Brook as well as New Boston Brook, Charles Brown Brook, and Bragg Brook in 2004: *E. coli*, conductivity, discharge, and temperature were measured. No *E. coli* geometric mean for the season was above standard although a few individual samples were above standard - some very high. Temperature showed a seasonal climb and then drop into the fall. Conductivity had a spike in August not associated with an increase in discharge rates.

The *E. coli* results (and number of samples) for Bloody Brook for the three years are as follows:

	2004	2005	2007
BB0	5 (11)	21 (15)	-----
BB1	66 (20)	49 (18)	-----
BB2	48 (20)	47 (18)	-----
BB3	48 (20)	69 (18)	-----
BB4	-----	81 (18)	-----
BB5	-----	88 (18)	229 (7)

The Bloody Brook watershed has a relatively high percentage of developed land (about 15%) and agricultural land (about 20%). With water and wetlands occupying about 6% of the watershed area, less than 60% of the watershed is forested. “Extensive portions of the Blood Brook mainstem and part of Charles Brown Brook were bulldozed and windrowed with the stone removed from the channel following the 1973 floods that hit part of the Connecticut River Valley. This historical instream work and current encroachment have led to stream channel instability in Bloody Brook. The brook has lost access to floodplain areas in upper reaches because the stream channel has downcut in a number of stretches. The brook has overwidened and moved laterally in downstream reaches.

Charles Brown Brook, a tributary to Bloody Brook, was also seen at several locations in September 2010. This brook was well-shaded. Just upstream of where Tucker Hill Road joins Beaver Meadow Road (which runs along Charles Brown Brook), there was very recent and fairly extensive beaver activity. The dam creating Norwich Reservoir on Charles Brown Brook was partially breached in 1987.

Lakes and Ponds of Fairlee, Thetford, and Norwich

There are seven lakes and ponds in the lake inventory and lake assessment database maintained by the Vermont DEC Water Quality Division in this portion of the watershed and some characteristics of these are shown in the table below.

Table 16. Lakes and ponds of Fairlee, Thetford, Norwich towns in Basin 16

Lake or Pond	Town	Waterbody ID	Lake Acres	Watershed Acres	Outlet Type	Trophic Status[1]	Monitoring Data[2]
BOG (FAIRLE)	Fairlee	no	1	16	unknown	U	none
CHARLES BROWN;	Norwich	no	2	3259	unknown	U	none
CHILDS	Thetford	VT16-20L02	10	33	unknown	U	none
LEWIN	Norwich	VT16-01L01	4	24	unknown	U	none
LILY (NORWCH)	Norwich	VT16-21L01	6	57	unknown	U	none
MOREY	Fairlee	VT16-20L01	547	5101	natural w/ artificial control	M	LMP, SpP
MOSLEY;	Hartford	no	7	unknown	unknown	U	none

1 - O=oligotrophic; M=mesotrophic; E = eutrophic; D = Dystrophic; U = unknown
2 - LMP=lay monitoring program data (Secchi, chorophyll a,phosphorus); SpP = spring phosphorus data

Note that the use of a semi-colon (;) after the pond name denotes a water for which Vermont DEC has established a name based on USGS topographic map features. These names were established for tracking purposes, and may not reflect local pond names.

Lake Morey

Altered Acres

110 acres due to Eurasian milfoil growth - aesthetics, aquatic life, secondary contact recreation, and swimming uses altered.

Selected References

1) *Blood Brook Watershed Corridor Plan*, Norwich, Vermont, March 2008. Prepared by Redstart Consulting for Two Rivers-Ottauquechee Regional Commission, Norwich Conservation Commission, and Vermont Agency of Natural Resources.

2) *Bloody Brook Watershed Study*, Norwich, Vermont, February 2000. Upper Valley Lake Sunapee Regional Planning Commission.

3) *The Complete Boating Guide to the Connecticut River for New Hampshire, Vermont, Massachusetts and Connecticut*, 1986. Edited by Mark C. Borton. The Connecticut River Watershed Council and Embassy Imprint Inc.

4) *Natural Communities and Rare Vascular Plants of West Mountain Wildlife Management Area and Nulhegan Basin Division of the Silvio O. Conte National Fish and Wildlife Refuge, Essex County, Vermont*, April 2002. Marc Lapin and Brett Engstrom for the U.S. Fish and Wildlife Service, Vermont Agency of Natural Resources, The Nature Conservancy, Vermont Housing and Conservation Board, and Vermont Land Trust.

5) Petition to designate the Nulhegan River, its Tributaries and Collective Water as Outstanding Resource Waters, October 27, 1998. Filed by the Vermont Natural Resources Council, Vermont Audubon Council, Northeast Kingdom Chapter of Audubon, Vermont Chapter of the Sierra Club and Individual Petitioners.

6) *A Survey of the Fish and Macroinvertebrate Communities of the Silvio Conte National Wildlife Refuge Lands in the Nulhegan Drainage and the West Mountain Wildlife Management Area*, January 2002. Rich Langdon and Steve Fiske, Vermont ANR Department of Environmental Conservation, Waterbury, Vermont.

7) Vermont Dam Inventory database, August 2009. Custom report generated for the Vermont DEC Water Quality Division Planning Section by the Vermont DEC Facilities Engineering Division Hydrology Section.

8) Vermont Department of Fish and Wildlife fact sheets on Wildlife Management Areas. http://www.vtfishandwildlife.com/wma_maps.cfm

9) *Waterfalls, Cascades and Gorges* of Vermont**,** 1985. Jerry Jenkins & Peter Zika for the Vermont Department of Environmental Conservation and Department of Forests, Parks and Recreation.

10)) *Wetland Woodland Wildland: A Guide to the Natural Communities of Vermont*, 2000. Elizabeth H. Thompson and Eric R. Sorenson. Published by the Vermont Department of Fish and Wildlife and The Nature Conservancy.

11) The *Whitewater Rivers of Vermont: Their Biology, Geography, and Recreational Use*, 1992. Jerry Jenkins and Peter Zika.

Appendix A:
Dams in the Northern Connecticut River Basin

Dam Name	Stream	Town	Status	Use*	Built	Re-con+	State ID
Cannan	Connecticut River	Canaan					42.01
Wallace Pond	Leach Creek	Canaan	In Service				
Stone	Nulhegan River	Bloomfield	Breached				22.01
Dam No. 1	East Branch Nulhegan River	Bloomfield					22.02
Dam No. 2	East Branch Nulhegan River	Bloomfield					22.03
Dam No. 3	East Branch Nulhegan River	Bloomfield					22.04
Dam No. 4	East Branch Nulhegan River	Lewis					113.01
Dam No. 5	East Branch Nulhegan River	Averill					7.03
Dam No. 6	East Branch Nulhegan River	Averill					7.04
Conway	East Branch Nulhegan	Averill					7.05
Big	Black Branch Nulhegan	Bloomfield					22.05
Brooks	Black Branch Nulhegan	Lewis					113.03
Buzzell	Black Branch Nulhegan	Lewis					113.04
Peanut	Trib Black Branch Nulhegan						113.02
Lyman Falls	Connecticut River	Bloomfield	Breached				22.07
Browns Mill	Paul Stream	Maidstone	Breached				120.02
Bull Throat	Paul Stream	Maidstone	Breached				120.03
Walker	Paul Stream	Ferdinand					75.01
Maidstone Lake	Maidstone Brook	Maidstone	In Service	R	1931	1948	120.01
Stevens Pond	Trib to Connecticut River	Maidstone	Unknown				120.04
Wyoming Valley	Connecticut River	Guildhall	Breached				89.01
Gilman	Connecticut River	Lunenburg	In Service	H	1928		118.02

Dam Name	Stream	Town	Status	Use*	Built	Re-con+	State ID
Neal Pond	Neal Brook	Lunenburg	Breached				118.01
Miles Pond	Miles Stream	Concord	In Service	R	1900	1993	52.01
Concord-5	Halls Brook	Concord					52.05
Moore	Connecticut River	Waterford					227.10
Chandler Brook (Lower)	Chandler Brook	Waterford					227.03
Chandler Brook (Upper)	Chandler Brook	Waterford					227.02
Nutter Pond (Upper)	Chandler Brook	Waterford					227.04
Nutter Pond (Lower)	Chandler Brook	Waterford					227.05
Waterford - 7	Trib to Chandler Brook	Waterford					227.07
Waterford - 8	Chandler Brook	Waterford					227.08
Waterford – 9	Chandler Brook	Waterford					227.09
Comerford	Connecticut River	Barnet					12.13
McIndoes Falls	Connecticut river	Barnet					12.14
Ryegate Paper Co.	Connecticut River	Ryegate					175.03
Twin Flower	Halls Brook	Newbury					138.11
Old Stone	Halls Brook	Newbury	In Service[1]	H	1838	1930	138.10
Halls Lake	Halls Brook	Newbury	Breached	R			138.02
Cole	Trib to Halls Brook	Newbury		R		1967	138.07
The Fish Pond	Trib to Connecticut River	Newbury	In Service	R	1973		138.01
Newbury Water supply (Upper)	Trib to Connecticut River	Newbury	In Service	S			138.03
Newbury Water Supply (Lower)	Trib to Connecticut River	Newbury		S	1890		138.04
Blodgett	Roaring Brook	Bradford	In Service	R	1965		24.02
Lake Morey	Trib to Connecticut River	Fairlee	In Service	R	1897	1954	73.01
„ Bancroft Mill	Trib to Connecticut River						

Dam Name	Stream	Town	Status	Use*	Built	Re-con+	State ID
Fin n feather	Trib to Lake Fairlee	Thetford		R	1956		206.11
Thetford Hill Reservoir (Upper)	Zebedee Brook	Thetford	Deleted ?				206.04
Thetford Hill Reservoir (Lower)	Trib to Zebedee Brook						
Thetford - 24	Roaring Brook	Thetford					206.24
Thetford - 21	Trib to Connecticut River	Thetford					206.21
Hunt Griswold	Trib to Connecticut River	Norwich					146.02
Norwich - 3	Trib to Charles Brown Brook	Norwich					146.03
Norwich Reservoir	Charles Brown Brook	Norwich	Partially breached	O	1920	1987	146.01
Wilder	Connecticut River	Hartford					94.14

1 The dam is still considered in service because it is sound and still gets inspections but at Old Stone, the hydro facility has not been operational since 1999.

Appendix B
Population and Housing Data for Basin 16 Towns

Table B.1. Population of Basin Towns

Town	1970 Pop	1980 Pop	1990 Pop	2000 Pop	change 70-80	change 80-90	change 1990-2000
Canaan	949	1196	1121	1078	26%	-6%	-4%
Averill	8	15	7	8	87%	-5%	14%
Lemington	120	108	102	107	0	0	0
Lewis	0	0	0	0	---	---	---
Bloomfield	196	188	253	261	-4%	35%	3%
Ferdinand	14	12	23	33	-14%	92%	43%
Brunswick	45	82	92	107	82%	12%	16%
Maidstone	94	100	131	105	6%	31%	-20%
Granby	52	70	85	86	35%	21%	1%
Guildhall	169	202	270	268	20%	34%	-1%
Lunenburg	1061	1138	1176	1328	7%	3%	13%
Concord	896	1125	1093	1196	26%	-3%	9%
Waterford	586	882	1190	1104	51%	35%	-7%
Ryegate	830	1000	1058	1150	20%	6%	9%
Newbury	1440	1699	1985	1995	18%	17%	1%
Fairlee	604	770	883	967	27%	15%	10%
Norwich	1966	2398	3093	3544	22%	29%	15%

Table B.2. Housing Units and Housing Growth in Basin Towns

Town	1980 HUnits	1990 Hunits	2000 HUnits	% change 1980-1990	% change 1990-2000
Canaan	505	596	650	18%	9%
Averill	131	187	192	43%	3%
Lemington	52	73	77	40%	5%
Lewis	51	53	42	4%	-21%
Bloomfield	128	202	191	58%	-5%
Ferdinand	69	79	56	14%	-29%
Brunswick	69	87	89	26%	2%
Maidstone	201	269	276	34%	3%
Granby	47	66	78	40%	18%
Guildhall	130	142	151	9%	6%
Lunenburg	566	649	746	15%	15%
Concord	616	688	764	12%	11%
Waterford	324	426	477	31%	12%
Ryegate	472	531	564	12%	6%
Newbury	977	1132	1153	16%	2%
Fairlee	460	551	575	20%	4%
Norwich	1027	1382	1505	35%	9%