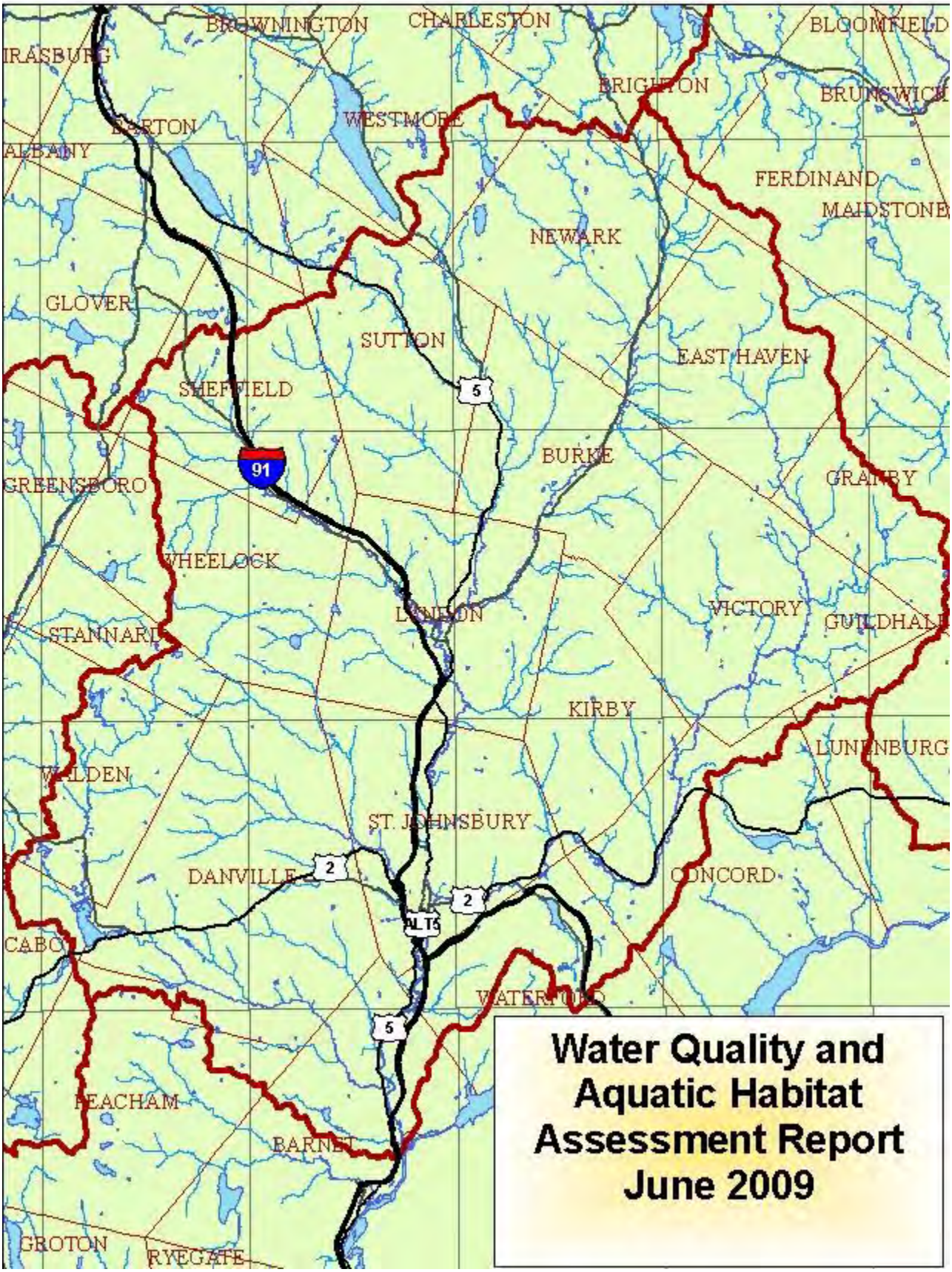
Passumpsic River Watershed



Water Quality and Aquatic Habitat Assessment Report
June 2009

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General Description of the Passumpsic River Watershed

The Passumpsic River watershed is located in northeastern Vermont and drains 507 square miles, a major portion of Caledonia County and minor portions of Essex, Orleans and Washington counties. The watershed is largely forested (see table below). The Passumpsic River mainstem forms where the East Branch and West Branch join just northeast of Lyndonville and flows about 23 miles north to south until it reaches the Connecticut River in East Barnet. The East Branch originates in the town of Brighton and flows south-southwesterly for about 19 ½ miles draining a 65-square-mile watershed before meeting the West Branch. The West Branch originates with several tributaries in the town of Westmore and it flows south-southeasterly for about 14 miles before joining the East Branch. The West Branch drains a 68-square-mile watershed.

The discharge of the Passumpsic River varies significantly from season to season and month to month. Information from a USGS gaging station below Passumpsic village and between the years 1929 to 1997, showed the mean monthly discharge has been as low as 340 cubic feet per second (cfs) in August to 2269 cfs in April. A peak flood flow during the 1929-1997 period occurred on July 1, 1973 when the river's discharge reached 18,200 cfs!

Substantial tributaries to the Passumpsic River include: Millers Run, which makes its way from Sheffield for 12 miles to the Passumpsic, draining a 45.5-square-mile watershed; the Moose River, which flows from the mountains in East Haven for 30 miles draining 126.5 square miles; the Sleepers River, which flows east from North Danville for 11 miles draining 44 square miles; and Joes Brook originating in Walden and flowing 20 miles, not including the length of Joes Pond, which is an impoundment of the brook in West Danville. Joes Brook watershed is approximately 52 square miles.

Table 1. Land Use and Land Cover for the Passumpsic River watershed[1]

Land Use	Acres	% of Total
Forested	250,375.7	77.0
Agriculture	33,746.0	10.4
Transportation	13,711.5	4.2
Surface Water	12,507.7	3.8
Wetlands	11,194.2	3.4
Developed Land[2]	3,369.1	1.0
Old Field & Barren	133.7	0.0
Total:	325,037.9	99.8

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

Uses, Values, Special Features of the Passumpsic Watershed

Waterfalls, Cascades, Gorges, and Swimming Holes

For a fairly large watershed, there were only two waterfalls and cascades identified in the 1986 *Waterfalls, Cascades, and Gorges* Report (WC&G) and only four swimming holes in the 1992 *Vermont Swimming Hole Study*. The falls identified included Emerson Falls on the lower end of the Sleepers River, which was developed for hydroelectric power after WC&G was written. In addition, a series of cascades and pools were identified on Mill Brook in East Haven on a small stream. The Mill Brook site is used for shallow bathing and fishing.

During an exploration of the watershed, other falls or cascades were observed. A pretty set of small falls are located in Wheelock village on the Millers Run. There is also a dramatic waterfall at the mouth of the Water Andric where it meets the Passumpsic, however, both Route 5 and the railroad tracks go over it spoiling the aesthetics.

Four swimming holes were identified in the *Vermont Swimming Hole Study*, three of which are located on Joes Brook and one site on the West Branch of the Passumpsic. The site on the West Branch is in the village of West Burke just below an old wooden dam and small cascades. The three sites on Joes Brook include Greenbanks Hollow, Adam's Hole, and Joes Brook South. A brief description of each of these is provided in the chapter on Joes Brook watershed below.

Significant Natural Communities

The Passumpsic River watershed has ten northern white cedar swamp communities (often containing rare, threatened, or uncommon plants) that were described in the Vermont Department of Fish and Wildlife Nongame and Natural Heritage Program's inventory of significant northern white cedar and red maple-cedar swamps. These interesting and valuable natural communities are described below in the subwatershed sections in which they occur.

Public Lands and Private Conservation Land in the Basin

The Passumpsic River watershed contains many acres of unique and valuable conservation land including four wildlife management areas (WMAs), four state forests, a state park, and farms and forestland conserved by private land conservation organizations. Full descriptions of the wildlife management areas are in the subwatershed sections of this report below. The information about these areas are excerpted from the fact sheets on the WMAs available from the Vermont Department of Fish and Wildlife. The four wildlife management areas include: the 413-acre Calendar Brook Wildlife Management Area in the East Branch subwatershed; the 4,970-acre wetland and forest complex known as Victory Basin WMA in the Moose River watershed; the Steam Mill Brook WMA, which is a 10,421-acre tract in the Joes Brook subwatershed; and the 932-acre Bald Hill WMA in the West Branch subwatershed. The four state forests are Mathewson, Willoughby, Victory, and Groton. The state park in the watershed is Darling State Park.

Water Quality/Aquatic Habitat Assessment Basinwide

Introduction

Vermont's rivers, streams, lakes, and ponds have been designated into "waterbodies" which serve as the units for statewide water quality and aquatic habitat assessment. Waterbodies are either: 1) entire lakes; 2) subwatersheds of river drainages; or 3) segments of major rivers. In the report sections below, the Passumpsic River mainstem and its tributaries up to the East and West Branches are described together but represent three waterbodies. The text chapters describing each of the other streams or branches and their watersheds equal a single waterbody in the river assessment system.

The Vermont Water Quality Division determines whether each waterbody, or a portion of a waterbody, meets or does not meet Vermont Water Quality Standards and then places waters into one of five categories. The four categories used in Vermont's surface water assessment are full support**,** stressed, altered, and impaired. Waters that support designated and existing uses and meet Water Quality Standards are attributed to the full support or stressed categories. Waters that do not support uses and do not meet standards are placed into the altered or impaired category. Waters can also be put into an unassessed category.

The full support assessment category includes waters of high quality that meet all use support standards for the water's classification. As it is not possible to visit, monitor, and assess every water, some waters are considered full support based on these factors:

- no discharges or contaminated sites in proximity to the waterbody;
- low probability of habitat degradation as evaluated by "Phase One" geomorphic assessments or land use/land cover evaluations;
- nearby sites, if any, have biological assessment findings showing full support;
- no problems are uncovered during the rotational assessment or basin planning; and
- no known water level manipulations.

Stressed waters are those that support designated uses but the water quality and/or aquatic habitat have been disturbed to some degree by point or nonpoint pollution sources. The water may require some attention to enhance its water quality and/or aquatic habitat and it may be at risk of not supporting uses (becoming altered or impaired) in the future. Many stressed waters need further assessment to fully describe their status.

Altered waters are those where a lack of flow, water level or flow fluctuations, modified hydrology, physical channel alterations, documented channel degradation or stream type change is occurring <u>and</u> arises from some human activity, or where the occurrence of exotic species has had negative impacts on designated uses. In these waters, the water quality standards are not being met but the problem(s) are not caused by a pollutant.

Impaired waters are where there are chemical, physical and/or biological data collected from quality assured and reliable monitoring efforts that reveal 1) an ongoing violation of one or more of the criteria in the Water Quality Standards and 2) a pollutant of human origin is the most probable cause of the violation.

Waters for which DEC has no monitoring data and only limited information and knowledge is available are considered unassessed. The Vermont Surface Water Assessment Methodology describes the assessment process in more detail.

Overall Assessment of Lake, Pond, River, Stream Uses

Lakes and Ponds

Most of the acres of lakes and ponds in the Passumpsic River watershed support the designated uses of these waters. Aquatic biota and/or habitat as a use is fully supported for over 50% of the acres assessed and fully supported but stressed for about 20% of the acres. Aquatic biota and/or habitat is not supporting – altered – for about 30% of the acres. There are no impaired lake acres in this basin. Swimming, boating, fishing, aesthetics are largely fully supported with relatively small numbers of acres stressed and no acres in the not supporting category. Fish consumption is considered fully supported but stressed due to a statewide advisory on the amounts of fish considered safe to eat due to mercury. When the use support status of individual lakes is discussed below, fish consumption use is not described again because of its consistent status. See Table 2 below for the uses and acres in each assessment category for lakes and ponds.

Table 2. Use Support Status of Lake and Pond Acres in Basin 15

Use	Full support	Full Support but Stressed	Altered	Impaired	Insufficient Information
Aquatic biota, aquatic habitat	696	272	396	0	31
Swimming, contact recreation	1171	46	0	0	43
Boating and fishing	1174	43	0	0	43
Fish consumption	0	1395	0	0	0
Aesthetics	1209	147	0	0	39
Public water supply	203	0	0	0	0

Rivers and Streams

Most of the river and stream miles also fully support the designated uses of these waters: very few miles of river and stream have documented alterations or impairments. Swimming is impaired on stretches of the Passumpsic and Sleepers River due to discharges from combined sewer overflows (CSOs). Fish consumption status is the same as for lakes.

Table 3. Use Support Status of River and Stream Miles in Basin 15

Use	Full support	Full Support but Stressed	Altered	Impaired	Not Assessed
Aquatic biota, aquatic habitat	344.0	12.1	2.7	0	31.8
Swimming,contact recreation	345.6	6.7	0	6.5	31.8
Boating and fishing	349.3	9.5	0	0	31.8
Fish consumption	0	390.6	0	0	0
Aesthetics	341.6	9.5	2.7	5.0	31.8
Drinking water supply	0	1.0	0	0	389.6

Assessment of Cause and Sources affecting River, Stream, Lake, Pond Uses

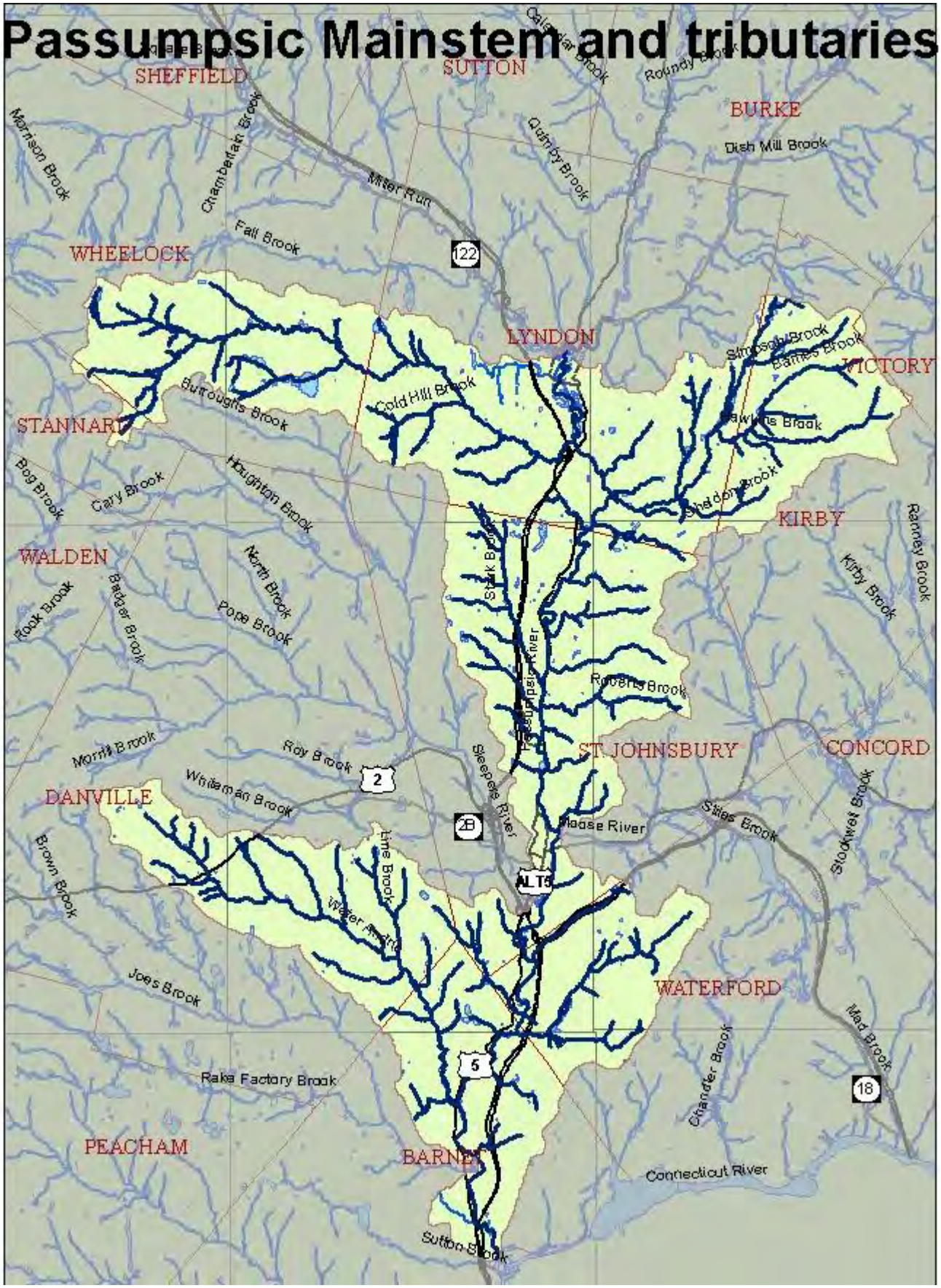
The following tables indicate which causes (pollutants) and sources (activity, land use change impact) affect the most acres of lakes and ponds or miles of river and stream as summarized for the basin.

Table 4. Causes and Sources affecting Lake and Pond Acres of Designated Uses

Causes	Magni-tude	Aquatic Biota/Habitat	Swimming	Boating and Fishing	Fish consumption	Aesthetics
Flow alteration	alter	396	0	0	0	0
Mercury in fish tissue	stress	0	0	0	1395	0
Sedimentation /siltation	stress	150	43	43	0	143
Org enrichment /D.O	stress	135	0	0	0	0
Phosphorus	stress	104	0	0	0	104
pH	stress	80	0	0	0	0
Algae	stress	7	3	0	0	4
Sources	Magni-tude	Aquatic Biota/Habitat	Swimming	Boating and Fishing	Fish consumption	Aesthetics
Water diversion	alter	396	0	0	0	0

Table 5. Causes and Sources affecting River and Stream Miles of Designated Uses

Cause of impairment, alteration or stress	Impaired or altered by cause	Stressed by cause	Total miles of impact by cause
Pathogens (E. coli)	6.5	5.7	12.2
Nutrients	5.0	0	5.0
Physical alterations	2.7	9.5	12.2
Sedimentation/siltation	0	10.9	10.9
Flow alterations	0	1.3	1.3
Priority organics	0	1.0	1.0
Metals	0	1.0	1.0
Sources of impairment, alteration or stress	Impaired or altered by source	Stressed by source	Total miles of impact by source
Combined sewer overflows	6.5	0	6.5
Channelization	2.7	0	2.7
Agriculture	0	15.2	15.2
Channel instability	0	9.5	9.5
Streambank destabilization	0	9.5	9.5
Developed land runoff	0	1.4	1.4
Road/bridge runoff	0	1.4	1.4
Hazardous waste	0	1.0	1.0


Passumpsic Mainstem and tributaries
SHEFFIELD
SUTTON
BURKE
Dish Mill Brook
Morrison Brook
Chamberlain Brook
Miller Run
Quimby Brook
Fall Brook
WHEELOCK
122
LYNDON
Simpson Brook
Barnes Brook
VICTORY
Cold Hill Brook
Burroughs Brook
STANNARD
Sawyers Brook
Bog Brook
Gary Brook
Houghton Brook
Sheldon Brook
KIRBY
Ranney Brook
WALDEN
North Brook
Kirby Brook
Rock Brook
Badger Brook
Pope Brook
Stark Brook
Roberts Brook
Morrill Brook
Roy Brook
ST. JOHNSBURY
CONCORD
2
DANVILLE
Williamson Brook
Sleepers River
Moose River
Stiles Brook
Stockwell Brook
Brown Brook
Lime Brook
ALT5
Water Works
Joes Brook
WATERFORD
Mad Brook
5
Rake Factory Brook
Chandler Brook
18
PEACHAM
BARNET
Connecticut River
Sutton Brook

Passumpsic River up to the Branches and some tributaries

Description

The East and West Branches of the Passumpsic River join just north-northeast of Lyndonville and from this junction downstream is the Passumpsic River mainstem. The river flows southwest then south through Lyndonville with Millers Run joining it in the northern part of Lyndonville. A little further downstream, the small outlet stream of Lily Pond comes in and downstream from that the much more significant contribution from South Wheelock Branch joins the Passumpsic River from the west.

South Wheelock Branch begins on Wheelock Mountain and flows west for 11 miles draining a watershed of 17 square miles before it reaches the Passumpsic River. Chandler Pond Brook, Bean Pond Brook, and Cold Hill Brook are all tributaries to South Wheelock Branch.

The Passumpsic River continues on south in Lyndon for just over a mile and encounters the Vail Dam of the Lyndonville Electric Department. Then Sheldon Brook and its tributaries, Hawkins Brook, Simpson Brook, and Barnes Brook join it from the east. Sheldon Brook drains an 11.4-square-mile watershed. The Passumpsic then continues its flow southwesterly encountering the Great Falls Dam also owned by Lyndonville Electric. After the dam, the river flows south into the town of St. Johnsbury.

In St. Johnsbury, it continues south in an agricultural setting and soon reaches Pierces Mill dam and hydroelectric facility owned by Central Vermont Public Service (CVPS). Riverside, there is a picnic area and canoe portage/river access area that is quite nice. From here, the Passumpsic continues south and is soon encroached upon by Route 5, railroad tracks, and town roads. Stark Brook and some unnamed tributaries join the river before it reaches downtown St. Johnsbury.

Right in St. Johnsbury, the river encounters the Arnold Falls hydroelectric facility and dam also owned by CVPS, which stretches across two braids of the channel that are separated by an island. Just below the dam on bank left is a nice city park with picnic tables and a view of the river, the falls over the dam when the water is high, and the mouth of the Moose River that enters from the east just downstream. The Moose River watershed is described separately on page 42.

Just below the St. Johnsbury city line but still in the town, the Sleepers River and all its tributaries contribution enter the Passumpsic River from the west. The Sleeper River watershed is also described separately on page 21.

The Passumpsic continues south still, passes under Interstate 91, and encounters the CVPS Gage dam and station. It then flows into the westernmost tip of the town of Waterford and continues for under a mile and a half in Waterford before entering the town of Barnet. The river encounters the CVPS Passumpsic Station and dam as it flows into Barnet. There is a marked canoe portage just above the dam. Then above the dam, and just upstream of Hale Road, there is a nice fishing access area that is owned by the Passumpsic Valley Land Trust.

As the Passumpsic River continues towards the Connecticut River through farm, forest and rural residential land, Water Andric enters from the west. Water Andric begins in Danville and flows southeasterly and southerly to the Passumpsic. It is over nine miles long and drains a 13-square-mile watershed.

Further downriver still, Joes Brook and all its tributaries enter the Passumpsic River. This 20-mile long stream and its 52-square-mile watershed contribute significantly to the flow of the Passumpsic as it continues downstream.

The Passumpsic River completes its run to the Connecticut through East Barnet where the river encounters its last dam, another CVPS hydroelectric facility, before joining the Connecticut River at Nine Islands.

Sampling Results and Assessment Information

Wastewater and Other Discharges

The St. Johnsbury wastewater treatment facility (WWTF) went from primary to secondary treatment in 1991. The collection system for the WWTF is a combined sewage collection system that collects both sanitary sewage and stormwater runoff, and during storm events, there are overflows that discharge untreated or partially treated sewage to the Passumpsic and Sleepers Rivers. In May 1991, a preliminary engineering assessment conducted for St. Johnsbury determined that the best alternative for elimination of the CSO discharges is separation of the storm and sanitary collection systems. The assessment identifed a multi-phased approach to the separation of the stormwater and sanitary wastewater systems. As of 2006 (when the amended 1272 order from which this information comes was written), St. Johnsbury had completed portions of the sewer separation and had eliminated CSO #019 (Oak Street) and CSO #003 (Ely Street) and reduced the frequency of overflows at CSO #021 (Route 5). Since the 1272 order, St. Johnsbury has started on some of the Phases A, B, C, D, E that were identified - Phase A and B1, which reduced flows at CSOs #027 and #020 respectively (at the two ends of Railroad Street), have been completed. CSO #027 was supposed to be eliminated but more of an area went into that CSO than previously known before the separation work actually began. A CSO effectiveness study was done in Fall 2006 and Spring 2007 and then specific recommendations were developed for how St. Johnsbury could proceed.

The Lyndon WWTF, the St. Johnsbury Country Club, one industry, and 49 stormwater discharges are all treated discharges that also go to the Passumpsic River. In addition, two industries pre-treat their wastewater and send it to the St. Johnsbury WWTF and two industries pre-treat wastewater and send it to the Lyndonville WWTF.

Hydroelectric Dams

Seven hydroelectric dams are on the Passumpsic River mainstem from its mouth at the Connecticut River up to the East and West Branches above Lyndonville. The dams are (from the mouth upstream): East Barnet, Passumpsic, Gage Station, Arnold Falls, Pierce Mills, Great Falls, and Vail Station.

The East Barnet hydroelectric project was constructed at the site of the Roy Brothers Manufacturing dam – the Roy Brothers factory made maple croquet sets. This hydro

project was approved by DEC and by FERC in 1982 and 1983 and constructed shortly thereafter. Great Falls hydro-electric project got a license in 1979 and certification in 1984. The Pierce Mills, Arnold Falls, Gage, and Passumpsic hydroelectric plants owned by CVPS were issued 401 water quality certificates and received FERC licenses in 1994 - 1995. The projects, when operating under the conditions of the 401, meet water quality standards - minimum flows for the bypasses and flow regulation restrictions downstream have been required. The Vail hydroelectic facility owned by Lyndonville Electric has received 401 water quality certification and was granted a FERC license in March 2004. All facilities are licensed to operate in a run-of-river mode.

Vermont DEC Water Quality Division Biological Monitoring

The macroinvertebrate community on the mainstem of the Passumpsic River sampled from 1987-1990 below the WWTF was in fair-poor condition. The community was degraded with low species richness and dominated by taxa tolerant of organic enrichment. In 1991-1992, the community had improved considerably likely the result of the WWTF going from primary to secondary treatment. More recent sampling (see Table 6 below) at three different stations found the macroinvertebrate community at station 6.7 to be in "excellent" to “very good” condition and at stations 8.6 and 12.9 to be in "very good" condition. Station or rivermile (measure up from a river or stream mouth) 6.7 is located below the St. Johnsbury WWTF; station 8.6 is located above the WWTF; and station 12.9 is located below the Route 5 bridge north of St. Johnsbury Center.

Table 6. Macroinvertebrate Sampling Sites and Results

Wbid	River or Stream	Town	Station (by rivermile)	Date	Assessment
VT15-01	Passumpsic River	St. Johnsbury	6.7	9/21/2000	Excellent
VT15-01	Passumpsic River	St. Johnsbury	6.7	9/06/2005	Very good
VT15-01	Passumpsic River	St. Johnsbury	8.6	9/21/2000	Very good
VT15-01	Passumpsic River	St. Johnsbury	12.9	9/21/2000	Very good
VT15-03	Water Andric	Barnet	3.3	9/21/2000	Very good
VT15-03	Simpson Brook	Waterford	0.4	9/16/2005	Exc-Very good
VT15-03	Simpson Brook	Waterford	0.4	9/05/2006	Very good-good
VT15-03	Roberts Brook	St. Johnsbury	0.1	9/08/2005	Good
VT15-03	Roberts Brook	St. Johnsbury	0.1	9/05/2006	Good
VT15-05	Barnes Brook	Kirby	0.1	9/16/2005	Excellent

As shown in the table above, the tributaries to the Passumpsic of Water Andric, Simpson Brook, Roberts Brook, and Barnes Brook were sampled once or twice in 2000 to 2006 to fill some gaps in information on these waters.

The fish community of Water Andric was sampled in September 2005 at rivermile (rm) 3.3 and was in “excellent” health. Barnes Brook in Kirby and South Wheelock Branch in Wheelock were also sampled in 2005 at rm 0.1 and at rm 5.2 respectively and fish community health was “excellent” in both of these brooks.

The macroinvertebrate community sampled in Simpson Brook in 2005 and 2006 was assessed as "excellent-very good" and "very good-good" respectively. The fish community was also sampled in Simpson Brook in 2005 and 2006, however, the

assessment results found a "poor" fish community. Despite no problems with the water quality or the macroinvertebrates, few fish were found when that community was sampled and the low numbers resulted in the “poor” assessment.

The fish community in Roberts Brook was also sampled in 2005 and 2006. The first time that it was sampled, the assessment was “poor” per indices but it was “very good” the second time around. During both years, the substrate at the site was characterized by a large amount of sand. The section sampled was also channelized. Water quality for both years was judged to be adequate for supporting brook trout and slimy sculpin.

Vermont DF&W game fishery sampling and stocking

The Vermont Department of Fish and Wildlife has sampled the Passumpsic River in St. Johnsbury village most recently in 2008 and wild salmonids are rare in this stretch. It is stocked with Atlantic salmon fry, brown trout, and rainbow trout. Water Andric, which was last sampled in 2000, has wild brook trout as does South Wheelock Brook, which was last sampled in 2007.

Hazardous Waste Site Sampling

Speedwell Gas

Speedwell Gas in Lyndonville (site # 95-1904) is a hazardous waste site as a result of contamination discovered when nine underground storage tanks (mostly gasoline but also no. 2 fuel oil and diesel) were removed. The site is near the edge of the floodplain of the Passumpsic River. Monitoring wells were installed in February 1996. Water table elevations measured in the wells, along with the groundwater contour map generated, indicate that groundwater flow is west-southwest towards the Passumpsic River. Samples taken from the wells found very high concentrations of benzene, MTBE, and total BTEX especially on the site.

Monitoring well 6 is the well furthest downgradient of the site and towards the Passumpsic River. In the November 2007 sample, there was quite a spike in benzene, total BTEX, MTBE, and naphthalene, however, the June 2008 sample found no-detects and low values of the contaminants. In December 2008 sampling, "dissolved petroleum contamination continues to be detected in groundwater collected at the Site at concentrations greater than the Vermont Groundwater Enforcement Standards (VGES). The core of the plume remains concentrated in the vicinity of the UST system and monitoring well MW-3" according to the Semi-annual Groundwater Monitoring Report by KAS consultants. The natural processes of dispersion, dilution, and biodegradation are not occurring at a very fast pace and the site is not expected to fall below the VGES until 2035. The recommendation is to do some remediation at the site to reduce or remove the contamination.

St. Johnsbury Railyard

The St. Johnsbury Rail Yard Site (# 98-2356) underwent a Phase II Environmental Site Investigation from October to December 1997. According to the March 1998 report done for Canadian Pacific Railway: "[t]he analytical data show significant levels of petroleum-impacted soil and groundwater present beneath a leased parcel which has been used since the 1940s as a bulk storage facility. In other portions of the site, soil and groundwater data show no significant levels of petroleum constituents…". In the three test pits in the Lewis Oil yard operations area (the leased parcel referred to above), gasoline

range organics (GROs) were found from 1800 to 2200 mg/kg and total petroleum hydrocarbons (TPHs) were from 5500 to 12000 mg/kg. The groundwater also had "significant petroleum detections with GROs ranging from 0.350 to 4.1 mg/liter and TPHs from 2.4 to 4.0 mg/liter."

More recently the Lewis Oil company site (#98-2484) was sampled in 2006 by Leggette, Brashears and Graham Inc for Lewis Oil. During that June 2006 sampling round, free product was measured and then removed from six wells. In addition, benzene was above the VGES in three wells; 1,2,4-trimethylbenzene was above the VGES in four wells; 1,3,5-trimethylbenzene was above the VGES in three wells; and naphthalene was above the standard in one well.

In October 2008, the consultants conducted a two day multi-phase extraction pilot test at the site as part of potential remediation and then extended the pilot test through the end of November 2008. Based on that work, they discovered a lot more gasoline contamination than previously thought. Lewis Oil never stored gasoline on this site but companies that leased the site before Lewis Oil did. As of February 2009, a Corrective Action Plan was currently being developed for this based on the results of the six week pilot test.

Parker Landfill Superfund Site

The Parker Landfill Superfund Site is located on Lily Pond Road in Lyndon. An unnamed stream flows around the eastern side of the landfill and into the Passumpsic River. The landfill, prior to 1972, was used as a sand pit and town disposal area. In 1972, it was operated as a private landfill taking municipal solid waste and industrial waste. The solid waste disposal area portion of the site was used until 1992. Three smaller industrial waste areas on the site were used at various times between 1972 and 1983: about 1.3 million gallons of liquid industrial wastes and 688,900 kilograms of liquid, semi-solid, and solid wastes were disposed of at the site in those eleven years. These wastes included TCE, 1,1,1-TCA, acetone, lacquer and stain sludge, PCE, barium chloride, chromium and nickel plating rinse water, mercury, and other industrial waste.

Monitoring wells were installed in 1979. Volatile organic compounds were found in the groundwater and in the stream adjacent to the landfill. Vermont DEC completed a Preliminary Assessment/Site Evaluation in 1985 and EPA proposed the site for listing on the National Priorities list (Superfund) in June 1988. In February 1990, the Parker Landfill site was added to the National Priorities List. In 1990 EPA instigated a Remedial Investigation/Feasiblity Study (RI/FS) with a subset of the 14 "Potentially Responsible Parties" (PRPs). The Remedial Investigation results were released in May 1994 and the Feasibility Study was released in June 1994. EPA issued a Record of Decision in April 1995.

The Remedial Investigation phase found the following contaminants in surface waters and sediments: some metals and low levels of 1,2-DEC and TCE in the stream on the eastern side of the landsfill. The stream sediments contained metals but VOCs and SVOCs were detected "infrequently and at low concentrations." No VOCs or SVOCs were found in Passumpsic River samples. There was no mention of metals testing in Passumpsic sediment.

In 1996, EPA and one PRP had the landfill cap portion of the remedial action designed. In 1999, EPA, Vermont DEC and thirteen PRPs agreed to be responsible for construction and maintainance of the landfill cap portion. The last PRP agreed to address the groundwater contamination problem at the site. Construction of the landfill cap began in April 1999 and was completed in December 2001. One of the industrial waste areas (IWS #2) was excavated and put in the Solid Waste Disposal Area and that area was capped along with IWS #1. A separate cap was put on IWS #3.

In September 2004, construction activity with respect to the Permeable Reactive Barrier (PRB) and Bio-enhanced Natural Attenuation (BNA) remedial systems began. In September 2005, the landfill, PRB, and BNA remedial actions were completed and a final inspection was performed in May 2006.

Groundwater monitoring wells are in place with the last installed in June 2008 on a residential property downgradient of the Parker Landfill. These are to confirm the direction of the groundwater plume from the landfill towards the Passumpsic.

Chamberlain Bus Service
Petroleum contamination of the Chamberlin Bus Service site was found when a 4000 gallon underground storage tank was removed in June 1994. Analyses of the groundwater taken from the monitoring wells found only the sample in MW2, which is located downgradient of the former UST and of the area of remaining soil contamination (some soils had been removed from the site), with BTEX and MTBE above the Vermont Groundwater Enforcement Standards. Some impact to South Wheelock Branch has probably occurred due to contaminated groundwater. A significant amount of the contaminated soil between the brook and the bus shed area has been removed, but contaminated soils still remain under the bus shed and paved lot areas so the risk to the brook is reduced but not eliminated.

River and Stream Assessment Summary

<u>Impaired Miles</u>
Passumpsic River: 5.0 - from Pierce Mills dam downstream 5 miles (through St. Johnsbury) - contact recreation, aesthetics impaired due to pathogens and nutrients from numerous CSOs associated with the St. Johnsbury WWTF.

<u>Stressed Miles</u>
Simpson Brook: 0.2 - from above the cascade near rm 0.4 upstream - aquatic biota (fish community) stressed but for unknown reasons as the water quality and macroinvertebrates showed no problems.

Tributary to Passumpsic River: 1.0 - east of Parker Landfill and downstream to the confluence with the Passumpsic River - drinking water supply, contact recreation and aquatic biota at least stressed due to the presence of inorganic contaminants and low levels of organic contaminants in the water as well as inorganic contaminants in the stream sediments. Threats to aquatic biota/habitat also from soil erosion and sediment deposition from the landfill area.

Lakes and Ponds

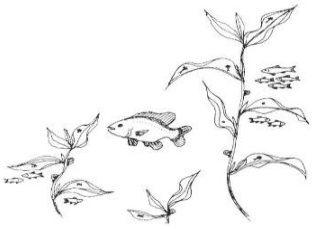
There are three lakes and ponds in the lake inventory and lake assessment database maintained by the Vermont DEC Water Quality Division in this portion of the watershed and some characteristics of these are shown in the table below. Both Bean and Chandler are considered fully supporting their designated uses but currently there is insufficient information to assess Lily Pond. The uncommon blunt-leaf pondweed (*Potamogeton obtusifolius*) is found in Bean Pond.

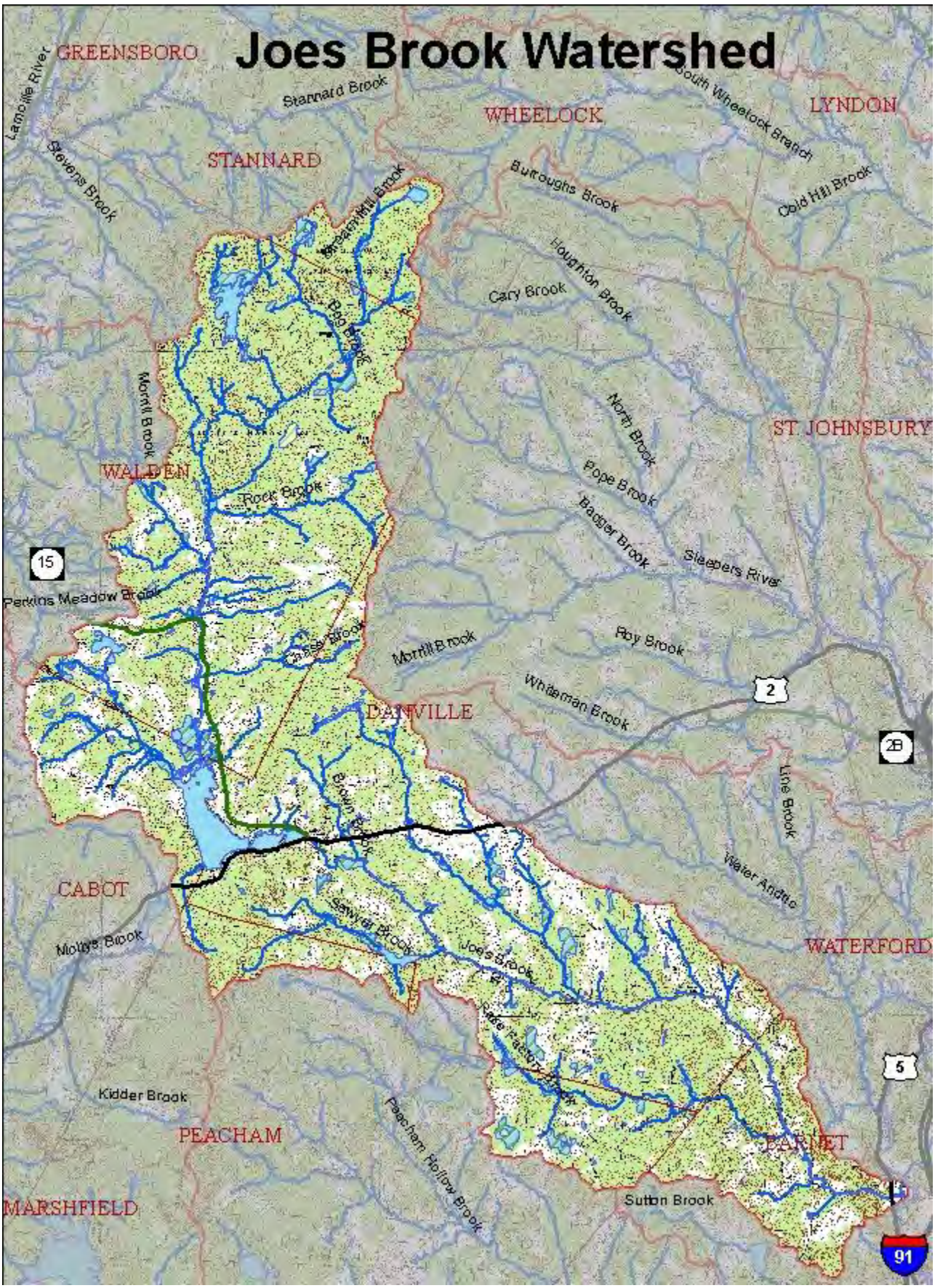
Table 7. Lakes and ponds of the Passumpsic mainstem watershed

Lake or pond	Acres	Water-shed acres	Town	Trophic status[1]	Type of pond outlet	Monitor-ing data[2]	Waterbody id
Chandler	68	1,050	Wheelock	O	natural w/ artificial control	SpP	VT15-05L01
Bean	24	223	Lyndon	M	natural	SpP	VT15-05L02
Lily	8	26	Lyndon	U	unknown	none	VT15-05L03

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

Bean Pond was last sampled by Vermont Department Fish and Wildlife Fishery Division in 1979. The game species present in this pond are chain pickerel, rock bass, yellow perch, and brown bullhead.




Joes Brook Watershed
GREENSBORO
Lamoille River
Stevens Brook
Stannard Brook
STANNARD
WHEELOCK
South Wheelock Branch
LYNDON
Burroughs Brook
Cold Hill Brook
Houghton Brook
Cary Brook
Morrill Brook
WALDEN
Rock Brook
North Brook
ST. JOHNSBURY
Pope Brook
Badger Brook
Sleepers River
15
Perkins Meadow Brook
Roy Brook
Morrill Brook
Whiteman Brook
2
DANVILLE
2B
Lime Brook
Water Andric
CABOT
Molly's Brook
Joes Brook
WATERFORD
5
Kidder Brook
PEACHAM
Peacham Hollow Brook
BARNET
Sutton Brook
MARSHFIELD
91

Joes Brook and Tributaries

Description

Joes Brook originates in the eastern portion of Walden on lands that are part of the Steam Mill Brook Wildlife Management Area (WMA). Joes Brook begins where Steam Mill Brook and Rock Brook meet just north of Goslants Mill. The brook flows south through Walden into wetlands and then Joes Pond in Cabot. Named tributaries of Joes Brook upsteam of Joes Pond include Bog Brook and Chase Brook. From the outlet of Joes Pond, Joes Brook flows southeasterly through the southern portion of Danville and into Barnet. In Barnet, the flow becomes more southerly until about the last half-mile where the brook turns east again to then meet the Passumpsic River. Joes Brook joins the Passumpsic about a mile upstream of the point at which the Passumpsic meets the Connecticut River.

The named tributaries of Joes Brook downstream of Joes Pond include Sawyer Brook, Brown Brook, and Rake Factory Brook. Rake Factory Brook's name is all that is left to mark the existence of a rake handle factory that once was on the brook but is no more.

Riverside Outcrop by Libby Walker Davidson

Uses, Values, Special Features and Designations

Joes Brook is a very special brook with unique and beautiful cascades, rapids, sculptured rocks and ledges providing excellent places to swim, photograph, picnic, fish, and whitewater boat. There are three swimming hole sites identified in the *Vermont Swimming Hole Study*. There are nutrient inputs and likely temperature changes to the brook below Joes Pond because of the developed area runoff into the pond and heating of the impounded waters that are a threat to the health of the brook's aquatic community but the brook itself flows through long wooded stretches and is shaded and protected for much of its length. Designation of the brook as an outstanding resource water should be explored.

Swimming Holes

Three swimming holes were identified on Joes Brook in the statewide survey of swimming holes done in the 1990s. The upstream most site is at the Greenbanks Hollow Covered Bridge. This location is an old dam site and has flat ledges, broad cascades, and a small pool. The next site downstream is called Adams Hole and is located on Morses Mill Road. This site is down in a steep wooded ravine and has a series of small cascades, a 30 by 50 foot swimming hole and a rope swing for jumping when the water is deep enough. The third site identified is labelled Joes Brook South and is a local swimming area with a wide, shallow pool that can have little water in it. It is used by local kids.

Whitewater Boating

Joes Brook is known among the paddling community for its exciting and challenging whitewater. According to a trip report on the Vermont Paddlers Club website, the brook is a ”7 course meal for solid class III-IV boaters who are ready for a bonafide class IV experience” and “spectacular in its beauty and remoteness.” The place to put in is below Joes Pond at the end of Powerhouse Road. There are a number of known and named features from the put-in down to the covered bridge at Greenbanks Hollow – “Corkscrew”, “Pinball” and “Great Escape” are examples. A continuous and steep section of white water is below the covered bridge down to Morses Mills. Below Morses Mill is “The Gorge” and other “drops” before the take out.

State Conservation Lands

Steam Mill Brook WMA is a 10,421-acre tract of land located in the southern part of Vermont’s Northeast Kingdom and managed by the Vermont Fish & Wildlife Department. It lies in the towns of Walden, Stannard, Wheelock and Danville. The terrain is typical for the region, with rolling mountains, hills, and plateaus. Elevations range from 1,600 feet along the southern boundary to 2,783 feet on Wheelock Mountain. The WMA is dominated by forestland, a mixture of northern hardwoods (beech, yellow birch and sugar maple) and red spruce-balsam fir forests. Intermingled with the forests are 288 acres of wetland habitats, comprised of alder swales, streams, beaver flowages and several ponds, including Coles Pond. Steam Mill Brook originates from Stannard Pond and runs south through the length of the WMA.

The Vermont Fish & Wildlife Department purchased the majority of the property in 1971. Smaller parcels were added in later years, and Wheelock Mountain was added in 1996. Much of the WMA was previously owned by the Fairbanks Scales Company and was an important timber source for their large factory in nearby St. Johnsbury. In the late 19th century, Steam Mill Brook supplied power to at least six sawmills along its banks and tributaries. Many old mill, barn, house, and school foundations, along with stone walls, remnant fields and apple trees are testimony to what was once a bustling community tucked away in the remote hills of Walden.

Sampling Results and Assessment Information

Biological Monitoring

Only Joes Brook and Steam Mill Brook in this subwatershed were sampled in the last ten years and there are only two macroinvertebrate samples in this time period. The assessment did show that the macroinvertebrate community was healthy and diverse, however, more current information would be valuable. A sample of the fish community on Joes Brook in August 2003 at rivermile 6.3 found this community in "very good" health.

Table 8. Macroinvertebrate Sampling Sites and Results – Joes Brook

Wbid	River or Stream	Town	Station (by rivermile)	Date	Assessment
VT15-02	Joes Brook	Walden	14.7	8/24/2004	Very good
VT15-02	Steam Mill Brook	Walden	5.5	9/08/1999	Excellent

Vermont DF&W game fishery sampling and stocking

Joes Brook near the mouth is stocked with Atlantic salmon fry and brown trout – wild salmonids are rare here. However the brook at Goslant Mill has wild brook and brown trout. The lower segment was last sampled in 2008 and the Goslant Mill stretch in 2007.

The Vermont DF&W Fishery Division last sampled Joes Pond in 2008. The game species present in this pond include lake trout, smallmouth bass, northern pike (which were illegally introduced within the last ten years), rainbow smelt, rock bass, pumpkinseed, chain pickerel, yellow perch, and brown bullhead. The pond is stocked with brown trout and rainbow trout. Lake trout were not stocked after 2000 so the population in Joes Pond is a residual population from the earlier stocking.

Coles Pond was last sampled in 1992 by the Vermont DF&W fisheries biologists. The game species present in this pond included smallmouth bass, chain pickerel, yellow perch, and brown bullhead.

Lyford Pond was last sampled by Vermont DF&W in 1989. The game fish species present in this waterbody include largemouth bass, chain pickerel, yellow perch, rock bass, and brown bullhead.

Keiser Pond was sampled recently, in 2008. The game fish species in this pond include chain pickerel, yellow perch, brown bullhead, pumpkinseed sunfish, and rock bass.

Stannard Pond, which was last sampled in 2007, is stocked with brook trout and no other game fish were found when it was sampled.

Other

The West Danville Project dam is at the outlet of Joes Pond and is used for hydroelectric generation. Public Service Board orders of 2003 and 2004 and a related settlement agreement between ANR and GMP resolved management of pond levels and flow issues below the dam on Joes Brook.

The Frye Quarry in Danville had an individual discharge permit for seepage water and stormwater collected in the quarry sump. The permit expired in 2004 and has yet to be renewed because the treatment system, which consists of two detention ponds was not constructed as designed. The owner is planning on making the necessary modifications so that the treatment system fully complies and was supposed to complete the work by November 20, 2008. The owner has been granted an extension until June 15, 2009. This was granted by DEC "provided that quarrying operations do not commence until such time as the work is complete and the Department is notified with certification documentation."

River and Stream Assessment Summary

No stretches of river or stream in the Joes Brook watershed have been put into the categories of stressed, altered, impaired. The limited biological monitoring done on Joes Brook and a tributary indicate full support of designated uses.

Lakes and Ponds

There are six lakes or ponds in the lake inventory and lake assessment database for the Joes Brook watershed. The largest of these by far is Joes Pond, a 396 acre body of water, which drains a 18,445-acre area in two towns. Most of Joes Pond fully supports its uses although the aquatic biota/habitat use is altered in about 100 acres by water level fluctuation and aesthetics are stressed in 100 acres by sedimentation and developed shoreline runoff. Joes Pond is home to the endangered common mare's tail (*Hippuris vulgaris*) and the threatened small bur-reed (*Sparganium fluctans*).

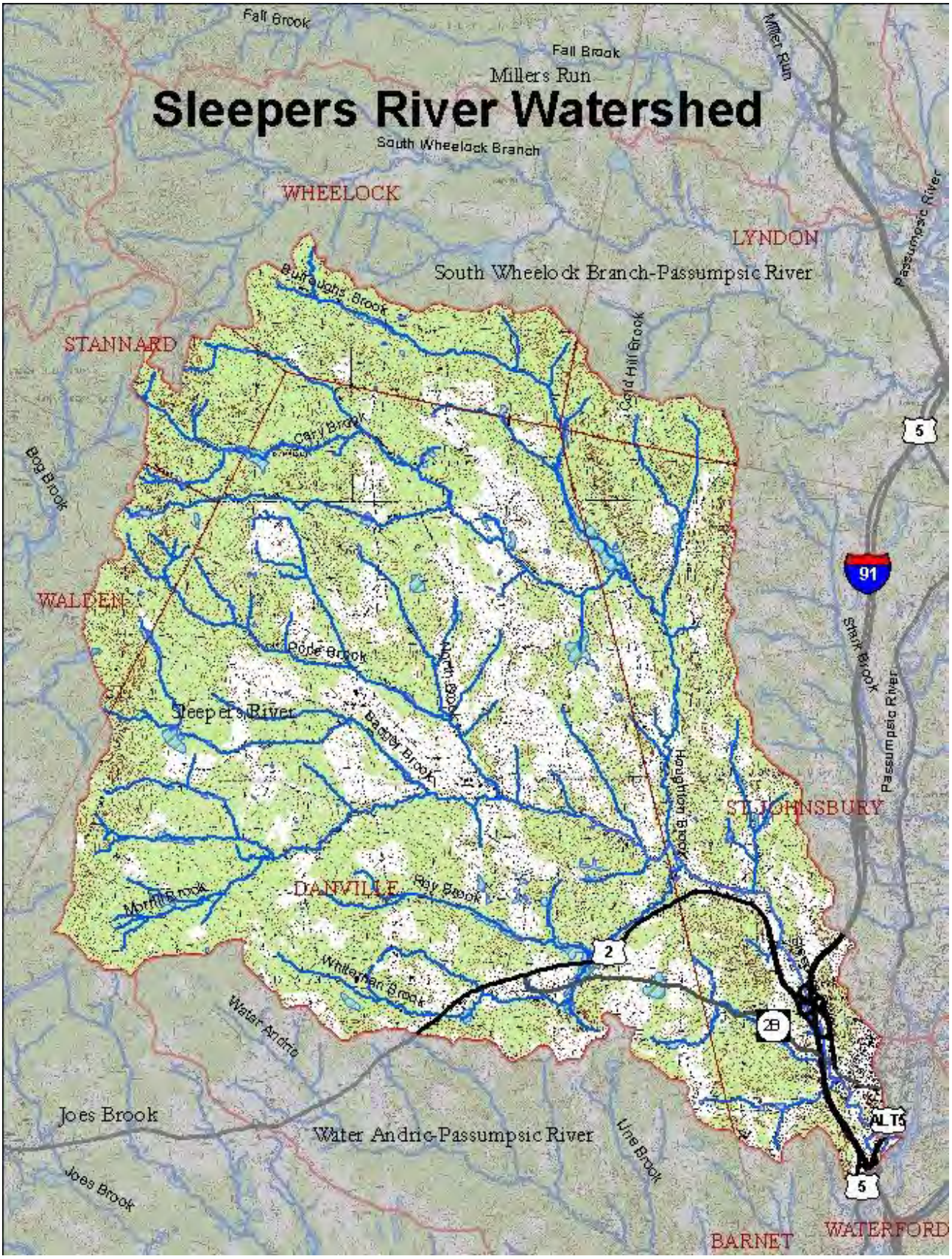
Coles Pond in Walden is 125 acres in area and the lake quality and habitat fully support the designated uses. Of the 125 acres, aquatic biota/habitat, recreation (swimming as well as boating and fishing), and aesthetics are stressed on five acres by sedimentation. Coles Pond has two rare (in Vermont) watermilfoils in it – the little watermilfoil (*Myriophyllum alterniflorum*) and Farwell's watermilfoil (*Myriophyllum farwellii*).

Lyford, Keiser, and Stannard Ponds all fully support their uses whereas Goslants Mill is not assessed – there is insufficient information to judge use support in this pond. Lyford Pond has the uncommon blunt-leaf pondweed as part of its aquatic plant community. Keiser Pond is home to three rare or uncommon plants: the rare slender pondweed; the uncommon to rare small bur-reed; and the uncommon blunt-leaf pondweed.

Table 9. Lakes and ponds of Joes Brook watershed

Lake or pond	Acres	Water-shed area	Town	Trophic status[1]	Type of pond outlet	Monitor-ing data[2]	Waterbody id
Joes Pond	396	18,445	Cabot & Danville	O	Natural with artificial control	LMP SpP	VT15-02L03
Coles Pond	125	744	Walden	O	Natural with artificial control	LMP SpP	VT15-02L01
Lyford Pond	33	229	Walden	M	Natural	LMP SpP	VT15-02L02
Keiser	33	1,611	Danville	M	Natural with artificial control	SpP	VT15-02L04
Stannard	25	125	Stannard	U	Natural	SpP	VT15-02L05
Goslants Mill	15	7,526	Walden	U	Artificial	none	VT15-02L06

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


Sleepers River Watershed
Fall Brook
Fall Brook
Millers Run
Miller Run
South Wheelock Branch
WHEELOCK
LYNDON
South Wheelock Branch-Passumpsic River
Passumpsic River
Bullroughs Brook
STANNARD
Cold Hill Brook
Cary Brook
Bog Brook
5
91
WALDEN
Pope Brook
Sleepers River
Bailey Brook
Strait Brook
Passumpsic River
Houghton Brook
ST. JOHNSBURY
DANVILLE
Bay Brook
Morrill Brook
2
Whiteman Brook
2B
Water Andric
Joes Brook
Water Andric-Passumpsic River
Une Brook
ALT5
5
Joes Brook
BARNET
WATERFORD

Sleepers River and tributaries

Description

The Sleepers River in Danville is created by the flow from Morrill and North Brooks, which join in North Danville. Badger Brook and Pope Brook are significant tributaries to Morrill and North Brooks respectively.

The Sleepers River flows southeasterly from North Danville in a fairly narrow channel. Bank right, which is steep and high, has areas of dark grey soil eroding or sliding into the stream. Downstream, but above the point where the North Danville Road crosses the Sleepers River and above the Danville/St. Johnsbury border, there is a small concrete dam and a gaging station. The Sleepers River makes a sharp turn to the northeast under the road and then turns sharply again to the southeast at the point where Burroughs Brook joins in.

Burroughs Brook is a nine and a half mile long tributary draining a 17 ½ square mile watershed to the north of the Sleepers River. Burroughs has a gaging station about one-half mile upstream of its confluence with the Sleepers. Houghton Brook is a tributary to Burroughs.

Downstream on the Sleepers River, Roy Brook joins on the opposite bank from where Burroughs entered. Roy Brook is a three and a half mile long brook with a seven square mile watershed. Whiteman Brook, also three and a half miles, is a tributary to Roy Brook.

Below Roy Brook and below the upstream road bridge that connects North Danville Road with Goss Hollow Road, there is a pretty series of small cascades and pools over sculptured bedrock on the Sleepers River. Goss Hollow Road runs along the river here so this stretch is visible to passersby.

The Sleepers River continues southeasterly under the downstream bridge that connects the two roads and is then bordered by forest and some cropland. It turns more southerly and soon encounters a concrete weir and a low concrete dam just above Emerson Falls. The dam has a wooden beam that diverts some of the Sleepers River flow to a small power station near the base of the falls. A USGS gaging station accessible by a footbridge sits on bank left just upstream of the dam and weir.

The Sleepers River continues in a southerly direction flowing adjacent to a business park-type development that houses non-profit educational and health facilities among others. Lawn area and a new septic system are where forested buffers should be in this stretch.

Downstream of this developed area, the Sleepers River is channelized under Interstate 91 on and off ramps and taken through the center of the cloverleafs. It is then culverted under Route 2, then the Interstate itself and then through the center of another on and off ramp. It flows inbetween Interstate 91 and Route 2 and is still largely contained as it is put under Route 2B.

Below Route 2, the river flows at the southwestern edge of St. Johnsbury passing under High Street bridge. There are falls below the bridge as well as brick and concrete walls keeping the river from too much lateral movement. The river here flows along the Old Fairbanks Morse Foundry site, which is now a monitored hazardous waste site due to petroleum spills in earlier years. Downstream of Fairbanks Morse, the river makes a few bends and goes under an old railroad bridge near the current St. Johnsbury transfer station and old St. Johnsbury Dump. There is a swimming hole with a rope just below the bridge. The river goes under Route 5; behind a row of houses; under another road and railroad; past the St. Johnsbury wastewater treatment facility and enters the Passumpsic River.

Uses, Values, Special Features and Designations

Swimming Holes

As mentioned above, downstream of the Fairbanks Morse site and St. Johnsbury Academy, the river goes under an old railroad bridge where there is a swimming hole with a rope swing. The transfer station operator says he can hear the kids shouting and splashing at this swimming hole throughout the summer.

Sampling Results and Assessment Information

Hydroelectric Dams

There have been two hydroelectric facilities on the Sleepers River: Fairbanks Mills in North Danville, which is now gone, and Emerson Falls in St. Johnsbury. The Emerson Falls facility was constructed at a former fish hatchery site in the 1980s by a small power producer. There is a 200-foot wide concrete spillway and a 390-foot buried penstock that takes water from the river to the powerhouse below the dam. A 60-foot long tailrace diverts the water back to the river. A conservation flow is maintained in the penstock bypassed reach (over the falls) to protect aquatic habitat. The owner is required to do a study to determine the necessary bypass flows for aesthetics. Pools in the bypass are very popular for swimming and fishing.

Wastewater and other discharges

The St. Johnsbury WWTF has five combined sewer overflow sites on the Sleepers River and there are seven permitted stormwater discharges to the Sleepers. Treated groundwater from the Coltec Industries site, the old Fairbanks Morse hazardous site, is the other discharge to the lower Sleepers River.

Biological Monitoring

Two sites on the Sleepers River itself and four sites on tributaries to the Sleepers River have had their macroinvertebrate communities sampled and evaluated in the last ten years. The results are shown in the table below. Fish communities were sampled on North Brook, Roy Brook, and Houghton Brook and are discussed below.

Table 10. Macroinvertebrate Sampling Sites and Results – Sleepers River

Wbid	River or Stream	Town	Station (by rivermile)	Date	Assessment
VT15-04	Sleepers River	St. Johnsbury	1.1	09/06/2005	Vg-good
VT15-04	Sleepers River	St. Johnsbury	4.4	09/06/2005	Vg-good
VT15-04	Burroughs Brook	St. Johnsbury	0.9	09/21/2000	Very good
VT15-04	Burroughs Brook	Danville	2.8	10/08/1999	Excellent
VT15-04	Pope Brook	Walden	3.2	10/08/1999	Good
VT15-04	Pope Brook Trib	Danville	0.1	09/07/1999	Excellent

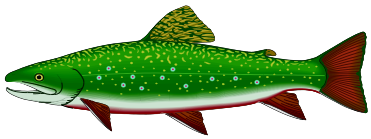
Rivermile (rm) 4.4 on the Sleepers River is just up from the bridge on North Danville Road at the junction with Old Prue Road and rivermile 1.1 is located 0.75 miles above mouth and below the Fairbanks Foundry site.

The fish community sampled on North Brook in Danville in 2005 was in “excellent” condition around rivermile 0.4. The fish community on Houghton Brook also in Danville was in “very good” condition – this sampling was done at rivermile 0.8. The sample on Roy Brook in St. Johnsbury at rivermile 0.1 found the fish community in “good” condition.

Vermont DF&W game fishery sampling and stocking

The Sleepers River downstream of Houghton Brook was sampled in 2008. Wild brook trout were present. This stretch is stocked with Atlantic salmon fry, brown trout, and rainbow trout.

Morrill Brook was sampled in 1984 and wild brook trout were present in this stream as well.



Hazardous Waste Site Sampling

Fairbanks Morse Foundry

The Fairbanks Morse Foundry site is located on the banks of the Sleepers River off High Street in St. Johnsbury. Thaddeus Fairbanks built a foundry on the site in 1823 and then over the years with his brother built a factory and more buildings to house the successful Fairbanks Scales enterprise. Supposedly the manufacturing buildings were on the east side of the Sleepers River although there is no access to that part of the property now. Manufacturing at the site included casting scale parts, plating, acid etching, and painting. There isn't documentation of where the waste from the production processes went but there are accounts of rinse water and the contents of tanks used for plating and etching being disposed of in the river. There is reportedly a dump with the slag and sand wastes from the forging process on the site but that has not been identified.

In 1966 or 1967, a factory was built at a new location in St. Johnsbury although it is thought that the foundry portion operated on the original site until 1972. In the late 1960s or early 1970s, many of the buildings on the original site were destroyed by fire. The remains of the foundry were demolished and burned in 1985. Currently there are only two buildings left on the site - one large brick building on the west side of the Sleepers River has been renovated by the current property owners and is used for their business.

There have been two known unrelated petroleum spills on the property. The first one occurred in 1960 from a broken pipe. Contaminated soil from the spill was moved to a concrete pad on the property. The second occurred in 1972 when aboveground tanks overflowed during a fuel oil delivery. The delivery being made was 6000 gallons (note the amount of oil recovered over the 20 years of treatment below - it seems likely that there were more than the two leaks or spills in these earlier years). In 1975 an oily sheen was first reported on the Sleepers River. The aboveground tanks and some soil from the site was removed. Another sheen was reported in 1984 and at that time Coltec Industries hired a consultant to do an investigation and remedial work. An oil recovery system became operational in 1987 and since that time over 10,000 gallons of fuel oil has been recovered. Johnson Company goes to the site once a month and takes groundwater samples, checks the river for sheens, and checks the operation of the recovery system.

St. Johnsbury Dump

Information on the St. Johnsbury Dump hazardous waste site (#770080) was best summarized to date in the Final Site Inspection Prioritization Report done for EPA by a consultant in 1995: "The St. Johnsbury Dump is located on approximately 4 acres of land south of High Street in St. Johnsbury.. The dump accepted paint sludges, water soluble coolants, and electroplating sludge from a local industrial manufacturer, and household refuse from local residents from prior to 1943 to 1975.. Upon closure in 1975, the dump was covered with approximately 2 feet of soil and seeded. NUS Corporation Field Investigation Team (NUS/FIT) and CDM Federal conducted SI and SIP sampling events in November 1988 and December 1994, respectively. The NUS/FIT sampling event revealed elevated concentrations of polynuclear aromatic hydrocarbons, phthalates, and inorganic elements in both the soil and groundwater. The CDM Federal sampling event revealed elevated concentration of polychlorinated biphenols, semivolatile organic compounds and inorganic elements in onsite surface soil and in the sediment from the adjacent Sleepers River. The data from both field events reveal contaminants associated with electroplating and painting process wastes known to be disposed of in the dump."

<u>Sleepers River Research Watershed longterm monitoring</u>

The Sleepers River watershed has been used for hydrologic data collection and research for over four decades by a number of federal agencies including the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) and the U.S. Geological Survey (USGS). Longterm datasets are available on the Sleepers River and its subwatersheds for numerous parameters going back to 1959 in some cases. Some of the data collected include precipitation measured from 1959 to the present on an hourly basis at 15 stations; snow cover depth measured daily at one station from 1959 to the present; stream discharge measured continuously at three stations from 1959 to the present; stream temperature measured half-hourly at three stations from 1984 to the present and measured every five minutes at five stations from 1991 to the present; snow cover outflow measured hourly from 1968 to the present at two stations; stream chemistry measured

weekly plus event sampling from 1991 to the present; precipitation chemistry measured weekly from 1991 to the present; plus numerous other snow cover, soil, and groundwater measurements at a number of stations over many years. The data are not easily available because of the volume of data collected over many years by several different federal entities with their own methods of collecting and storing data and during a time when technologies have been changing quickly.

Other

A USGS study of inorganic and organic compounds in streambed sediment included a site on the Sleepers River in the early 1990s. Of those where the probable effects level (PEL) was known, only nickel was found in Sleepers River sediment above the PEL. Another USGS study focused on organochlorines in fish tissue and again the Sleepers River was a site in this study. No DDT, chlordane, or PCBs were detected in the Sleepers River fish that were analyzed.

River and Stream Assessment Summary

Impaired Miles

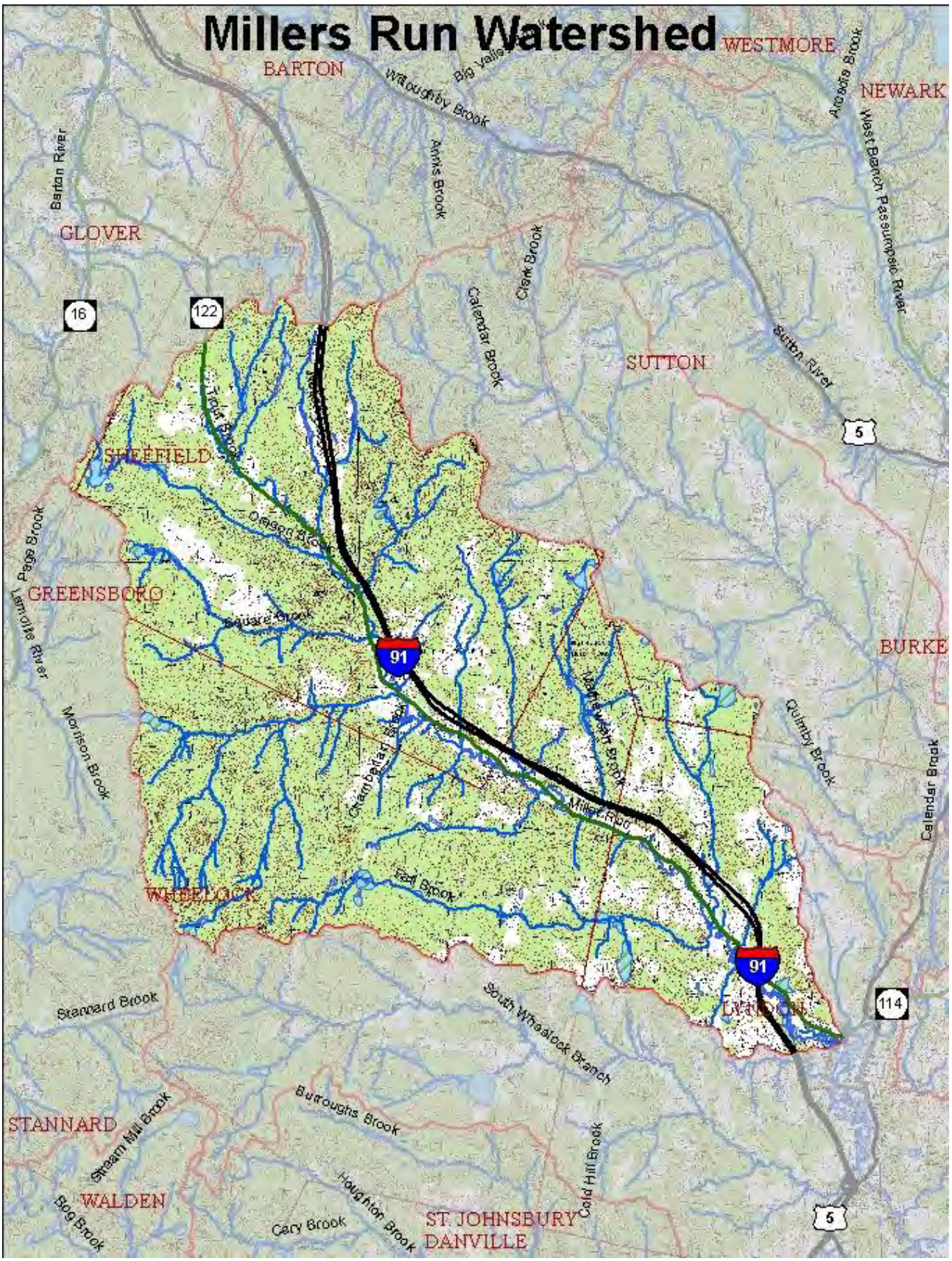
Sleepers River: 1.5 miles - from mouth upstream - contact recreation impaired due to pathogens from CSOs.

Altered Miles

Sleepers River: 2.7 miles - from the mouth upstream - aquatic habitat and aesthetics altered due to channelization from I-91 construction that straightened and confined the Sleepers through the on and off ramps and then is rip-rapped and walled below the High Street bridge.

Stressed Miles

Sleepers River: 1.3 miles - from the mouth upstream - aquatic habitat, drinking water supplies, and secondary contact recreation stressed due to an oil spill and dumping of heavy metals, iron wastes, acids, solvents, and paint wastes from now defunct industrial sources. Macroinvertebrate numbers are reduced but diversity is not impaired. Contaminants not found in surface waters but there were elevated levels of inorganics, PCBs, and SVOCs in Sleepers River sediments.


Millers Run Watershed
BARTON
WESTMORE
NEWARK
GLOVER
SUTTON
SHEFFIELD
GREENSBORO
BURKE
WHEELOCK
STANNARD
WALDEN
ST. JOHNSBURY
DANVILLE
Barton River
Willoughby Brook
Big Valley
Annis Brook
Clark Brook
Calendar Brook
Arcadia Brook
West Branch Passumpsic River
Sutton River
Page Brook
Lamoille River
Morrison Brook
Square Brook
Chamberlain Brook
Miller Run
Quimby Brook
Calendar Brook
Fall Brook
Standard Brook
South Wheelock Branch
Burroughs Brook
Stream Mill Brook
Bog Brook
Houghton Brook
Cary Brook
Cold Hill Brook
16
122
91
5
114

Millers Run and tributaries

Description

Oregon Brook and its tributaries (Trout Brook and Nation Brook) from the north and Square Brook and its waters from the west converge about a mile north of Sheffield Village and form the Millers Run. Dunn Mountain Brook, which is four and a half miles long, and its tributaries join the Millers Run from the west in the village of Sheffield.

The river flows southeasterly through more of Sheffield town downstream of the village and then into the northern extension of the town of Wheelock. The three and a half mile long Matthewson Brook flowing out of Matthewson State Forest enters the Millers Run from the north.

Millers Run next flows through the western half of Lyndon with Squabble Hollow Brook soon draining into it from the north and then Fall Brook coming in from the west. Squabble Hollow Brook is three and a half miles long and drains a two square mile watershed. Fall Brook is a six mile long stream draining a five and a half square mile watershed.

Millers Run meanders the rest of the way southeasterly through old fields and wetland communities where it joins the Passumpsic River just north of the athletic fields of Lyndon Institute. The Millers Run length is approximately 12 miles and it drains a 48.5 square mile watershed.

The headwater tributaries and mile of Millers Run above Sheffield Village have a 7½ % gradient. From Sheffield through Wheelock, Millers Run flows at a 1.3% gradient and then flattens to a 0.1% gradient in the last four miles before entering the Passumpsic River about Lyndonville. Much of the Millers Run is a sandy-bottomed, sinuous stream with abandoned meanders, eroding outer bends, and ever-growing point bars.

Uses, Values, Special Features and Designations

There is a nice, small set of falls over bedrock in the village of Wheelock.

Sampling Results and Assessment Information

<u>Biological Monitoring</u>
The macroinvertebrate communities at three sites on the Millers Run were sampled in the last several years. The assessments based on the sampling are given below. Rivermile 5.0 is located upstream of Hubbard Hill Road bridge; rivermile 6.9 is located adjacent to Route 112 below the Mathewson Brook confluence; and rivermile11.6 is located directly behind Millers Run School in a riffle below the bend.

The fish community was sampled on Millers Run in Sheffield in September 2005 at rivermile 7.8 and was found in “excellent” condition.

Table 11. Macroinvertebrate Sampling Sites and Results – Millers Run

Wbid	River or Stream	Town	Station (by rivermile)	Date	Assessment
VT15-06	Millers Run	Lyndon	5.0	9/16/2005	Vg-Good
VT15-06	Millers Run	Wheelock	6.9	9/23/2004	Exc-Vgood
VT15-06	Millers Run	Sheffield	11.6	9/20/2005	Vgood

Physical Assessment

The sinuous character of the Millers Run along with agricultural land uses that dominate in the valley have resulted in a lot of streambank erosion on this river. A multi-year, multi-partner project in the mid-1990s used a number of bioengineering treatments on eroding banks to attempt to slow the erosive processes but many did not work well. The science of fluvial geomorphology as well as where and how to use bioengineering techniques were relatively new in Vermont and there was not a full understanding of the river system at the time of these bank stabilization projects.

Currently stream geomorphic assessment work is being done on the Millers Run and this physical assessment will be useful in determining what is natural and what is unnatural erosion and stream movement; what changes in the stream might be expected over time; and how best to protect the instream aquatic habitat and whole river corridor (the river, its floodplain, and associated riparian habitat). Phase I geomorphic assessment work and some Phase II geomorphic assessment has occurred on the Millers Run but results are not available at this time.

River and Stream Assessment Summary

Stressed Miles

Miller Run: 9.5 miles - aquatic habitat, aesthetics, secondary contact recreation stressed due to sedimentation, habitat alteration from streambank erosion, unstable channel, pasture (grazing on banks, no stream buffer, cows in river).

Lakes and Ponds

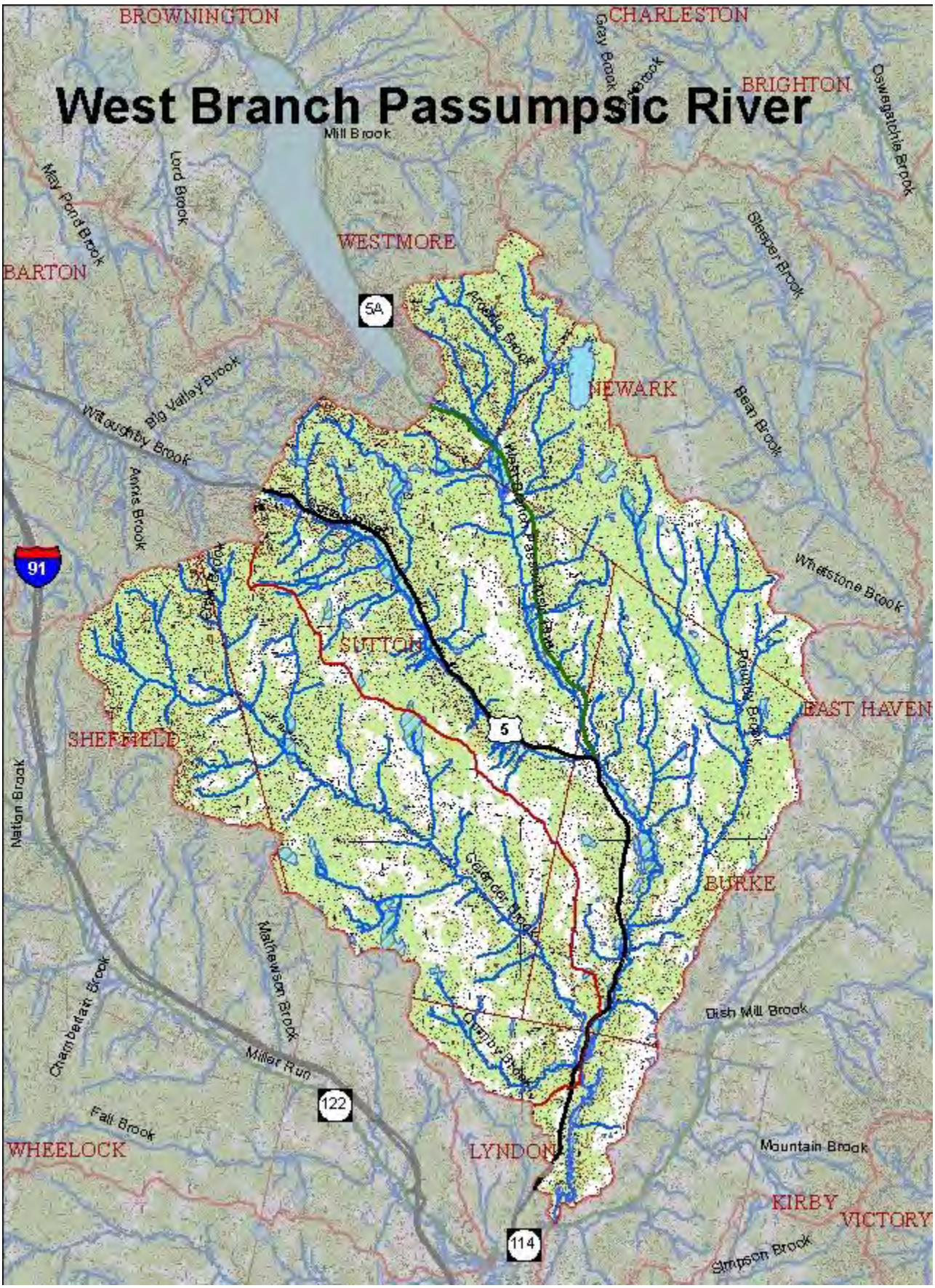
The uses and values of both Bruce Pond and Blake Pond are fully supported at this time. In addition, Bruce Pond is home to the uncommon Fries' pondweed.

Table 12. Lakes and ponds of Millers Run watershed

Lake or pond	Acres	Watershed area	Town	Trophic status[1]	Pond outlet	Monitor-ing data[2]	Waterbody id
Bruce	27	396	Sheffield	U	Natural	SpP	VT15-06L01
Blake	7	160	Sheffield	U	Unknown	none	VT15-06L02

1 - O=oligotrophic; M=mesotrophic; E = eutrophic

2 - LMP=lay monitoring program data (Secchi, chorophyll a, phosphorus); SpP = spring phosphorus data


West Branch Passumpsic River
BROWNINGTON
CHARLESTON
BRIGHTON
WESTMORE
BARTON
NEWARK
SUTTON
SHEFFIELD
EAST HAVEN
BURKE
LYNDON
WHEELOCK
KIRBY
VICTORY
Mill Brook
May Pond Brook
Lord Brook
Gray Brook
Oswegatchie Brook
Slasper Brook
Bean Brook
Big Valley Brook
Willoughby Brook
Annis Brook
Wheelstone Brook
Round Brook
Nation Brook
Chamberlain Brook
Mathewson Brook
Miller Run
Fall Brook
Dish Mill Brook
Mountain Brook
Simpson Brook
54
91
5
122
114

West Branch Passumpsic River and tributaries

Description

The West Branch of the Passumpsic River originates on the southern slope of Mt. Pisgah in the southern tip of Westmore and flows for about 15 miles draining a 68 square mile watershed. The West Branch flows south/southeasterly through Sutton and into the village of West Burke in the town of Burke. The Sutton River joins the West Branch from the northwest in West Burke village.

The Sutton River begins at Marl Pond in Sutton, Marl Pond and Swamp Natural Area being within the Willoughby State Forest. The river flows south, southeasterly, and near its mouth, easterly through the town of Sutton before entering the town of Burke where it meets the West Branch. Much of the Sutton River flows through state significant wetland ecosystems including cedar swamps and alder-dominated swamps. The Sutton River is about seven miles long and drains an 11.4 square mile area.

From West Burke, the West Branch of the Passumpsic River flows southeasterly and then southerly through the town of Burke with Route 5 running to its west. Just upstream of the point where Roundy Brook joins the West Branch, the West Branch flows through significant and fairly extensive wetland communities. The seven mile long Roundy Brook enters from the east and north after draining a nine and a half square mile watershed.

The West Branch then flows south still into and through the central part of the town of Lyndon. Calendar Brook enters the West Branch from the west in Lyndon. Calendar Brook's headwaters flow from the steep mountainsides of Granby Mountain, Libby Hill, Frost Mountain, Grout Mountain and Hardscrabble Mountain. Clark Brook is a 1.8 mile-long tributary from the north that drains a one and a half mile watershed. Calendar Brook flows 10 miles in a southeasterly direction from Sheffield through Sutton and then into Burke then Lyndon where it meets the West Branch. It drains a 21-square mile watershed.

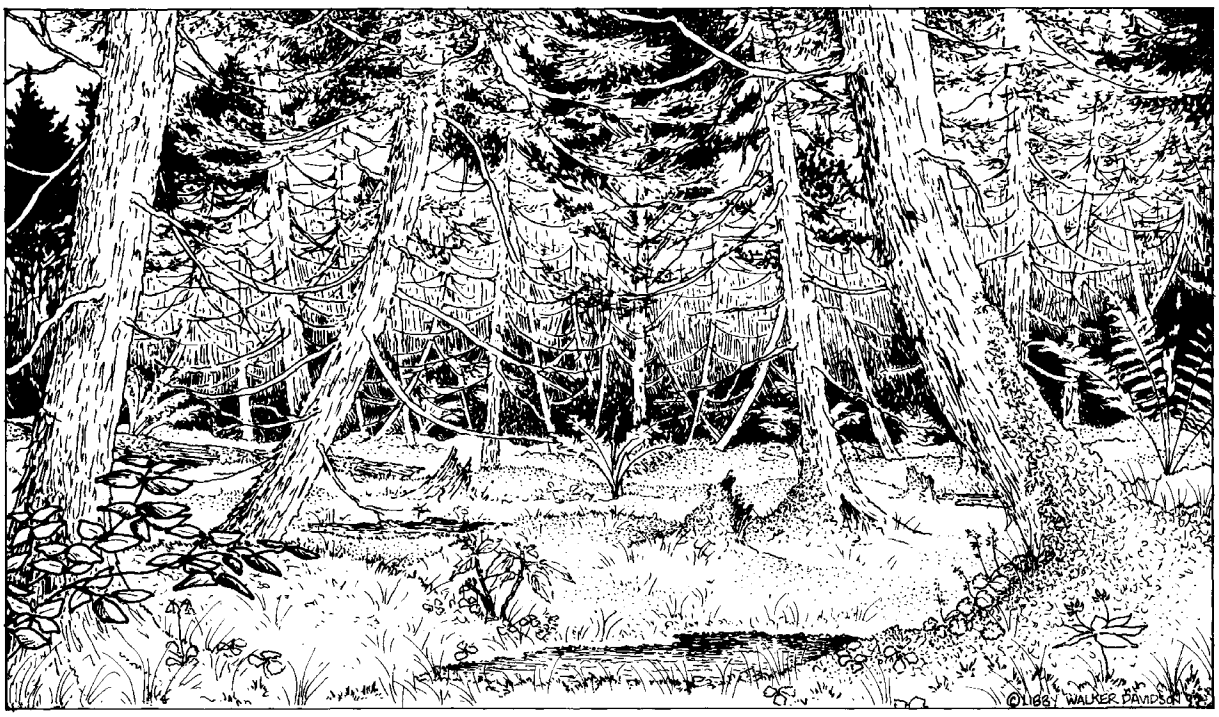
Just north of Lyndonville, the West Branch meets the East Branch of the Passumpsic River. Here the mainstem Passumpsic begins comprised of the two branches and all their tributaries.

Uses, Values, Special Features and Designations

<u>Natural Communities</u>
There are four identified state significant white cedar swamp natural communities in the West Branch Passumpsic River watershed. The Burke Hollow Cedar Swamp is located between the West Branch and the railroad bed south of Burke Hollow Road in Burke. This forty-acre swamp contains a population of a rare moss and a population of uncommon showy lady's slipper. The ground cover of the swamp is *Sphagnum*-dominated and along with uneven-aged cedar, there is balsam fir, black ash, and larch in the canopy and mountain holly, velvet-leaf blueberry, and red-osier dogwood in the shrub layer among others.

The Doloff Ponds are in a basin ringed by Bartlett Mountain, another small mountain, and North Ridge in Sutton. The ponds and basin drain to a tributary to the Sutton River. In this basin surrounding the ponds are northern white cedar swamps, some of which are relatively young, but there is also one stand of cedar about 90 years old. This older portion of swamp contains a diversity of tree, shrub, and herbaceous species in addition to the cedar including red maple, yellow birch, balsam fir, mountain maple, Canada fly-honeysuckle, wood sorrel, foamflower, and shining clubmoss among others.

Marl Pond, so-named because of the marl (calcium or magnesium carbonate) once mined from its bottom for fertilizer, and its mature northern white cedar swamp on the eastern side are part of Marl Pond and Swamp Natural Area in Willoughby State Forest. The swamp although small in area has some 80-foot tall cedar, red spruce, and yellow birch. Three cedars that were cored at the time of a field visit in 1997 (11 years ago now) were 90, 118, and 150 years old.



Northern White Cedar Swamp – Libby Walker Davidson

Passumpsic River Swamp so-called is an A-ranked example of a northern white cedar swamp that extends along the West Branch Passumpsic River. It was described as “one of the largest contiguous areas of northern white cedar swamp in Vermont” in the Nongame and Natural Heritage Program study report on cedar swamps. At the time that this swamp was visited, there had been a fair amount of clearing and logging but there was a high quality, 80-acre portion of the swamp west of Route 5A and south of the Westmore town gravel pit.

State Conservation Land

Calendar Brook Wildlife Management Area (WMA) is a 413-acre parcel of land owned by the State and managed by the Vermont Fish & Wildlife Department. The property is located in the town of Sutton in Caledonia County just west of the village of Sutton near the Sheffield-Sutton town line. The Vermont Fish & Wildlife Department purchased 340 acres that became the Calendar Brook WMA in 1965. An additional 73 acres was purchased in 2000. The WMA takes its name from Calendar Brook, a tributary of the Passumpsic River which flows through the heart of the property. Elevations range from 1,300 to 1,500 feet, and the terrain is moderately sloped to flat. The land is mostly softwood forest, dominated by white and red spruce and balsam fir in the drier uplands and white cedar in the wetland habitats.

Beavers have made their homes and impoundments on Calendar Brook and its small tributaries, creating habitat for mink, otter and other species. The northern spring salamander is one of few species that prefer cold streams in spruce-fir forests so it might reside in Calendar Brook. Heavy shade provided by forest canopy keeps Calendar Brook cold, providing good fishing for native brook trout in an off-roadside setting.

Swimming Holes

There is a swimming hole on the West Branch of the Passumpsic River in the village of West Burke just below an old wooden dam and small cascades. There is an 8-foot deep pool and, as it is so accessible to the village, it is heavily used by kids.

Boating

A short three and a half mile stretch of quickwater and Class I boating is described for the West Branch from Calendar Brook down to the Passumpsic in the Appalachian Mountain Club (AMC) River Guide.

Sampling Results and Assessment Information

Biological Sampling

The West Branch of the Passumpsic River subwatershed has not been well sampled. In the last ten years only Calendar Brook was sampled for its macroinvertebrate community health and integrity. In September 2005 at rivermile 5.3 in Sutton, the community was found to be in “excellent” shape. The fish community sampled in the same year in the same stretch was assessed as “good”. The sampling station is located just upstream of the Center Road bridge in Sutton.

Vermont DF&W game fishery sampling and stocking

The West Branch of the Passumpsic River was last sampled by Vermont Fish and Wildlife in 1995 along with Calendar Brook and the Sutton River. The West Branch had wild brook and brown trout present. It is also stocked with brook and brown trout. Wild brook trout are present in Calendar Brook and the Sutton River and brown trout are in Calendar Brook. Roundy Brook sampled last in 2007 has wild brook trout present.

The Marl Pond inlet and the Doloff Pond inlet was last sampled in 2001 and wild brook trout were found in both locations. Newark Pond sampled last year, 2008, had smallmouth bass, yellow perch, and brown bullhead. Rainbow trout are stocked here.

Hazardous Waste Sites

Darling Hill Dump

The Darling Hill Dump was a concern identified in earlier assessments. It is located off of Route 114 on Darling Hill Road with the dump itself at the top of a hill about 300 feet from the West Branch of the Passumpsic River (just above the point where the East and West Branches join). The information following is from the EPA New England sites information. "From 1952 to 1972, the Village of Lyndonville leased and operated the dump. The dump was used for the disposal of light industrial and municipal wastes. Ray O Parker and Son, Inc of Lyndonville leased and operated the dump from 1972 to 1983 and purchased it in 1983. During this time, the dump was used mainly for the disposal of scrap wood, metal, demolition materials, and industrial wastes. The site continued operating until the 1980s; in 1989 it was closed. An estimated 92,000 gallons of liquid industrial wastes were dumped directly on the ground at the unlined site, as were 2,000 tons of liquid, semi-liquid and solid industrial waste including metal plating rinse water, alkali degreasers, and organic solvents."

The site was closed in 1989. In 1991, a carbon filtration system was installed at the Lyndonville water supply. In 1992 following an investigation of the site, EPA decided that no further actions were necessary because the water supply was safe. There were apparently low levels of VOCs in the soils and groundwater. EPA signed the only and Final Record of Decision in June 1992 with "No Further Action" as the remedial response. The site was taken off the National Priorities List in September 1999.

Mountain View Lumber (Burke Lumber)

Burke Lumber Company (formerly Mountain View Lumber) off Barton Road in Sutton (site#s 770082/98-2510), is a hazardous waste site that following investigation was determined to be eligible for a "Site Management Activity Completed" (SMAC) designation in 2001. The site is now closed. The history of this site near the Sutton River was summarized in the SMAC letter and some of that information follows here.

The site once contained a creosote dip tank that was removed in May 1990; a 10,000 gallon #2 fuel oil UST and three waste oil USTs that were removed in July 1993; two 10,000 gallon #2 fuel oil USTs that were removed in September 1998; and an old dry well that was closed in December 1999. Groundwater monitoring wells were installed following the underground oil tank removals and all sampled contaminants were below the VGES. Soil was excavated in the area of the creosote dip tank and dry well and soil samples from the excavated areas found no contaminants above soil guideline levels.

Sediment samples were taken from the adjacent Sutton River and analyzed for VOCs, SVOCs, and metals. Only silver was found at a level of concern. Silver was sampled at 1.75 mg/kg or 1750 ug/kg (ppb). The Low Effects Level (LEL) given for silver in the National Oceanic and Atmospheric Administration guidance (NOAA Squirts) is 500 ppb.

The contaminated soil and treated wood timbers at this site were properly disposed of. The 12 monitoring wells were properly closed. The site was given the SMAC status in an August 9, 2001 letter from Vermont DEC Waste Management Section.

Wastewater and other discharges

The only permitted discharges in this watershed currently are five stormwater permits. However, there are also ten construction erosion permits issued for the Sheffield Wind Project with five brooks listed as susceptible to impacts should construction occur without adequate protection.

River and Stream Assessment Summary

No stretches of river or stream on the West Branch or in its watershed have been put into the categories of stressed, altered, or impaired. There needs to be much more sampling up in this watershed in order to have some baseline information on the West Branch and its tributaries especially as the area is becoming increasingly vulnerable to impacts from second home development, gravel pits, and recreational uses.

There is also the potential for serious impacts from the clearing and construction of industrial wind machines and the roads to access them being built on, and at the top of, very steep slopes in the headwaters of the West Branch. Over 37 acres proposed for clearing and disturbance are in the West Branch watershed within the Calendar Brook subwatershed. Most of these acres are on 15 to 35% slopes (20+ acres) with some acres disturbed on 8 to 15% slopes (almost 4 acres) and some on 35 to 60% slopes (13+ acres). The other acres of disturbance that are part of this wind tower project are in the Millers Run watershed or in the Lake Memphremagog drainage.

Lakes and Ponds

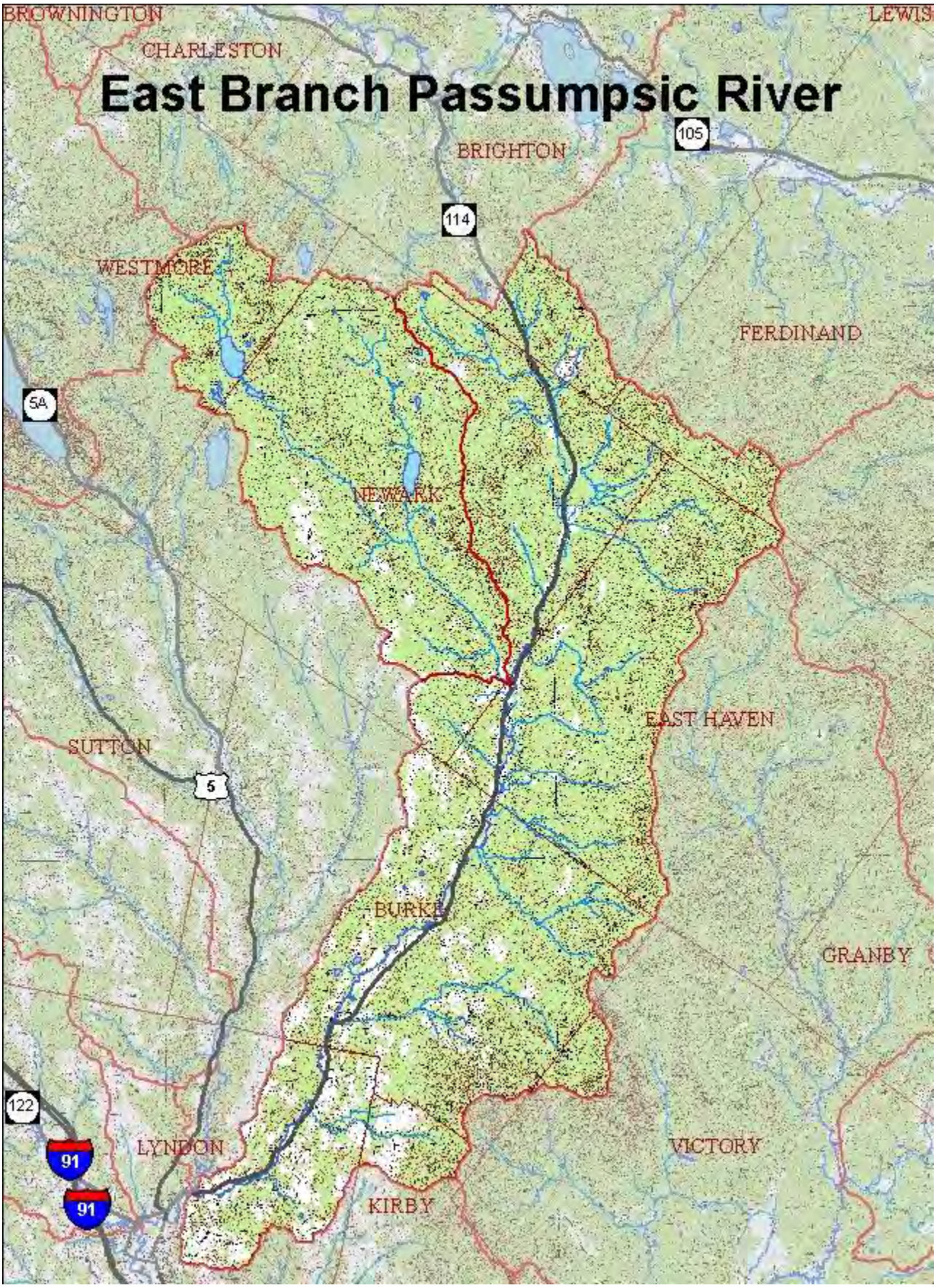
Newark Pond and Marl Pond both fully support the designated uses; South Doloff Pond also fully supports its uses but the aquatic habitat and aesthetics of this 3-acre pond are stressed by algae.

Table 13. Lakes and ponds in West Branch Passumpsic watershed

Lake or pond	Acres	Water-shed area	Town	Trophic status[1]	Pond outlet	Monitoring data[2]	Waterbody id
Newark	153	554	Newark	O	Natural	LMP, SpP	VT15-07L01
Marl	10	256	Sutton	U	unknown	none	VT15-07L02
South Doloff	3	768	Sutton	U	unknown	none	VT15-07L03

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

Newark Pond was historically a brook trout pond. There was an unauthorized introduction of yellow perch in the 1960s. In 1971, the then Fish and Game Department attempted to reclaim the pond with rotenone and restock brook trout. Yellow perch were again introduced in 1985. At some point, another unauthorized introduction resulted in the establishment of smallmouth bass.


East Branch Passumpsic River
BROWNINGTON
LEWIS
CHARLESTON
BRIGHTON
105
114
WESTMORE
FERDINAND
5A
NEWARK
EAST HAVEN
SUTTON
5
BURKE
GRANBY
122
91
91
LYNDON
VICTORY
KIRBY

East Branch Passumpsic River and tributaries

Description

The East Branch of the Passumpsic River begins in the southwest portion of Brighton and flows generally south for over 19 miles draining a 77-square-mile watershed before it meets the West Branch. A number of unnamed tributaries join the East Branch as it flows from Brighton into Newark from both the east and the west flowing from the mountainsides that are just north and south of the Brighton/Newark town line. The East Branch continues southerly through the east part of Newark with the flows of Howard and LaPawac Brook then Jack Brook joining from the east. As the river continues south-southwesterly, it is joined by a significant unnamed tributary from the west. This tributary begins to the west and north of Hawk Rock in a wetland and has a large wetland complex associated with it midway on its course to the East Branch.

As the East Branch continues its flow south, the two-mile-long Mill Brook and its tributary, King Brook, join the branch before it continues over the town border into East Haven. Just into East Haven, Bean Brook flows into the East Branch from the west.

Bean Brook is a six and a half mile long brook that drains a 22-square-mile watershed. It flows the width of the town of Newark. The watershed includes Bald Hill Pond, Sleeper Brook, Center Pond, Walker Pond, Beck Pond, Whetstone Brook, and a number of unnamed tributaries.

The East Branch continues south through the western tip of East Haven with at least four small tributaries joining between East Haven and the Burke town border. In Burke, the flow of the East Branch is more southwesterly. As the river courses towards East Burke village and the town of Lyndon, Flower Brook, off the slopes of East Haven Mountain, and Dish Mill Brook and tributaries, off the slopes of Umpire and Burke Mountains, join in. Dish Mill Brook is approximately five and a half miles long and drains a six and a half square mile watershed.

Downstream of the confluence with Dish Mill Brook, the East Branch flows into the town of Lyndon where the two and a half mile long Mountain Brook soon joins from the east. As the East Branch turns westerly and approaches Lyndonville, it meets the West Branch flowing from the north and the Passumpsic River mainstem is formed.

The East Branch of the Passumpsic River is cobble-boulder river for much of its length with clear but gold-brown tannic water. For the most part, the river is well-shaded with white cedar a significant part of the streamside forest.

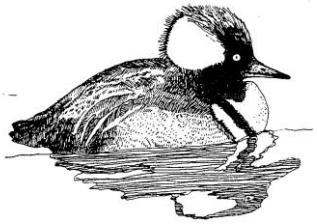
Uses, Values, Special Features and Designations

State Conservation Lands

Bald Hill Wildlife Management Area (WMA) is a 932-acre tract of land surrounding the Bald Hill Fish Culture Station. It is owned by the State of Vermont and managed by the Vermont Fish & Wildlife Department. The area is located in the middle of Vermont's Northeast Kingdom region in the towns of Newark and Westmore between the villages of West Burke and Island Pond.

During the spring and summer of 1940, the Vermont "Fish & Game Service" started development of the Bald Hill "Rearing Station" by acquiring land and water supplies in the towns of Newark and Westmore. World War II interrupted the project, however, in 1946 construction of the fish culture station began, and by 1951 it produced its first lot of 200,000 young salmon. Additional land was purchased in 1954 in order to control the outlet of Bald Hill Pond. These purchases included land from the Willoughby Lumber Company, which logged the area and operated a sawmill at Sawdust Pond prior to state acquisition. Signs of this timber operation are still evident at the site today.

The WMA is located in a high basin, with elevations ranging from 2,400 feet on the steep sides of McSherry Mountain to 1,500 feet in the southeast corner along Bean Brook. Forest cover on the hillsides is primarily sugar maple, beech, black cherry, yellow and paper birch. A dominant feature is Bald Hill Pond, a 105-acre pond that lies almost entirely within the WMA. Sawdust Pond and Brown's Pond are much smaller ponds located in and adjacent to the WMA. These ponds are the result of poor drainage caused by thick glacial deposits. Bean Brook drains these ponds southeast (towards the hatchery) through beaver ponds and gently sloping wetlands forested by red spruce, balsam fir, white cedar and alder swales.



Signs of mink, raccoon, otter, beaver and weasel may be seen along the banks of streams and ponds. Moose frequent the area in relatively low numbers and are found mainly using wetlands during the summer. Common loons occasionally nest and are frequently observed fishing on Bald Hill Pond. Great blue herons, black ducks, common and hooded mergansers use the wetlands.

Boating

There are 11 miles of whitewater boating on the East Branch from East Haven down to the confluence with the West Branch described in the Whitewater River of Vermont report and partly in the AMC River Guide. It is mostly Class I and II whitewater but just below the East Burke dam, which has to be portaged, is a Class II to III rapid.

Sampling Results and Assessment Information

Biological Monitoring

The macroinvertebrate communities at five sites were sampled on eight occasions in the last ten years on the East Branch of the Passumpsic River. Dish Mill Brook was sampled at two sites on three occasions and Dish Mill Brook Tributary was sampled at one site in two different years.

Rivermile (rm) 1.7 on the East Branch is next to Burrington Bridge, a covered bridge over the river; rivermile 3.8 is located below the confluence of Dish Mill Brook just south of East Burke and behind the firehouse; rivermile 5.3 is located above the Duck Pond tributary and below the Burke Mountain ski area leach field; rivermile 5.7 is located just above the Burke Mountain ski area leach field; and rivermile 8.9 is located below the East Haven WWTF about 50 meters.

Table 14. Macroinvertebrate Sampling Sites and Results – East Branch Passumpsic River

Wbid	River or Stream	Town	Station (by rivermile)	Date	Assessment
VT15-08	East Branch Passumpsic River	Lyndon	1.7	9/23/2004	Vg-Good
VT15-08	East Branch Passumpsic River	Burke	3.8	9/07/2005	Excellent
VT15-08	East Branch Passumpsic River	Burke	5.3	8/03/2001	Vg-Good
VT15-08	East Branch Passumpsic River	Burke	5.3	10/03/2005	Excellent
VT15-08	East Branch Passumpsic River	Burke	5.3	9/23/2007	Very good
VT15-08	East Branch Passumpsic River	Burke	5.7	9/10/2001	Vg-Good
VT15-08	East Branch Passumpsic River	Burke	5.7	9/23/2007	Vg-Good
VT15-08	East Branch Passumpsic River	East Haven	8.9	10/03/2005	Excellent
VT15-08	Dish Mill Brook	Burke	0.8	9/07/2006	Good-Fair
VT15-08	Dish Mill Brook	Burke	1.3	9/07/2005	Good-Fair
VT15-08	Dish Mill Brook	Burke	1.3	9/07/2006	Good-Fair
VT15-08	Dish Mill Brook Trib	Burke	0.1	9/07/2005	Fair
VT15-08	Dish Mill Brook Trib	Burke	0.1	9/07/2006	Good

Dish Mill Brook and the tributary to Dish Mill Brook have been noted in the water quality stream assessment database since 1988 when construction at Burke threatened Dish Mill Brook and sand embeddedness affected the tributary to Dish Mill along Burke Mountain Access Road. During this time, Dish Mill Brook and to a greater extent, Dish Mill Brook tributary, were degraded with low abundance and altered functional group composition in the macroinvertebrate community. Monitoring will continue due to new threats from development in this watershed. Dishmill Brook rm 0.8 is located 50 meters below the first

Burke Mountain Access Road bridge and rm 1.3 is located several hundred meters above the third access road bridge. The tributary site rm 0.1 is located about 50 meters below the access road.

Vermont DF&W game fishery sampling and stocking

In the East Branch subwatershed, the Vermont Department of Fish and Wildlife has sampled Jack Brook, Bean Brook, and the East Branch itself as well as several ponds. Jack Brook, last sampled in 1994, had wild brook trout present. Bean Brook sampled in 2008 had wild brook trout as well and it is stocked with Atlantic salmon fry. The East Branch also last sampled in 2008, has wild brook trout from Jack Brook upstream to its headwaters. It is stocked with Atlantic salmon fry, brook trout, and brown trout.

The ponds sampled include Brown Pond, Bald Hill Pond, Beck Pond, and Center Pond. Brown Pond was last sampled many years ago in 1971 but is stocked with brook trout. Beck Pond is also stocked with brook trout. Bald Hill Pond is stocked with rainbow trout and has pumkinseed and a few wild brook trout present. Center Pond, last sampled in 2006, is stocked with brook trout and lake trout and its fishery population includes rock bass and pumpkinseed.

Hazardous Waste Sites

Burke View Garage

Concerns about potential water quality impacts to the East Branch from Burke View Garage were in past waterbody reports from the late 1980s and early 1990s. In July 1996, a "Site Inspection Prioritization" (SIP) field visit was done by the Roy F. Weston Superfund Technical Assessment and Response Team for EPA. Their report on the site is dated April 30, 1997. A letter from the Vermont DEC Waste Management Division was written in September 1997 noting closure of the site based on results from several investigations.

Burke View Garage was originally investigated as the Vermont Department of Health tried to find the source of VOCs in the Lyndonville municipal well system that is downgradient. As noted below, no VOCs were found associated with Burke View Garage but in the late 1980s, the same VOCs that were found in the Lyndonville water supply were found in high concentrations in the soils and groundwater of the upgradient Darling Hill Dump.

A brief summary of the site follows using information from the above-mentioned report and letter as well as a memorandum from the Burke View Garage site file. Burke View Garage has had an auto repair garage there since 1957. It had a gasoline station as well from 1965 to 1974 but then the property was vacant from 1974 to 1980. The auto repair business re-opened in 1981. The gas station portion remained closed and the gasoline underground storage tanks were removed in 1994. Past and present waste that has been onsite includes antifreeze, degreasers, waste motor oils, scrap tires, auto-related debris. Under the Superfund process, EPA did a Preliminary Assessment in 1986, a Supplemental Site Investigation (SSI) in 1991, and a SIP in 1997 (no sampling). The SSI included soil sampling and a drinking water sample. The samples were analyzed for VOCs, SVOCs, pesticides/PCB, and priority pollutant metals. Lead and arsenic were the only pollutants found in the soils above the soil reference samples but the amounts were below Vermont Department of Health and EPA standards. Metals were detected in the drinking water sample but below thresholds of concern.

The small quantities of hazardous waste generated by the auto repair shop as a part of its business are contained properly and are transported offsite by certified waste haulers. No contamination was found when the underground gasoline storage tanks were removed and the tanks were in good condition at the time of removal.

River and Stream Assessment Summary

Stressed Miles

Dishmill Brook: 1.3 miles - from mouth upstream - aquatic biota/habitat stressed due to hydrologic scour and some sedimentation from ski area development and roads.

Dish Mill Brook, Tributary: 0.1 miles - from mouth upstream (along Burke Mtn Access Road) - aquatic biota/habitat stressed due to habitat degradation from a high sand bedload causing most of the substrate to be embedded.

Many miles of the East Branch of the Passumpsic have documented good-very good to excellent macroinvertebrate communities indicating very healthy water quality and aquatic habitat (see Table 14 above for the sites).

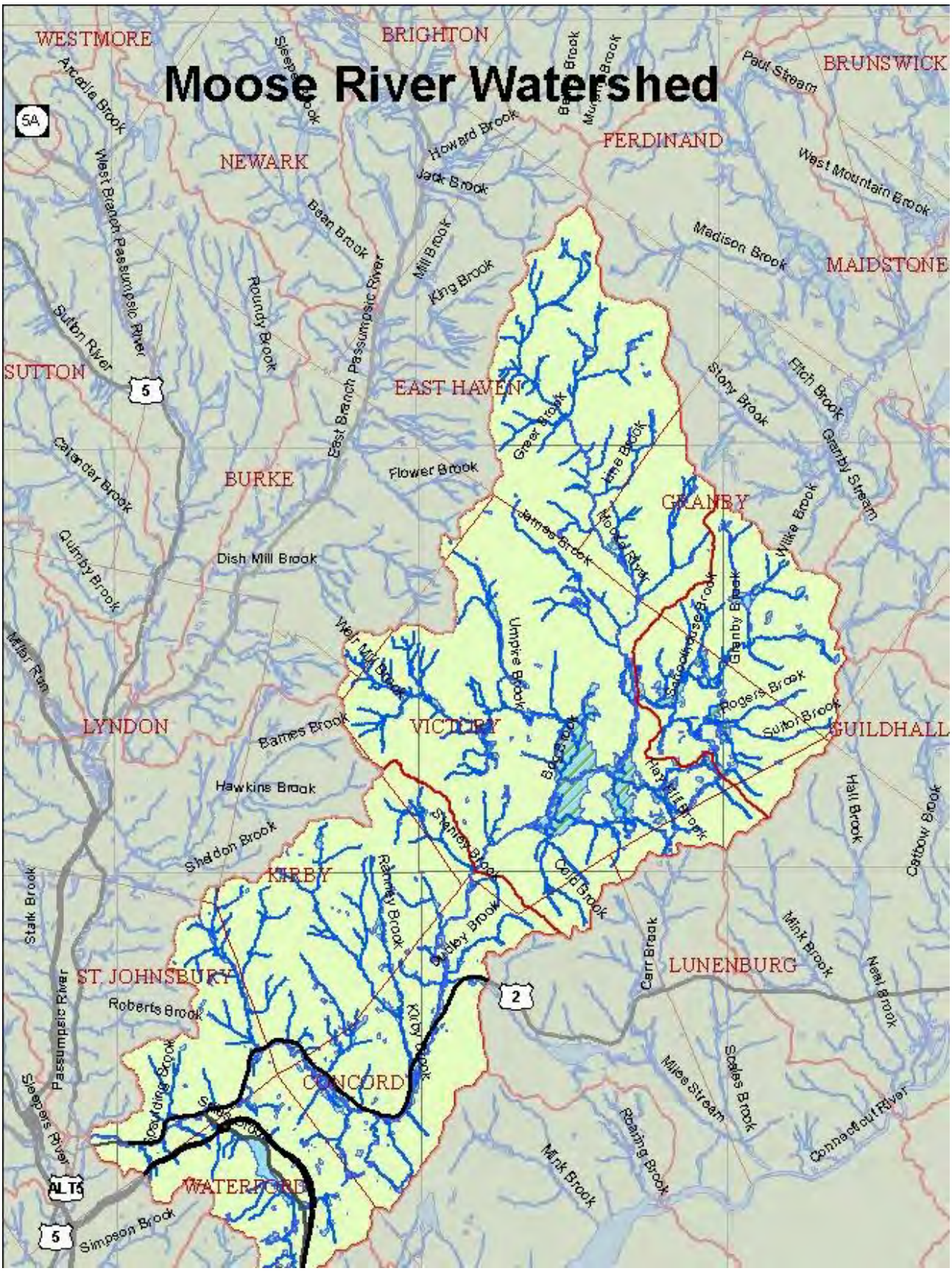
Lakes and Ponds

Table 15. Lakes and ponds of East Branch Passumpsic watershed

Lake or pond	Acres	Water-shed area	Town	Trophic status[1]	Type of pond outlet	Monitoring data[2]	Waterbody id
Bald Hill	108	2,588	Westmore	O	natural	SpP	VT15-08L01
Sawdust	15	2,751	Newark	U	unknown	none	VT15-08L02
Center	79	3,793	Newark	O	unknown	SpP	VT15-08L03
Brown	15	254	Westmore	U	unknown	none	VT15-08L04
Walker	3	45	Newark	U	unknown	none	VT15-08L05
Beck	6	294	Newark	U	unknown	none	VT15-08L06
Duck	4	32	Burke	U	unknown	none	VT15-08L07

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

The uses and values of the 108-acre Bald Hill Pond and the 15-acre Brown Pond both in Westmore are fully supported. Except for Duck Pond in Burke where there is insufficient information to assess the uses of the pond, the other four ponds in the table above also fully support the uses but have some acres of one or more uses that are stressed by a pollutant or condition. Aquatic biota/habitat, swimming, boating and/or fishing, and aesthetics are stressed on the 15 acres of Sawdust Pond in Newark by sedimentation. These four uses are also stressed on ten acres of the 79-acre Center Pond again because of sedimentation. On 6-acre Beck Pond, aquatic biota/habitat are fully supported but stressed by sedimentation and in the 3-acre Walker Pond, aquatic biota/habitat is stressed by sedimentation in about one acre.


Moose River Watershed
WESTMORE
BRIGHTON
BRUNSWICK
FERDINAND
NEWARK
MAIDSTONE
SUTTON
EAST HAVEN
BURKE
GRANBY
LYNDON
VICTORY
GUILDHALL
KIRBY
ST JOHNSBURY
LUNENBURG
CONCORD
WATERFORD
Arcadia Brook
Sleepers Brook
Howard Brook
Bean Brook
Mun Brook
Paul Stream
West Mountain Brook
Jack Brook
West Branch Passumpsic River
Bean Brook
Mill Brook
King Brook
Madison Brook
Roundy Brook
East Branch Passumpsic River
Sutton River
Stony Brook
Fitch Brook
Granby Stream
Calendar Brook
Flower Brook
Greer Brook
Lime Brook
James Brook
Moose River
Willke Brook
Quimby Brook
Dish Mill Brook
Weir Mill Brook
Umpire Brook
Granby Brook
Rogers Brook
Miller Run
Barnes Brook
Sutton Brook
Hawkins Brook
Bdg Brook
Hay Mill Brook
Hall Brook
Catbow Brook
Sheldon Brook
Stanley Brook
Ramsey Brook
Cole Brook
Stark Brook
Quigley Brook
Carr Brook
Mink Brook
Neal Brook
Roberts Brook
Kelly Brook
Passumpsic River
Sleepers River
Cowdine Brook
Milne Stream
Scales Brook
Connecticut River
Robins Brook
Mink Brook
Simpson Brook
54
5
2
ALT5

Moose River and tributaries

Description

The Moose River is the longest Passumpsic River tributary at approximately 30 miles in length from its mouth up to the junction of the East and West Branches. It drains a 126 square mile watershed, which is a quarter of the whole Passumpsic River watershed. The northern half of the watershed is largely forested and relatively wild. This portion of the watershed also includes the Victory Basin Wildlife Management Area, an ecologically spectacular area. The lowest and western portion of the watershed has a different character then the portion up in East Haven, Granby, Victory, and Kirby. At North Concord where the Moose River encounters Route 2 and below, the river valley contains roads, railroads, gravel pits, industry, rural and urban development.

The East and West Branches of the Moose River begin up on the forested slopes of the mountains in East Haven. From their respective origins, each branch has a westerly and southerly flows and then join to form the Moose River.

Uses, Values, Special Features and Designations

Natural Communities

There are two wetland sites of special significance in the Moose River watershed that are described in the Essex County Natural Areas Inventory (1990). The Umpire Brook Wetlands site consists of a large, diverse wetland complex that includes a mature white cedar swamp with some cedars up to 18 inches diameter. Other wetland communities that are part of the complex include shrub swamp and sedge marsh. There are also calcareous seeps and calcium-loving plants in this wetland area surrounding Umpire Brook.

The other described briefly is a 220-acre area of Victory Basin, which includes the 35-acre Victory Bog. Victory Basin includes not only the bog, which is one of the best examples of a lowland bog in the state, but also shrub swamp, sedge meadow, and stands of black spruce, which are home to a number of boreal bird species.

State Conservation Land

The Victory Basin is part of the Victory Bog Wildlife Management Area now - a 4,970-acre wetland and forest complex owned by the State of Vermont and managed by the Vermont Fish & Wildlife Department. The property is located 15 miles northeast of St. Johnsbury in the town of Victory. Access areas are located along Victory Road, a dirt road that bisects the WMA and follows the Moose River from North Concord to Gallup Mills.

Prior to State acquisition, the basin was the focus of important logging and lumbering activity that spanned the period from 1810 to 1948. Early attempts to farm the basin's shallow, rocky soil following lumbering soon failed and the area reverted to forest. Victory Basin WMA was acquired from the New England Power Company in 1969, ending a long debate over the U.S. Army Corps of Engineers' plan to construct a dam on the Moose River. The dam would have flooded the entire basin, and was strongly opposed by State and local conservation groups who were concerned about the loss of such a large deer wintering area and unique wetland complex.

This WMA hosts a variety of habitat types, all within close proximity to each other. Within the heart of Victory Basin lies a 20-acre, broad-leaved, evergreen scrub-shrub community classified as a "boreal bog". Small stands of black spruce are scattered across the lowest elevations, growing on lush S*phagnum* moss beds. Extensive stands of red spruce and balsam fir surround these wetland sites on slightly higher elevations, providing critical wintering habitat for white-tailed deer. The Moose River's meandering floodplain is dotted by alder swales, black cherry "islands" and sedge meadows. The hills surrounding the basin are dominated by yellow birch- beech-sugar maple forest typical of the region.

Active and inactive beaver flowages create valuable wetland habitat for a variety of wildlife including muskrat, mink, otter and raccoon. After hibernating, hungry black bear find early spring foods available in the wetlands. Moose are common, as the diverse wetlands and uplands are ideal habitats for them. Beaver ponds provide feeding grounds for great blue herons and bitterns, and nesting habitat for wood, black and mallard ducks, and hooded and common mergansers. Woodcock feed in the alder swales and breed in old fields and openings along the Moose River. Forest management activities compliment the natural ruffed grouse habitat on the floodplain.

The tremendous diversity of uplands and wetlands may provide habitats for many reptiles and amphibians including northern spring, red-backed and spotted salamanders and eastern newt. Snapping and painted turtles may be found near open water. Ring-necked and red-bellied snakes may be found. Frogs species may include mink, green, pickerel, wood, leopard, gray tree and bull frogs, spring peeper and American toad. The section of the Moose River upstream of Rogers Brook provides the best habitat for brook trout.

Boating

There is a 21-22 or 15-16 mile stretch of whitewater boating on the Moose River depending on whether the starting point is south of Gallup Mills as described in the AMC River guide or at the snowmobile bridge below Victory Bog as described in Whitewater Rivers of Vermont. There is Class II, III, and IV rapids throughout and the three mile stretch just below Victory Bog is rated one of the two wildest whitewater segments in the state.

River Sampling Results and Assessment Information

Biological Monitoring

The macroinvertebrate sampling sites on the Moose River include: rivermile 14.3, which is above the first bridge upstream from North Concord; rm 3.9, which is located below the Route 2 bridge west of East St Johnsbury (below Phelps Enterpises, which is above bridge); and rm 0.1, which is just above the confluence with the Passumpsic off Concord Avenue above the bridge. One site on Stiles Brook, a tributary to the Moose River, is sampled near its mouth. These sites are summarized in a table below.

The fish community was sampled on Chesterfield Valley Brook in St. Johnsbury in September 2007 at rivermile 0.1 and was in “excellent” condition.

The native crayfish, *Cambarus bartoni*, was found in Chesterfield Valley Brook and is the brook is the first stream in the Connecticut River basin found with this species.

Table 16. Macroinvertebrate Sampling Sites and Results – Moose River

Wbid	River or Stream	Town	Station	Date	Assessment
VT15-09	Moose River	St. Johnsbury	0.1	9/21/2000	Very good
VT15-09	Moose River	St. Johnsbury	0.1	9/06/2005	Very good
VT15-09	Moose River	St. Johnsbury	1.7	9/06/2005	Very good
VT15-09	Moose River	St. Johnsbury	3.9	9/22/2004	Exc-Vgood
VT15-09	Moose River	Concord	14.3	9/04/1997	Excellent
VT15-09	Moose River	Concord	14.3	9/07/1999	Good
VT15-09	Stiles Brook	St. Johnsbury	0.1	9/08/2005	Exc-Very good

Vermont DF&W game fishery sampling and stocking

The Moose River upstream of St. Johnsbury village was sampled in 2008 and wild salmonids are are in this stretch. The river here is stocked with Atlandtic salmon fry and brown trout. Kirby Brook, last sampled in 2000, has wild brook trout present and is stocked with brook trout. Weir Mill Brook and Rogers Brook were both sampled last in 1985. Wier Mill Brook has wild brook trout whereas wild trout are rare in Rogers Brook.

Cow Mountain Pond was last sampled in 2007 and this pond has a wild brook trout population.

E. coli Concerns

The failing septic sytems and/or straight pipes in East St. Johnsbury that have had an impact on the Moose River have been corrected. An onsite solution (versus a sewer line to St. Johnsbury) was chosen. The construction of the East St Johnsbury individual replacement wastewater disposal systems project is now complete. The impaired status on a mile of the Moose River was removed in 2005, however, follow-up *E. coli* and other sampling done by DEC found that *E. coli* numbers were still above standard in the Moose. The source is potentially on Chesterfield Valley Brook, a tributary to the Moose River. Stretches of river were added back into the database as being stressed for the time being.

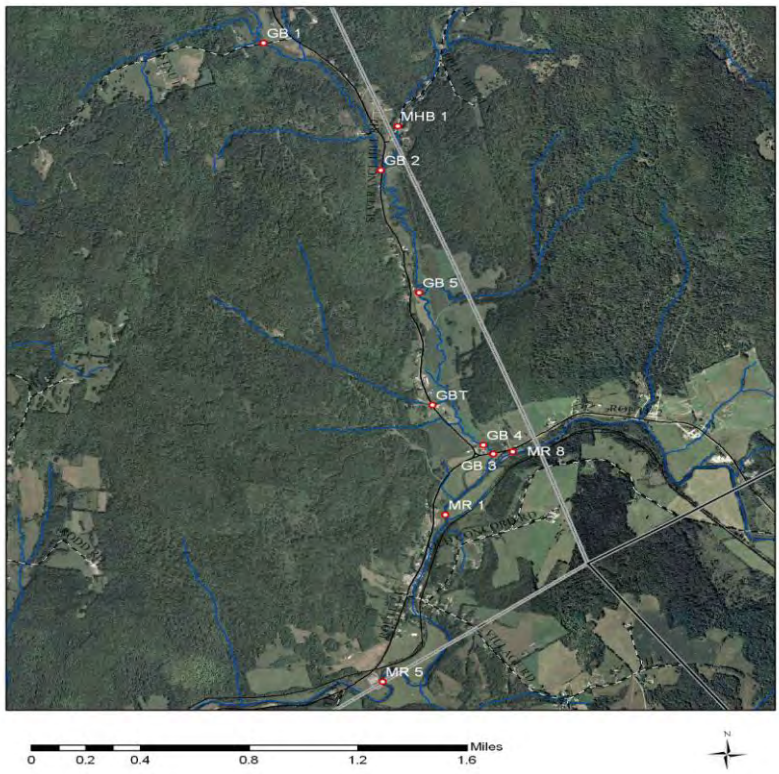
Five sites on the Moose River in East St. Johnsbury were sampled for *E. coli* and conductivity on either 5 or 6 different dates from June until September 2006. The geometric means (gm) of the sites ranged from 288 to 318 mpn/100 ml. Three additional sites were sampled on the Moose River but upstream between Concord and East St. Johnsbury on three days in 2006. Four sites were sampled just once on Chesterfield Valley Brook, a tributary to the Moose River. There was a substantial increase in *E. coli* levels in the Moose from above to below the Chesterfield Valley Brook confluence with the Moose hence the addition of 4 sites on Chesterfield Valley Brook on the last sampling date for the season, which occurred in September. The lowest site on Chesterfield Valley Brook had an *E. coli* count of 1425 on that one sample day lending credence to the possibility that this brook is at least part of the source of the elevated *E coli* levels in the Moose River.

In 2008, *E. coli* samples were collected at three sites on the Moose River and at four sites on Chesterfield Valley Brook and a tributary on five sampling days. In addition, three other

sites in the Chesterfield Valley Brook watershed were sampled on three sampling days. As a result of this second season of sampling, three sites on the Moose River and three sites on Chesterfield Valley Brook now have data from two seasons although the sampling on Chesterfield Valley Brook in 2006 were single samples.

The uppermost site on the Moose River (above the mouth of Chesterfield Valley Brook), MR8, had *E. coli* geometric means barely above the 77 *E. coli*/100 ml. standard: 78 gm in 2006 and 93 gm in 2008. The two Moose River sampling sites downstream of Chesterfield Valley Brook, MR1 and MR5 had higher geometric means with MR1 having a gm of 292 in 2006 and 218 in 2008 and MR5 having a gm of 262 in 2006 and 141 in 2008.

The sampling site at the mouth of Chesterfield Valley Brook had very high *E. coli* numbers with a single sample in 2006 of 1425 *E. coli*/100 ml and a geometric mean of 5 samples in 2008 of 650. Two upper sites on Chesterfield Valley Brook, above a farm and its barnyard that sits along the brook, had low means with GB1 with a single sample reading of 29 in 2006 and gm of 35 (3 samples) in 2008 and GB2 with a single sample reading of 29 in 2006 and a gm (also 3 samples) of 15. Chesterfield Valley Brook is very likely the source of elevated *E. coli* in the Moose River downstream of its mouth. And the farm on Chesterfield Valley Brook is likely the specific source of the *E. coli* given the numbers above and below. A liquid manure storage pit was built on the Chesterfield Valley Brook farm in mid-September 2008 and there were drops in the *E. coli* numbers from late August and early September on Chesterfield Valley Brook through mid-September to early October. A few more samples next season on Chesterfield Valley Brook below the farm would provide very useful information as to whether the farm was the primary contributor to the high *E. coli* numbers and whether the manure storage pit has helped the situation.



Hazardous Waste Sites

Rod's Mobil

Rod's Mobil in St. Johnsbury (site # 97-2172) is a hazardous waste site as a result of contamination discovered during the removal of two permitted 3000 gallon underground gasoline storage tanks and one unpermitted 1000 gallon underground tank in April 1997. Further investigation found that volatile organic compounds had come from the site and under Route 2 to the Moose River. An Initial Site Investigation was performed in February 2004 and a Supplemental Site Investigation occurred in October 2004. This latter investigation found "groundwater contamination at concentrations above VGES was confirmed immediately adjacent to the Moose River and visual and olfactory observations suggested petroleum impacted groundwater was discharging to the river." Remediation is ongoing at this site with a "high intensity targeted multiphase extraction" to remove free phase contamination from the source area and "air sparging together with soil vapor extraction to remediate dissolved and adsorbed phase contamination at the Site." Sampling done in August 2008 found that BTEX increased since the previous sampling event in two of the 14 monitoring wells including in MW-7R adjacent to the Moose River.

Colt Industries

The former Colt Industries hazardous waste site (site # 77-0078) is located on Route 2 near the Moose River in St. Johnsbury. Colt Industries purchased the scale manufacturing operation from the Fairbanks Morse Company in 1959 and at that time, the buildings were located at the Fairbanks Morse Foundry property on the Sleepers River. In 1967, Colt Industries moved the scale manufacturing operation to the Route 2 property. In 1988, the property was purchased by the current owner Fairbanks Scales.

Manufacturing on the site involved metal plating and painting with process wastewater, waterfall paint booth overflows, and cooling water put into a lagoon and then discharged into the Moose River. Metals in the plating wastewater included nickel, zinc, chromium, aluminum, iron, copper, and mercury as well as cyanide. After 1971, the discharge into the Moose River was regulated by an NPDES permit and in June 1971, the lagoon was dredged for the only time for which there is a record. Between 1967 and 1975, the only treatment of the waste stream was solids settling in the lagoon. In 1975, a system to precipitate the metals prior to discharge into the lagoon was installed. Sometime before spring 1981, the lagoon ceased to improve the effluent quality and in spring 1981, the lagoon was filled in with gravel. The sludge in the lagoon at that time was not removed.

Six sediment samples were collected from the Moose River in the area of Colt Properties in December 1994: one site upstream of the lagoon area, three sites near the Colt Property, and two sites farther downstream. Mercury was detected at SD-02, calcium was found at SD-03, and lead was found at SD-06. Lead was not detected in any of the source samples but calcium and mercury were. Vermont DEC took four sediment samples to analyze again for mercury in June 1995 due to concerns with the quality of the lab results the year before and the question of mercury contamination in the river. The DEC laboratory did not find mercury above the analytical detection limit of 0.1 mg/kg.

EPA finished an investigation into the Colt Industries site and entered a "No Further Remedial Action Planned" status into the Comprehensive Environmental Response, Compensation and Liability System. Groundwater was sampled in June and in August

1996 and only acetone was above analytical detection limit in the June samples and no VOCs were above the limit in the August samples. Zinc was the only inorganic found in both events and the levels were below the Vermont Groundwater Enforcement Standards. For these reasons, the Vermont DEC Waste Management Division Sites Management Section decided a "SMAC" or Site Management Activity Completed status was warranted for the site. A letter to that effect was sent to Fairbanks Scale on December 18, 1996.

River Assessment Summary

Stressed Miles

Moose River: 5.2 - from Chesterfield Valley Brook to mouth - contact recreation stressed due to elevated levels of *E. coli* likely from barnyard and other agricultural runoff.

Chesterfield Valley Brook: 0.5 - from farm along the brook to mouth - contact recreation stressed due to elevated levels of E. coli likely from barnyard and other agricultural runoff.

Lakes and Ponds

Mud Pond in Granby is 55 acres in size and its four designated uses are fully supported. Cow Mountain Pond also in Granby fully supports all its uses but aquatic biota and/or habitat is considered stressed in its ten acres by acidity/low pH. Johnson Pond in Kirby also has all uses fully supported but aquatic biota and/or habitat stressed in its seven acres also by acidity/low pH. All of the uses on eight of the ten acres of Kirby Pond are fully supported but stressed by sedimentation.

Stiles Pond in Waterford is a public water supply so the uses of swimming, boating, and fishing are not applicable to this pond. The uses of public water supply, aquatic biota and/or habitat, and aesthetics are all fully supported but aquatic biota/habitat is considered stressed on both segments of this lake by low dissolved oxygen.

There is insufficient information about Duck Pond in Waterford and Mud Pond in East Haven to really assess the uses on these bodies of water.

Table 17. Lakes and ponds in the Moose River watershed

Lake or pond	Acres	Water-shed area	Town	Trophic status[1]	Pond outlet	Monitor-ing data	Waterbody id
Mud Pond	55	2,128	Granby	U	natural	SpP	VT15-09L01
Cow Mtn Pond	10	128	Granby	M	natural	LAP	VT15-09L02
Johnson	7	691	Johnson	U	unknown	none	VT15-09L03
Stiles Pond	135	3,884	Waterford	U	natural w/ art. control	none	VT15-09L04
Kirby	10	326	Kirby	U	unknown	none	VT15-09L05
Duck Pond	16	215	Waterford	U	natural	none	VT15-09L06
Mud Pond	5	45	East Haven	U	unknown	none	VT15-09L07

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

References

1) *AMC River Guide*: New Hampshire-Vermont, 3rd edition, 2002. Appalachian Mountain Club, Boston, Massachusetts.

2) *E. coli Monitoring on the Moose River in East St. Johnsbury, Vermont* Draft Report, December 15, 2008. Vermont Agency of Natural Resources, Department of Environmental Conservation, Water Quality Division.

3) *Exceptional Natural Habitats and Rare Plant and Animal Species of Essex County, Vermont*, March 1990. Nongame and Natural Heritage Program, Vermont Department of Fish and Wildlife, Agency of Natural Resources, Waterbury, Vermont.

4) *Northern White Cedar Swamps and Red Maple-Northern White Cedar Swamps of Vermont: Some Sites of Ecological Significance*, August 1998. Eric Sorenson, Brett Engstrom, Marc Lapin, Robert Popp, and Steve Parren for Nongame and Natural Heritage Program, Vermont Department of Fish and Wildlife, Agency of Natural Resources, Waterbury, Vermont.

5) *Passumpsic River Canoeing and Recreation Guide*, 1996. Revised 1999. Edited and designed by Alay Boye (1996) with revisions by High Henry and Jack Crowther (1999). Produced by Central Vermont Public Service.

6) *Passumpsic River Watershed Preliminary Comprehensive River Plan: An Inventory of Uses, Values & Goals*, August 1991. Vermont Department of Environmental Conservation, Water Quality Division, Waterbury, Vermont.

7) Vermont Dam Inventory database, May 2008. 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) Vermont Indicators Online, http://maps.vcgi.org/indicators/profiles.cfm, Vermont Center for Geographic Information and the UVM Center for Rural Studies, last updated 2006.

10) *Vermont Swimming Hole Study*, 1992, Jerry Jenkins, Deborah Benjamin, and Jane Dorney for Vermont DEC, Water Quality Division.

11) *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.

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

Appendix A: Population and Housing Data

Population Data for Watershed Towns

Table A.1. Population Data from Passumpsic Watershed Towns

Town	1970 Pop	1980 Pop	1990 Pop	2000 Pop	% change 70-80	% change 80-90	% change 1990-2000
Barnet*	1342	1338	1415	1690	-3	6	19
Burke	1053	1385	1406	1571	32	1.5	12
Concord*	896	1125	1093	1196	25	-3	9
Danville	1405	1705	1917	2211	21	12	15
East Haven	197	280	269	301	42	-4	12
Granby*	52	70	85	86	35	21	1
Kirby	224	282	347	456	26	23	31
Lyndon	3705	4924	5371	5448	33	9	1
Newark	144	280	354	470	94	26	33
Saint Johnsbury	8409	7938	7608	7571	-6	-4	0.5
Sheffield	307	435	541	727	29	28	34
Sutton	438	667	854	1001	52	28	17
Victory	42	56	50	97	33	-11	94
Walden*	442	575	703	782	30	22	11
Waterford*	586	882	1190	1104	50	35	-7
Wheelock	238	444	481	621	86	8	29

* Approximately half of the town or less by land area is in the watershed

Housing Data for Watershed Towns

Table A.2. Housing Data from Passumpsic Watershed Towns

Town	1980 HUnits	1990 Hunits	2000 HUnits	% change 1980-1990	% change 1990-2000
Barnet*	732	812	831	11	2
Burke	616	805	892	31	11
Concord*	616	688	764	12	11
Danville	898	1087	1152	21	6
East Haven	122	141	173	16	23
Granby*	47	66	78	40	18
Kirby	113	162	207	43	28
Lyndon	1753	2080	2190	19	5
Newark	252	382	449	52	18
Saint Johnsbury	3377	3487	3482	3	0
Sheffield	178	271	399	52	47
Sutton	303	370	439	22	23
Victory	63	72	90	14	25
Walden*	323	433	499	34	15
Waterford*	324	426	477	31	12
Wheelock	175	253	321	45	27

Appendix B: Dams in the Passumpsic River Watershed

Table B.1. Dams in the Passumpsic River Watershed

Dam Name	Stream	Town	Status	Use *	Built	Re-con+	State ID
Roy Bros Mfg Co (East Barnet)	Passumpsic R.	Barnet	In Service	H			12.04
Passumpsic	Passumpsic R	Barnet	In Service	H	1929		12.03
Gage	Passumpsic R	St. Johnsbury	In Service	H	1928		179.03
Bay Street	Passumpsic R	St. Johnsbury					179.02
Arnold Falls	Passumpsic R.	St. Johnsbury	In Service	H		1977	179.01
Pierce Mills	Passumpsic R.	St. Johnsbury	In Service	H	1928		179.12
Great Falls	Passumpsic R.	Lyndon	In Service	H	1892		119.02
Vail	Passumpsic R.	Lyndon	In Service	H	1910		119.03
Ice Pond	Passumpsic R.	St. Johnsbury					179.10
St. Johnsbury Center	Passumpsic R.	St. Johnsbury	Breached				179.11
Tinkers Pond	Tributary Rake Factory Brook	Peacham			1908		151.05
Barnet - 7	Joes Brook	Barnet					12.07
West Danville No 15	Joes Brook	Danville	In Service	HR	1916	1961	58.02
Morses Mill	Joes Brook	Danville					58.05
Daniel	Joes Brook	Danville					58.06
Danville-7	Joes Brook	Danville					58.07
Danville-8	Joes Brook	Danville					58.08
Danville-9	Joes Brook	Danville					58.09
Danville-1	Joes Pond Trib	Danville					58.01
Danville Reservoir	Brown Brook (trib to Joes Brk)	Danville					58.03
Keiser Pond	Sawyer Brook (trib to Joes Brk)	Danville	In Service	R	1964		58.04
Goslants Mill	Steam Mill Brook	Walden	Partially Breached	O	1875		218.02
Fairbanks Scale Co	Sleepers River	St. Johnsbury					179.13

Dam Name	Stream	Town	Status	Use *	Built	Re-con+	State ID
U.S. Fish Hatchery	Sleepers River	St. Johnsbury	In Service	H	1900	1990	179.14
St. Johnsbury-15	Sleepers River	St. Johnsbury					179.15
Fairbanks Morse	Sleepers River	Danville	Breached		1956		58.10
Crow Hill (Lower)	Sleepers River Trib	St. Johnsbury					179.04
Crow Hill (Upper)	Sleepers River Trib	St. Johnsbury					179.05
American Fork and Hoe	Moose River	St. Johnsbury					179.06
Davies and Manton-Graylin	Moose River	St. Johnsbury					179.07
East St. Johnsbury	Moose River	St. Johnsbury	Breached				179.08
Smith Granite Co	Moose River	Concord					52.02
Lee	Moose River	Concord					52.03
Stanley Brook	Stanley Brook	Victory					216.01
Wilder Mill	Bog Brook	Victory					216.02
Stiles Pond	Stiles Brook	Waterford	In Service	S	1877	1991	227.01
Waterford-6	Tributary Stiles Brook	Waterford					227.06
Grays Pond	Tributary Passumpsic R	Lyndon					119.15
Institute Pond	Tributary Passumpsic R	Lyndon	In Service	O	1911	1913	119.01
Lyndon State College (Lower)	Tributary Passumpsic R	Lyndon	Breached				119.05
Lyndon State College (Middle)	Tributary Passumpsic R	Lyndon	In Service	R			119.06
Lyndon State College (Upper)	Tributary Passumpsic R	Lyndon	In Service	R	1950		119.07
Fay Young Reservoir	Squabble Hollow Brook	Lyndon	In Service				119.04
Ice Pond (Upper)	Tributary Miller Run	Lyndon					119.09
Ice Pond (Lower)	Tributary Miller Run	Lyndon					119.10
Buckley	Miller Run	Wheelock					241.02
Weed	Miller Run	Wheelock					241.03
Sheffield	Miller Run	Sheffield					185.01
Coe Brothers	West Branch Passumpsic R	Burke	Breached				37.02

Dam Name	Stream	Town	Status	Use *	Built	Re-con+	State ID
Browns Mill	West Branch Passumpsic R	Burke	Breached				37.03
Lucien (Lower)	West Branch Passumpsic R	Burke					37.04
Lucien (Upper)	West Branch Passumpsic R	Sutton					204.02
Burke - 7	Roundy Brook (trib to West Branch)	Burke					37.07
East Burke (Lumber Co)	East Branch Passumpsic R	Burke					37.01
Lyndon-14	East Branch Passumpsic R	Lyndon	Breached				119.14
Bean Brook (Lower)	Bean Brook	Newark					137.03
Bean Brook (Upper)	Bean Brook	Newark					137.02
Center Pond	Sleeper Brook	Newark					137.01
Donaldson Mill (Upper)	Sleeper Brook	Newark					137.04
Donaldson Mill (Lower)	Sleeper Brook	Newark					137.05
Sleeper Brook	Sleeper Brook	Newark					137.06
Chandler Pond	Tributary South Wheelock Branch	Wheelock	In Service				241.01
Whitcomb Mill	South Wheelock Branch	Lyndon					119.12
Lyndon-13	South Wheelock Branch	Lyndon					119.13
Woodworth Reservoir	Tributary South Wheelock Branch	Lyndon					119.08

*H = hydroelectric, R = recreation, C = flood control, S= water supply, O = other, blank = unknown
+ date re-constructed