Basin 11

West, Williams, and Saxtons Rivers Watersheds Water Quality and Aquatic Habitat Assessment Report

Agency of Natural Resources
Department of Environmental Conservation
Water Quality Division

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Contents

Basin 11 - The West, Williams, and Saxtons Rivers Watersheds

The Basin 11 planning unit includes three watersheds: the West, Williams, and Saxtons Rivers watersheds. Basin 11 is located in the southeastern corner of Vermont and drains the eastern slope of the Green Mountains. It covers approximately 395,520 acres. The rivers and their tributaries flow down from the mountains through the foothills and across the Vermont Piedmont to the Connecticut River Valley where they join the Connecticut River. The Williams River joins the Connecticut River in Rockingham, the Saxtons River joins the Connecticut River in Bellows Falls, and the West River joins it in Brattleboro.

The West, Williams, and Saxton's River Basins are characterized by having relatively few lakes. There are 49 lakes and ponds in the three basins, comprising 1,030 known acres.

Most of Basin 11 lies within Windham County although portions are also within Windsor and Bennington Counties and a very small portion is in Rutland County. The basin is part of the Southern Green Mountain biophysical region of Vermont.

Note: Figure not provided. Contact the Water Quality Division.

Figure 1. Location of Basin 11 in Vermont.

The West River and its Watershed

General Description of the Watershed

The mainstem of the West River originates in the south part of Mount Holly, 2,400 feet above sea level. It flows generally south through the towns of Weston and Londonderry then southeasterly through Jamaica, Townshend, Newfane, Dummerston, and Brattleboro where it meets the Connecticut River. The length of the mainstem is 46 miles and the river drains a watershed that is 423 square miles.

The uppermost section of the West River flows through forested then partially forested and partially open country. It has a stony bottom with extensive gravel bars in some places and is considered good trout and salmon habitat. The first major tributary, Greendale Brook, enters a mile and a half above Weston. The slope of the West is around 80-100 feet/mile near Greendale Brook and there is a bouldery cascade at Zion Chapel just above their confluence. The valley flattens about one half mile below Greendale Brook, and the slope decreases to 10-20 feet/mile. Near Weston, there is a small mill dam with a backwater about one half mile long.

Just below Weston, the river steepens, turns away from the road, and enters a wooded ravine. It remains in this ravine for the next three miles and includes a nice whitewater stretch in the spring.

Three miles below Weston, Route 100 crosses the West River at a small settlement called the Island, where a sharp bend in the river was formerly cut by a short canal used to feed a mill. Below the Island, the river flows through rough meadows and thickets for two miles, before flowing under a side road bridge and entering the backwater of the Williams Dam at Londonderry.

Below the dam and just west of Londonderry, Utley Brook enters the West River and increases the drainage area by about 75%. Utley Brook is 10 miles long. After the Utley Brook confluence, the West River turns south and parallels Route 100 for 1.5 miles. It then flows over a set of ledges just before going under Route 100 and over another set of ledges after the road bridge. Flood Brook enters right below these ledges contributing another 11 square miles of drainage area.

Moderately heavy whitewater continues for a quarter mile below the ledges. The stream then enters a swampy flat area, much of which was formerly in the backwater of a dam at South Londonderry. For about three quarters of a mile the stream is away from the road and there are alder thickets along the banks. It then returns to the road and passes under the Route 100 bridge in the middle of South Londonderry.

Below this bridge, the river has roads and houses on each side. It steepens again and about a half mile below the bridge, it goes over a set of three ledges dropping a total of 15 to 20 feet in 50 yards.

The West River is medium-sized, averaging 50-70 feet wide, where it leaves the paved road in South Londonderry. It has a small floodplain bordered by steep hills to the west and the gentler lower slopes of Glebe Mountain to the east. The shores were formerly cleared for farming but are now reverting to woods. The channel has a moderate (20 feet per mile) slope and mild Class II rapids. The stream appears “broad and sunny and handsome”, and it becomes apparent that the West is becoming a big river.

About a mile below the confluence of Lowell Lake stream, the floodplain narrows and the river begins to steepen, reaching 40 feet per mile at the confluence with the Winhall River. The Winhall River, 16 miles long, flows into the West River from the west. This large tributary drains a 62 square mile forested watershed that is largely higher elevation land.

At the confluence of the West and Winhall Rivers is the former Winhall Station, where a legendary West River train crew once waited for a neighbor’s hen to lay the twelfth egg so that she could send a dozen to Brattleboro. It is now the lower end of the Ball Mountain Camp Grounds, which extend up the Winhall River. Depending on the time of the year the backwater from the Ball Mountain Dam may extend up to or beyond Winhall Station. The river continues in a southerly direction below Winhall Station with the valley narrowing substantially in the mile before the river flows into the Ball Mountain impoundment. The winter pool at Ball Mountain is 25 feet and the summer pool is 65 feet. For the April whitewater release, the pool is raised from winter level as flows allow. For the September release, the summer pool is dumped.

From Ball Mountain Dam to the bridge at Jamaica, the West River flows in a narrow, steep, wooded ravine. The river is fairly deep and rocky and the riparian corridor is largely undeveloped. Below the Jamaica bridge, Ball Mountain Brook enters the West River, the river widens, and the whitewater is less intense than upstream. There is a large island with channels on each side, the greater flow on the eastern branch.

The rapids end near the Route 100 bridge in East Jamaica. Wardsboro Brook enters the West River from the west just below the bridge. Wardsboro Brook is a 12 mile long stream that drains a 37 square mile watershed. Below Wardsboro Brook, the river widens and enters a flat basin that is part of the backwater for Townshend Dam in the spring. The river winds and braids through this basin until it meets the permanent pool of the Townshend Reservoir. The permanent pool is approximately a mile long.

From the Townshend Dam to Newfane, the river flows southwesterly through a relatively wide valley where the river has a quarter to half mile floodplain. Below Newfane, the river narrows and steepens. At Williamsville Station, the Rock River enters from the east.

The headwaters of the Rock River are located in Dover. From its headwaters, the Rock flows east into South Newfane where it is joined by the Marlboro Branch. From this confluence, the Rock continues running east to Williamsville where it is joined by Baker

Brook. From here, the Rock continues east to connect with the West River. The Rock River itself is12 miles long and drains a 60 square mile watershed.
Just downstream of the Rock River, the West River sweeps to the east for about a mile and then flows generally southeasterly again. From Williamsville Station to the mouth, the riparian corridor is more developed. Route 30 runs along the bank for the last 8 miles. This lower section of the river is fairly wide with a number of bedrock exposures, wooded banks coming down to the channel, and nice hills adjacent to the river. One mile above the mouth is a wetland area called Retreat Meadows, a backwater created by the Vernon Dam on the Connecticut River that has become a large marsh.

The West River watershed is a forested watershed (86%) with only a small portion of the land in agricultural use (3%). Surface water (5%) and transportation uses (4%) comprise even more of the watershed area than agriculture. Wetlands and developed land cover only 1% each of the watershed area according to the 1991-1993 satellite photograph analysis that is the source of these numbers.

Recreational Uses of the West River Watershed Rivers and Streams

Swimming

As noted in the 1989 *Upper West River Basin Water Quality Management Plan*, swimming occurs throughout the West River watershed in deep river or stream pools and in ponds and "wherever there is easy access to an inviting pool, someone is likely to take a plunge from time to time." The plan lists and maps 25 river or stream swimming sites including sites on the reservoirs and 17 pond sites in the upper West River watershed. In addition, there are 17 other swimming holes in the West River watershed described in the 1992 Vermont Swimming Hole Study. Some of the listed and described swimming holes are well-known sites such as Hamilton Falls on Cobb Brook, Pikes Falls on North Branch Ball Mountain Brook, the Dumplings and Salmon Hole on the West River, Indian Love Call on the Rock River, Winhall Brook campground swim beach and Townshend Reservoir swim beach, but there are numerous other locally known and enjoyed sites throughout the watershed.

Boating

The West River is well-known for canoeing and kayaking and especially for the spring and fall Ball Mountain Dam whitewater releases. There are a number of challenging and pretty boating runs on both the West River mainstem and its tributaries. The stretches described and/or mapped in the 1987 *Whitewater Rivers of Vermont* publication or the 1988 *Guide for Evaluating the Outstanding Rivers and Streams of Vermont* include: the stretches on the West River mainstem from Weston to Londonderry, Londonderry to Ball Mountain Dam backwater, below Ball Mountain Dam to the Route 100 bridge, below Townshend Dam to the Connecticut River as well as the Winhall River from Kendall Road to the West River, and Wardsboro Brook from Wardsboro to Jamaica.

Note: Figure 1 not provided. Contact the Water Quality Division.

Figure 1. Map of the West River from its headwaters to below Ball Mountain Dam

Note: Figure 2 not provided. Contact the Water Quality Division.

Figure 2. Map of the West River from below Ball Mountain Dam to the Connecticut River

Fishing

Angling occurs throughout the West River watershed. Some highly used areas include the lakes, Townshend reservoir and the West River mainstem between Ball Mountain Dam and Townshend Reservoir. Yearling trout are stocked in a portion of the watershed for "put and take" fishing where the water temperatures are warm in summer and wild trout populations are low or nonexistent. The 1989 *Upper West River Basin Water Quality Management Plan* includes a map of some of the areas more intensively use for fishing.

Other Riverine Values and Features in the West River Watershed

Waterfalls, cascades and other natural features

Four stream sites with waterfalls or cascades in the West River watershed are described in the 1985 *Waterfalls, Cascades and Gorges* report. These include Jelly Mill Falls on Stickney Brook in Dummerston, Hamilton Falls on Cobb Brook in Jamaica, Rock River Cascades on the Rock River in Dover, and Pikes Falls on the North Branch Ball Mountain Brook in Jamaica. A number of other sites with gorges, waterfalls, pools, rare species, or other water-related natural features are listed and mapped in the 1989 Upper West River Basin Water Quality Management Plan.

Class A and Outstanding Resource Waters

There are three Class A designations and one Outstanding Resource Water designation in the West River watershed. Kidder Brook and its tributaries were reclassified from Class B to Class A in 1989. The Water Resources Board determined that Kidder Brook "is in an essentially pristine condition, has high quality waters, sustains a naturally viable brook trout fishery and makes an important contribution to preserving the water quality, fishery, and recreational uses and values downstream including at Pikes Falls.." In 1991, the stretch of the Winhall River from 2500 feet elevation downstream about 7.4 miles (the point where the river crossed the boundary of Green Mountain National Forest land) was reclassified from B to A also per petition of a citizen's group. Also in 1991, the Water Resources Board reclassified Cobb Brook from Class B to A based in part on the finding that "there are only approximately 50 pristine-like streams of similar length in the entire State of Vermont. The Brook is of a higher value than most of those streams and is relatively unique in that nutrients and sediments in excess of those attributable to natural conditions are essentially absent."

In 1991, a 4000 foot long stretch of the North Branch Ball Mountain Brook that includes Pike's Falls was designated Outstanding Resource Waters for the waters' "natural, recreational and scenic values."

Threatened and endangered species and significant natural communities

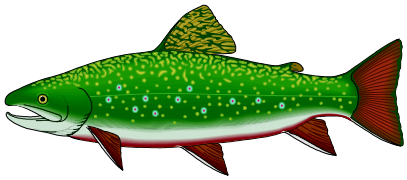
A 1996 inventory of rare freshwater mussels, tiger beetles, northeastern bulrush, and significant natural communities was conducted by staff in the Agency of Natural Resources Nongame and Natural Heritage Program along the West River primarily at the Army Corps of Engineers Ball Mountain and Townshend Dam project areas. Three rare invertebrate species were found either in the West River or on its shores. The cobblestone tiger beetle was reported for the first time from the West River as a result of this inventory. Both the brook floater mussel (*Alasmidonta varicosa*) and the eastern pearlshell mussel (*Margaritifera margaritifera*) were found at a site between the dams and then at several other locations on the mid-West River.

Another 1996 inventory was done at the Ball Mountain and Townshend Dam Project Areas: a survey for vernal pools and rare or protected reptiles and amphibians was done by Jim Andrews of Middlebury College. The survey was conducted over 21 days from April until November 1996 using a variety of reptile and amphibian survey methods. Nineteen species of reptile and amphibian were located in the areas searched: six salamander species, seven frog or toad species, three turtle species, and three snake species. Thirty-three locations of vernal pools or areas that serve as amphibian breeding sites were identified and mapped. Seven of the thirty-three sites are considered “classic” vernal pools being natural, temporary pools in forested areas with no inlet or outlet.

A report done for the Vermont Nongame and Natural Heritage Program in July 1996 summarized the results of an ecological inventory of the wetland natural communities in the West River Watershed. The following two paragraphs are taken almost directly from the report.

> Given the geology and the rugged topography of the watershed, it is not surprising that the wetlands of this area can be characterized as small and acidic (or at least not limy). The riverine wetlands along the West River, especially those associated with relatively high-gradient streams, are of particular significance in the state. The floodplain forests along the West River differ from floodplain forests in most other areas of Vermont in that they contain sycamore. Also unique to the West River and nearby sections of the Connecticut River is the presence of big bluestem and dwarf sand cherry in the rivershore grassland community. Furthermore, the examples of river cobble shore community along the West River are some of the most outstanding in the state. Five rare plants are associated with this community in several locations along the West River.

Wetlands resulting from beaver impoundments, so-called “beaver meadows” are by far the most numerous wetland type. These beaver meadows are shallow emergent marshes in the Nongame and Natural Heritage Program natural communities classification. Because these beaver meadows are most commonly found in a series along a slack stretch of stream they can add up to be wetlands of significant size. An impressive example of such a series is described for the Winhall River Headwater Beaver flowage site in Stratton. Although functionally very important as wetlands, beaver meadows are so common in Vermont that they rarely register as significant on a state level. However, the northeastern bulrush, a federally-listed species is restricted in Vermont to beaver wetlands in the southeastern portion of the state. This sedge species is apparently dependent upon the fluctuating water levels that these wetlands provide.



Fisheries resources in the West River watershed

The uppermost portion and smaller tributaries of the West River watershed support healthy populations of wild brook trout, and in some cases wild brown trout. However, high summer water temperatures limit trout populations in the lower mainstem and larger tributaries. Atlantic salmon can survive in significantly warmer water than trout and thus, salmon do well in most of this watershed from upland tributaries to the lower mainstem. The one exception is the West River below Townshend Dam where temperature conditions are marginal even for salmon in most years. A variety of non-game fish species occur throughout the watershed.

High water temperatures are a result of large portions of the watershed lacking adequate riparian buffers resulting in lack of shade. Roads are built on or close to river banks and there is additional commercial, residential, and agricultural development near streams. This situation is exacerbated on the West River by the presence of four mainstem dams which result in significant additional warming. The lower two dams, which are operated by the U.S. Army Corps of Engineers (the Corps) for flood control, cause substantial additional habitat impact from flow fluctuations, reservoir fluctuations, and sediment releases. However, with the above exceptions, physical habitat is generally in good shape in this watershed with only some localized exceptions. Atlantic salmon fry are stocked annually into streams in the West River watershed as part of the program to restore salmon to the Connecticut River basin. Salmon were

extirpated from the basin in 1798 when a dam was built across the mainstem of the Connecticut River in Turners Falls, Massachusetts. Salmon have been stocked in the West River since 1981. Initially, stocking was small scale and experimental, however, since the mid-1990s, annual fry stocking has been at or near desired stocking levels. In 2000, 1,080,000 fry were stocked in the West River. Annual electrofishing assessments throughout the watershed have shown generally good survival and growth of stocked salmon. Most salmon spend two years in freshwater before migrating to the ocean as smolts.

Currently, most adult salmon returning from the ocean are trapped at the Holyoke Dam in Massachusetts for broodstock. However, since the mid-1980s about ten percent of the salmon have been released to continue upstream and spawn naturally. Beginning in 1998, most of the released salmon have been radiotagged which has allowed monitoring of their movements. It is likely that adult salmon have been present in the West River almost annually since 1985, but monitoring was limited to snorkeling surveys and other incidental reports. Nine radiotagged salmon entered the West River in 1998, two in 1999, and two in 2000. Spawning was confirmed by the detection of six redds in the West River mainstem in Townshend and Newfane in 1998. One of the 1999 West River salmon, a 19-pound, 37-inch female, spent that drought summer in the upper portion of Ball Mountain Brook where it is assumed to have spawned with mature male parr in the fall.

A salmon trap and truck facility is operated by the Corps at Townshend Dam for the purpose of providing salmon passage in the West River basin. Traditional fish ladders are not feasible at the flood control dams because of their large size and often nearly empty pools. Currently, salmon are trapped and transported above Townshend Dam for release. As run sizes increase, salmon will also be transported above Ball Mountain, Londonderry, and Weston Dams for release. Without this facility, all four mainstem dams would be complete barriers to upstream fish migration. This facility was destroyed by flooding in 1998 and was not operational for salmon passage that year. All salmon that entered the West River in 1998 were likely migrating to areas above Townshend Dam because they all reached the dam and spent considerable time there. The facility was repaired in 1999 and upgraded in 2001. The Corps maintains the winter pool of 25 feet at Ball Mountain during the spring migration season to facilitate passage of smolts downstream through this bottom discharge reservoir. Radiotagging studies have indicated good smolt passage at moderate to high flows, but no evaluation has been done at lower flows. Water storage for whitewater releases and flood control can result in significant delay and mortality to smolts. Passage through Townshend Dam is much easier because it is a top-spill operation. The Corps has installed stop logs at the base of the dam to provide a pool for smolts to safely land in. Weston and Londonderry Dams are not thought to be major impediments to smolt migration but some minor improvements might be needed in the future to maximize smolt survival.

Lakes in the West River Watershed with Special Significance or Features

Vermont DEC's Lake Protection Classification System is one framework within which lakes can be evaluated for their special significance when compared to other lakes statewide. The Lake Protection Classification System identifies unique lakes based on: wilderness status; occurrence of scenic and natural features; existence of very high water quality; and/or the presence of very rare, threatened, and/or endangered species. The following lakes are significant in these respects:

Ball Mountain Reservoir, Jamaica: The steep-sided nature of the valley along this reservoir creates an interesting shoreline, which includes boulders, small cliffs, and waterfalls.

Cole Pond, Jamaica: Cole Pond supports a population of the rare pondweed *Potamogeton bicupulatus*.

Gale Meadows Pond, Londonderry: This pond has a population of the rare milfoil *Myriophyllum humile.*

Lily Pond, Londonderry: This small scenic pond supports the rare *P. bicupulatus*, and the rare *M. humile*.

Lowell Lake, Londonderry: Lowell Lake supports three noteworthy aquatic plants: the rare *P. bicupulatus*; the rare *M. humile;* and the rare bladderwort *Utricularia purpurea.* Lowell Lake also has a particularly diverse assemblage of aquatic plants, as well as several undeveloped islands.

Stratton Pond, Stratton: Stratton Pond is a wilderness lake, with access by foot only. The primary access is via the Appalachian Trail, which runs adjacent to the pond.

Sunset Lake, Marlboro: Sunset Lake is an ultra-oligotrophic lake, meaning it supports extremely high water quality as related to nutrients. The lake has a very scenic lake bottom, and supports both the rare *P. bicupulatus*, and the rare *Isoetes tuckermanii.*

Activities or Projects in the West River Watershed

Stratton Area Citizens Committee

In 1984, volunteers in the northern part of the West River watershed founded an organization to monitor the impacts of resort development on water quality and aquatic habitat and to advocate for adequate protection of the water resources in this portion of the watershed. This citizen group was responsible for achieving Class A status for Kidder Brook and for getting the designation of Pike's Falls as an Outstanding Resource Water. The group remains active in water quality monitoring as part of the West River Watch Program and in water quality remediation planning and implementation at Stratton Mountain Resort.

Stratton Mountain Resort Water Quality Remediation Plan

Stratton Mountain Resort is in the third year of implementing a largescale water quality remediation plan that involves monitoring, re-establishment of woody plants along streams, evaluation and remediation of sediment problem locations, streambank stabilization, stormwater control, limestone treatments at iron seeps, culvert removals, and other activities to improve water quality in streams on Stratton Mountain Resort land. Monitoring conducted in the year 2000 represents the second year of three years of background monitoring. Nutrients, metals, and temperature were monitored. Event-based monitoring measured turbidity and biomonitoring and/or sediment assessments were done at 27 monitoring stations. A description of the work done in the year 2000 is summarized in an annual performance report done by Pioneer Environmental Associates for the Stratton Corporation. The goal of the remediation plan is to restore Styles Brook and Tributary #1 of the North Branch Ball Mountain Brook, which are listed as impaired. The plan is to have the waters meet water quality standards by 2005.

West River Watershed Alliance

A newly incorporated organization, the West River Watershed Alliance (WRWA), now exists in the West River watershed and is planning its work. First as the West River Steering Committee and then as the unincorporated West River Watershed Alliance, a number of meetings, forums, and discussions were held throughout the watershed to bring together those interested in the watershed; issues and concerns were identified and discussed; and finally an action list and plan for the watershed was created. Many organizations and individuals came together in this process. Specific work began as a result of the comprehensive *West River Watershed Action Plan* including a Rock River riparian inventory, formation of the not-for-profit WRWA, and submittal of a grant to hire a watershed coordinator.

West River Tributaries Erosion and Stability Assessment

In 1997, the Windham Regional Commision with assistance from partners conducted a physical assessment of the Rock River, Winhall River, and Ball Mountain Brook determining their likely valley and stream types using maps, watershed characteristics including soils and land use/land cover, and erosion hotspots based on field investigations. The erosion sites were evaluated as to the priority for stabilization work. Three of the sites identified on the Rock River are addressed by the project described below.

Bonnyvale Environmental Education Center Watershed Projects

Bonnyvale Environmental Education Center (BEEC) has coordinated the West River Watch Program since 1994 although the program has been operating in some form since 1985. Over the years, BEEC has increased the number of sites monitored, added or removed parameters measured as appropriate, and developed a reader-friendly report summarizing the data and results of the season's sampling. In the year 2000, 23 volunteers monitored 37 sites throughout the watershed and provided data on E. coli levels, temperature, pH and phosphorus.

Bonnyvale Environmental Education Center has also completed the three nonpoint source control 319 restoration projects on the Rock River**.** Restoration work was completed at the Williamsville site at the old Grist Mill swim hole on the Rock River in spring 2001. Since the planting of willow wattles and live stakes, growth success has been noted despite the sandy soil conditions. In June, a streamside biosurvey was conducted above and below the second and third 319 project sites to verify water quality conditions prior to the in-stream construction work. Chemical parameters were measured, macroinvertebrates sampled, and a physical survey of the area was conducted. In mid July 2001, the US Fish and Wildlife Service and the USDA Natural Resource Conservation District completed their in-stream work at the project sites. On August 16 and 17, 2001, partnering with the USF&WS and the local NRCS, BEEC conducted streambank restoration work at the two in-stream projects on the Rock River in South Newfane. Over the two work days, a total of 18 people cut and stripped hundreds of willow branches and bundled them into wattles. At both project sites, wattles were placed in shallow trenches and covered. Live willow stakes were planted in the dirt areas of the riprap and on the beach area of the project sites**.**

BEEC received recognition for its work in the local newspaper and at the 55th annual Natural Resource Conservation District Annual Meeting in October 2001.

General Description of the Watershed

The Williams River originates on the eastern edge of the southern Green Mountains and flows easterly then southeasterly through the Southern Vermont Piedmont before joining the Connecticut River at Herricks Cove. The Williams River has a stream length of 25 miles and drains an area of 117 square miles. Much of the basin is rugged, hilly land with steep slopes and poor drainage.

The Williams River headwater streams come off the slopes of Terrible Mountain and other nearby mountains to form the Williams River mainstem. The river flows easterly through Andover and into the southern portion of Ludlow where Wheaton Brook, Lovejoy Brook, and Bear Brook join in. It continues its easterly flow into Chester and is confined to a relatively narrow valley until it turns south-southeast. At that point it flows in a broader valley down the length of the town of Chester. In the village of Chester, the Middle Branch of the Williams River joins the Williams River mainstem.

The Middle Branch originates in Windham and flows north for a ways before flowing east through Andover and Chester into the Williams River. Lymans Brook, Andover Branch, and South Branch are all tributaries to the Middle Branch. The Middle Branch is 13 miles in length and drains a watershed of 47 square miles.

From Chester village, the Williams River continues its southeasterly flow into the town of Rockingham where it flows through Bartonsville, over the Brockway Mills dam, and through a narrow valley before flowing out into Herricks Cove at the Connecticut River.

The Williams River watershed is also a predominately forested watershed (82% of the total area), however a slightly higher percentage of the watershed is in agriculture (4%) or covered by water (6%) than for the West River. Transportation uses cover 4% of the land area, developed land other than transportation covers another 2%. Areas identified as wetland cover another 1% of the watershed area.

Recreational Uses of the Williams River Watershed Rivers and Streams

Boating

There are three whitewater boating stretches in the Williams River watershed described in the 1992 *Whitewater Rivers of Vermont* report. One boating run is a five mile stretch of the Williams River from five miles above Chester down to Chester. This reach is judged to be primarily Class II whitewater at medium water and at least half Class III whitewater at high water levels and has been described as demanding and pushy.

The other two boating stretches are both on the Williams River mainstem with one stretch from Gassetts to Chester and the other from Chester to Brockway Mills. The uppermost stretch has only mild whitewater as the stream at this point has a small watershed and moderate slope. For the approximately seven mile stretch from Chester down, the Williams is a medium-sized stream with mostly quickwater, scattered Class II rapids, and one Class IV drop.

Swimming

The Williams River is relatively shallow in the summer and there are few known swimming holes. The river was not explored during the 1991 Vermont Swimming Hole Study although two sites are listed but not described in the study's report. One of the sites is Rainbow Rocks and the other is Brockway Mills both in Rockingham. Rainbow Rocks are ledges with a deep hole below. The Brockway Mills site is an 80-foot gorge with pools, potholes, and small cascades. The gorge is described in the Vermont DEC publication *Waterfalls, Cascades and Gorges of Vermont* although the investigators describe the site before hydro development there. No new sites were noted in summer 1999 during the river water quality assessment field surveys.

Other Riverine Values and Features in the Williams River Watershed

Fishery resource

The upper portions of the mainstem Williams and Middle Branch, as well as most of the smaller tributaries support healthy populations of wild brook trout, and in some cases, wild brown trout. However, high summer water temperatures limit trout populations in the lower mainstem Williams and Middle Branch. Hatchery trout are stocked in the mainstem and the Middle Branch on a put and take basis to provide fishing where wild trout populations are low. Because of their higher tolerance for warm temperatures Atlantic salmon do well throughout the watershed. A variety of non-game fish species occur throughout the watershed.

Salmon have been stocked in the Williams River since 1993. One adult salmon entered the Williams River in 1999. In 2000, 268,000 fry were stocked in the Williams watershed. The Williams River is currently impassable to upstream migrating salmon at Brockways Mills dam and falls. Historical passage status is uncertain, although it is likely that this series of small falls could be negotiated by salmon at certain flows. A bypass facility for smolts will be required when the new hydroelectric facility is constructed. An upstream fish ladder may be required in the future. There is excellent spawning, rearing, and holding habitat from the dam to the Connecticut River. See the discussion in the West River section for more details on Atlantic salmon restoration.

Threatened & endangered species and significant natural communities

There are 17 occurrences of plant species that are of statewide importance in the Williams River watershed. Most of these plants are found in wetlands associated with the river. The two bird species of importance are also found along the river. There are four occurrences of natural communities: three shallow emergent marsh communities and one riverside outcrop community. All of these significant natural communities are part of the river ecosystem.

Note: Figure 3 not provided. Contact the Water Quality Division.

Figure 3. Map of the Williams and Saxtons Rivers Watersheds

The Saxtons River and its Watershed

General Description of the Watershed

The Saxtons River rises on the eastern slopes of the southern Green Mountains in the town of Windham and flows southeasterly across the Vermont Piedmont to the Connecticut River. Its length is 20 miles draining an area of 78 square miles with a total drop of approximately 1800 feet. The basin is characterized by narrow steep gorges cut through rugged hilly uplands with outcropping bedrock and poor drainage.

The Saxtons River originates in an extensive wetland complex in the Lawrence Four Corners area in Windham from which it begins its easterly flow. Many headwater tributaries from the hills and mountains of the east part of Windham and the western part of Grafton flow northerly and southerly through narrow, forested valleys to join the Saxtons River. The Saxtons continues an easterly flow through Houghtonville where 1.5 miles downstream, the river turns south and flows in a somewhat wider valley to Grafton village.

In Grafton, the South Branch joins the Saxtons River from the south. The South Branch is six miles long and drains a watershed that is 20.3 square miles.

From Grafton village and the South Branch confluence, the river flows northeasterly then southeasterly around the base of Kidder Hill then continues southeasterly to the village of Saxtons River. Weaver Brook, Bull Creek, and Leach Brook all contribute to the river's flow in this stretch. From the village of Saxtons River, the river continues its southeasterly journey until North Westminster where it bends back on itself, flows over Twin Falls then continues in a northeast direction for a little more than a mile before emptying into the Connecticut River.

Deciduous, coniferous, and mixed forests comprise the dominant land cover type in the Saxtons River watershed covering approximately 82% of the watershed area. Surface water covers the next largest area of the watershed at 8%. Transportation uses cover 4% of the watershed, agricultural activities (hay, pasture, row crops) cover another 3%, wetland covers less than 2% and developed land, not including transportation, covers approximately 1%.

Recreational Uses of the Saxtons River Watershed Rivers and Streams

Boating

The only identified boating reach on the Saxtons River is an 8-mile stretch from Grafton to Saxtons River. It is popular with local kayakers and experienced open boat paddlers. It can be run after snowmelt and rain events. At medium water, it is mostly Class II whitewater.

Swimming

The Saxtons River does not have a large number of identified swimming holes or bathing areas. On the lower Saxtons River just above the Route 5 bridge in Bellows Falls is the area called Saxtons River Falls. There are rocks and a sandy beach for sitting and sunbathing and ledges for jumping. It gets good local use. At the mouth of the river is a sandy area that appears to be used as a picnic or gathering spot. The vacant land at the mouth which is a dirt turn-around has good potential for a park. Another popular local swimming and gathering site is Twin Falls upstream in Westminster that has a nice pool, the falls, and ledges.

Other Riverine Values and Features in the Saxtons River Watershed

Fishery resource

The upper mainstem Saxtons above Houghtonville and most of the tributaries support healthy populations of wild brook trout and, in some cases, wild brown trout. However, high summer water temperatures limit trout populations in the lower mainstem Saxtons River. Hatchery trout are stocked in the Saxtons mainstem on a put-and-take basis to provide fishing where wild trout populations are low. Because of their higher tolerance for warm temperatures, Atlantic salmon do well throughout the watershed. A variety of non-game fish species occur throughout the watershed.

Salmon have been stocked in the Saxtons River since 1988. One adult salmon entered the Saxtons River in 1998 and two in 1999. In 2000, 202,000 fry were stocked in the Saxtons River. Twin Falls on the lower Saxtons River is a barrier to upstream salmon migration at most flows, but it may be passable at certain flows. It is near the upper limit for salmon leaping ability of 10-12 feet. It presents no problem to outmigrating smolts. No other significant barriers to salmon migration occur in the watershed. Salmon have been documented passing the remnant dam and natural falls at Route 5. See the discussion in the West River section for more details on Atlantic salmon restoration.

Threatened & endangered species and significant natural communities

In the Saxtons River watershed, there are four occurrences of plant species, two occurrences of birds, and two significant natural communities of statewide importance. One of the natural communities is a river cobble shore and the other is a sugar maple - ostrich fern riverine floodplain forest.

Basin 11 River and Stream Assessment Summary

Designated Use Support Status for Rivers

For each river use or value that is assessed, the miles of river or stream fully supported, threatened, partially supported or not supported are determined. For example, river miles that are fully supported for aquatic biota have macroinvertebrate and fish communities in good to excellent health and good physical habitat. River miles that are fully supported for swimming have no known high levels of *E. coli*, a bacteria that is used as an indicator for pathogens. Table 1 gives the miles in each support category for seven uses or values: aquatic biota and/or habitat, contact recreation (swimming, tubing), secondary contact recreation (boating, fishing), aesthetics, drinking water supply, agricultural water supply and fish consumption. The use called "overall" reflects the miles for which one or more of the uses are not supported, partially supported, or threatened or for which all uses are fully supported. The fish consumption use is not factored into the "overall" category because all miles of river and stream are at least threatened for fish consumption due to a statewide fish consumption advisory. If taken into account in "overall," this status would mask the extent of other threats. There are 431.8 river miles total assessed for this basin.

Table 1. Use Support Status of Basin 11 Rivers and Streams

Use	Miles of full support	Miles threatened	Miles of partial support	Miles of non-support	Miles not assessed
Overall	235.4	72.2	120.5	3.7	0
Aquatic biota/habitat	235.4	82.7	110.0	3.7	0
Contact recreation	364.3	51.0	14.0	2.5	0
Secondary contact recreation	291.8	22.6	114.9	2.5	0
Aesthetics	320.0	70.0	39.3	2.5	0
Drinking water supply	46.9	0.1	0	2.5	382.3
Agricultural water supply	15.9	0.1	0	2.5	413.3
Fish consumption	0	431.8	0	0	0

The designated use most affected by pollution or undesirable conditions is secondary contact recreation (fishing and the fishery) with aquatic habitat/biota closely following in terms of miles having impacts. Water temperature data showed that a number of stretches in all three watersheds of the basin had high temperatures that affect the health and sustainability of the fishery and its habitat. Sedimentation and physical

habitat alterations also affected the aquatic habitat and its inhabitants. Aesthetics is the third most affected designated use. The loss of riparian vegetation, physical alterations to the channel, streambank erosion and the resulting sedimentation all have an impact on, or threaten, aesthetics.

There were not as many miles where contact recreation was not in full support. Impacts to this use are listed where *E. coli* data indicate potential pathogen problems or where physical alteration to the river or stream diminished the opportunity for swimming.

The miles of full support, threatened, partial support, and non-support for each use for each river segment or tributary watershed (waterbody) are given in tables in the individual waterbody reports in Appendix E. A narrative is also given in these individual reports that explains the causes and sources responsible for the lack of full support or the threats.

Causes and Sources of River Impacts and Threats

Causes are the pollutants or conditions that threaten or have an impact on the aquatic biota, the aquatic habitat, swimming, fishing, the fishery, boating, drinking water supply, fish consumption or other "uses" of the river or stream. The top causes of river water quality or aquatic habitat problems in Basin 11 are listed in Table 2 below along with the miles of river or stream that they affect. These are discussed in more detail below.

Table 2. Causes of River Impacts and Threats in Basin 11

Cause or pollutant	Miles of high impact	Miles with moderate impact	Total miles of impact	Miles threatened
Thermal modification	76.2	30.8	107.0	36.0
Sedimentation	3.0	54.8	57.8	97.0
Physical habitat alteration	0	44.3	44.3	39.5
Flow alteration	21.9	12.0	33.9	12.5
Nutrients	0.5	10.5	11.0	13.5
pH	0	8.4	8.4	0
Pathogens	0	7.0	7.0	17.0
Metals	0.5	0	0.5	8.6

Sources are the land uses, human activities, or occurrence of conditions responsible for the causes named above and that are the origin of the impacts on river or stream water quality or aquatic habitat. Table 3 lists the primary sources of river and stream impacts

and threats in the basin.

Table 3. Sources of River Impacts and Threats in Basin 11

Source	Miles of high impact	Miles with moderate impacts	Total miles of impact	Miles threatened
Riparian vegetation removal	26.5	69.0	95.5	36.0
Streambank destabilization	0.5	44.8	45.3	65.5
Flow regulation/modification	33.9	1.3	35.2	18.0
Channelization	7.0	14.5	21.5	33.3
Road/bridge runoff	0	20.8	20.8	57.0
Upstream impoundment	20.4	0	20.4	6.0
Land development	2.5	14.5	17.0	37.0
Agricultural activities	0	12.5	12.5	8.0
Recreational activities	1.0	10.0	11.0	6.5

The cause of most river or stream miles with impacts is thermal modification or water temperatures that are too high to fully support a coldwater fishery. Removal of the riparian trees and shrubs, which is the source affecting the most river miles, results in these higher temperatures. Dams and the resulting impoundment of water also results in higher downstream water temperatures. Much of the Williams River and West River as well as the lower half of the Saxtons River have high temperatures in the summer, which have an impact on the coldwater fishery.

Sedimentation is the second greatest cause of impacts to the rivers and streams in this basin. It is also the largest threat to aquatic habitat, biota, and other uses of these waters. Sources of sediment include streambank erosion, land development and road runoff among others.

Physical habitat alterations are a result of flow regulation, channelization/instream modification, road and bridge work, and channel instability. Other pollutants or conditions affecting the rivers or streams in this basin include flow alteration primarily from the two Army Corps of Engineers flood control dams, nutrients primarily from agricultural land activities, low pH as a result of acid rain and pathogens possibly from failed septic systems.

Basin 11 Lakes and Ponds Assessment Summary

Use Support Status of Basin 11 Lakes and Ponds

Overall, there are 360 lake acres in the basin that only partially support one or more uses, and 21 acres where one or more uses are precluded. All designated uses are fully supported on 624 assessed lake and pond acres. Table 4 provides an accounting of lake acres where designated uses are supported, threatened, or not fully supported.

Table 4. Designated use support for lakes in Basin 11

Use	Acres Fully Supporting Uses	Supporting Acres with Uses Threatened	Acres Partially Supporting Uses	Acres Not Supporting Uses	Acres Not Assessed
Overall Uses	88	536	360	21	0
Aesthetics	746	66	193	0	0
Aquatic Life Use Support	88	543	353	21	0
Agricultural Water Supply	0	0	0	0	1005
Drinking Water Supply	101	0	0	0	0
Fish Consumption	1005	0	0	0	0
Filtered Water Supply	101	0	0	0	904
Industrial Water Supply	0	0	0	0	1005
Secondary Contact Uses	939	66	0	0	0
Swimming Uses	939	66	0	0	0

A summary of overall use support by individual lake provides useful information (Table 5). It is noteworthy that the forested land cover and calcium-poor bedrock geology characteristic of these three watersheds results in surface waters that are naturally susceptible to acidification, owing to low acid buffering capacity. This condition means that in some lakes, precipitation of acid-forming sulfates and nitrates has either chronically, or even critically acidified the waters, thereby impairing aquatic communities.

Table 5. Overall use support by individual lake, for lakes within Basin 11

Lake Name	Lake Area (ac)	Last Assessed (YYYYMM)	Assessment Type	Acres Fully Supporting	Threatened Acres	Acres Partially Supporting	Acres Not Supporting
ADAM	7	200103	Evaluated	7	7	0	0
ANDOVER;	11	200103	Evaluated	11	0	0	0
ATHENS	21	200103	Monitored	21	21	0	0
BAILEYS MILLS;	10	200103	Evaluated	10	0	0	0
BALL MOUNTAIN	85	200103	Monitored	0	0	85	0
BURBEE	50	200103	Evaluated	50	50	0	0
CHESTER	5	200103	Evaluated	5	0	0	0
COLE	41	200103	Monitored	41	41	0	0
EAST TWIN	3	200103	Evaluated	3	0	0	0
FLOOD;	1	200103	Evaluated	1	0	0	0
FORESTER	9	200103	Monitored	0	0	0	9
GALE MEADOWS	195	200103	Monitored	195	195	0	0
HAPGOOD	7	200103	Evaluated	0	0	7	0
KENNY	26	200103	Evaluated	26	26	0	0
LANDGROVE;	14	200103	Evaluated	14	0	0	0
LILY (ATHENS)	12	200103	Evaluated	12	12	0	0
LILY (LONDRY)	21	200103	Monitored	21	21	0	0
LITTLE (WINHLL)	18	200103	Evaluated	0	0	18	0
LOWELL	109	200103	Monitored	109	109	0	0
MOSES	12	200103	Evaluated	0	0	0	12
MUD (PERU)	10	200103	Evaluated	10	10	0	0
SIMPSONVILLE;	12	200103	Evaluated	12	0	0	0
STRATTON	46	200103	Monitored	0	0	46	0
SUNSET (MARLBR)	96	200103	Monitored	0	0	96	0
TELEPHONE;	15	200103	Evaluated	15	0	0	0
TOWNSHEND	108	200103	Monitored	0	0	108	0
WANTASTIQUET	44	200103	Monitored	44	44	0	0
WEST TWIN	1	200103	Evaluated	1	0	0	0
WINHALL;	16	200103	Evaluated	16	0	0	0

(;) indicates an unnamed lake that has been given an unofficial name by DEC for database purposes

Causes and Sources of Threats and Impacts to Basin 11 Lakes and Ponds

The two principal causes of impairment to 193 acres in these watersheds, flow alteration and siltation, are both related to operation of two flood control reservoirs, which affects aquatic life uses. The critically low pH exhibited by several ponds impairs aquatic life uses on 181 lake acres. An additional 533 acres are threatened by acidification due to their low buffering capacity, which renders lakes susceptible to episodic low pH events. Table 6 provides an accounting of the causes of impacts and threats to lakes in these watersheds.

Table 6. Causes of impacts and threats to lakes in Basin 11

Cause of Impact	Acreage by Magnitude of Impact			Total Acres Not Fully Supporting	Total Acres Threatened
0900 Nutrients	0	0	0	0	10
1000 pH	181	0	0	181	533
1100 Siltation	85	108	0	193	41
1200 Organic enrichment – DO	0	0	0	0	15
1300 Salinity - TDS – chlorides	0	0	0	0	9
1500 Flow alteration	193	0	0	193	7
2200 Noxious aquatic plants - Native	0	0	0	0	25

The most important source of impairment to lakes in the West, Williams, and Saxtons Rivers watersheds is hydromodification, which impairs 193 lake acres due to habitat modification and partial loss of aquatic life uses. Shoreline destabilization, related to flow modification, impairs 85 acres on one flood control reservoir. Atmospheric deposition has critically acidified 181 lake acres, and presently threatens an additional 533 acres. Some of these acid-threatened waterbodies may also exhibit natural sensitivity to acidification, which explains the 533 threatened acres attributable to natural sources. Finally, general land development, road runoff, construction, and associated shoreline destabilization threatens 50 lake acres. Table 7 contains the sources of impairment and threats to lakes in Basin 11.

Table 7. Sources of impacts to lakes in Basin 11.

Source of Impact	Acreage by Magnitude of Impact			Total Acres Not Fully Supporting	Total Acres Threatened
	High	Moderate	Minor		
3000 CONSTRUCTION	0	0	0	0	41
3200 Land Development	0	0	0	0	41
7400 Flow Regulation/Modification	193	0	0	193	7
7550 HABITAT MODIFICATION	0	85	0	85	0
7600 Removal of Riparian Vegetation	0	85	0	85	0
7700 Streambank Destabilization	0	85	0	85	41
8100 ATMOSPHERIC DEPOSITION	181	0	0	181	533
8300 HIGHWAY MAINTENANCE/ RUNOFF	0	0	0	0	9
8600 NATURAL SOURCES	9	96	76	181	533

The following paragraphs describe the impacts and major threats to specific lakes, ponds, or reservoirs in the West, Williams, or Saxtons Rivers watersheds.

Ball Mountain Reservoir, Jamaica: This is one of two flood control reservoirs built and operated by the US Army Corps of Engineers along the West River. The operational regime of the reservoir is such that the water level fluctuates widely. The severity of

these fluctuations precludes the establishment of a stable littoral community. Indeed, the reservoir's littoral zone is characterized by barren stone, with alder the only visible vascular plant above or below the water's surface. Vermont Agency of Natural Resources DEC and DF&W are advocating elimination of the pool.

Burbee Pond, Windham: This 50 acre pond is threatened by acidic precipitation due to its low acid buffering capacity.

Cole Pond, Jamaica: This 41 acre pond is threatened by acidic precipitation due to its low acid buffering capacity. Rapid development of the lakeshore and watershed also threatens the quality of the lake water, which could impact not only biological communities, but also aesthetics, swimming, and boating enjoyment as well. Interestingly, available data show that the acid buffering capacity of the lake has increased, coincident with development. This alkalization, which is likely attributable to inputs of terrigenous material, may actually lessen threats posed by acidification over the near term.

Forester Pond, Jamaica: This 9 acre pond is critically acidified, and thus cannot support a stable aquatic community. VTDEC data also show a clear trend of rising chloride concentrations in the water, which may be attributable to road salt runoff from the adjacent town road. The potential impacts of this change in water chemistry are presently unclear.

Gale Meadows Pond, Londonderry: This 195 acre pond is threatened by acidic precipitation due to its low acid buffering capacity.

Little Pond, Winhall: This 18 acre pond experiences episodic acidification due to acid precipitation, which impedes the establishment of a stable aquatic community.

Lowell Lake, Londonderry: This 109 acre lake is threatened by acidic precipitation due to its low acid buffering capacity. In addition aquatic biota are also considered threatened in 15 of the lake acres due to low hypolimnetic dissolved oxygen, and swimming and boating uses are threatened on 15 acres due to heavy growth of the rare bladderwort *Utricularia purpurea*.

Moses, Weston: This 12 acre pond experiences episodic acidification due to acid precipitation, which impedes the establishment of a stable aquatic community.

Stratton Pond, Stratton: This 46 acre lake experiences chronic acidification due to acid precipitation, which impedes the establishment of a stable aquatic community. Moreover, based on several visits, it is apparent that the lake water is far too clear and green in hue for an episodically acidic lake. Despite being in an identical setting as other Lye Brook Wilderness lakes, this is the only lake in the Wilderness which is not naturally dystrophic. Trophic data show strong algal stimulation given the relatively moderate total phosphorus concentrations at the pond, and in the summer, the bottom-most waters become depleted of dissolved oxygen and enriched with hydrogen sulfide.

Stratton Pond's phytoplankton community only barely meets biological reference conditions for acidic small lakes. This is because plankton community density is quite high relative to the reference conditions, even if other biological measurements are within acceptable limits. It is reasonable to hypothesize that the pond has experienced significant nutrient inputs at some prior date, from which it is presently recovering.

Sunset Lake, Marlboro: This 96 acre lake experiences episodic acidification due to acid precipitation, which impedes the establishment of a stable aquatic community.

Townshend Reservoir, Townshend: This is the second Corps-operated flood control reservoir. Extreme water level fluctuations are understood to impede the establishment of a stable aquatic community. Further assessment of the severity of the situation is warranted, as some of the readily available data from this reservoir are outdated.

Basin 11 Lakes and Ponds in Need of Further Assessment

There are only three lakes and ponds in Basin 11 identified as being in need of further assessment at this time. There are also six small ponds for which DEC has limited information, but for which there is little reason to expect water quality problems. These latter ponds would make good candidates for assessment by citizens in conjunction with basin planning and assessment activities, pending public interest. A summary of information from the VTDEC Lake Assessment database is provided below for the three lakes needing assessment. Finally, there are numerous very small ponds (less than 10 acres in size) in the basin for which VTDEC has little or no information. The public accessibility of all of these smaller lakes is unknown.

Hapgood Pond, Peru: Hapgood Pond is located in the Green Mountain National Forest, and supports swimming and boating uses for a small day-use recreational area. The pond is drained annually by the U.S. Forest Service, for the purpose of reducing aquatic plant growth. The length of time that the pond is drained and the degree to which this drawdown impairs aquatic life uses is unknown.

Mud Pond, Peru: Conflicting information exists regarding this pond. It has been identified by some as having excessive native plant growth which may threaten aquatic life, aesthetics, swimming, and boating uses. However, a rich plant community is natural for many shallow small lakes. The degree to which the plant community in this pond threatens uses should be evaluated.

Townshend Reservoir: Limited information is available for this reservoir and VTDEC has no recent water chemistry data from the reservoir. An assessment of Townshend Reservoir water quality and use support status is thus warranted.

303(d) Listed Waters in Basin 11

There are five river or stream segments and five lakes or ponds on Vermont's Year 2000 List of Impaired Surface Waters (the 303(d) list) (Table 8 below). These are waters of the basin where Vermont DEC has sound monitoring data to identify the impairment and its cause(s). There are a number of other river and stream stretches in the basin that do not fully support one or more "uses" of the waters (aquatic biota or habitat, fishing, swimming, aesthetics), but the protocol to document the impairments is not yet developed (channel instability/physical habitat impairments); the impact is known from modelling (flow); or the information is based on observations of problem conditions but there is no instream monitoring (extensive algae, turbidity from observed runoff), as examples. New segments may be added during the 2002 listing process.

Table 8. 303(d) Listed Waters in Basin 11

Waterbody id	Segment	Pollutant	Problem
VT11-08L01	Sunset Lake	pH	Sensitive to acidification (episodic)
VT11-10	West River - below Ball Mtn dam to Townshed dam	sediment	Major sediment releases from Ball Mtn dam impaired the fishery and habitat
VT11-15	Ball Mountain Brook- above North Branch confluence	pH	Fishery critically impacted from acidification
VT11-15	North Branch Ball Mountain Brook - golf course pond to Kidder Brook	manganese	Releases of reduced manganese from the pond sediment coated rocks but stream recovery is underway
VT11-15	Styles Brook	sediment	Development and hydrologic alterations of the watershed causing embeddedness and impairing aquatic community and habitat
VT11-15	Tributary #1 North Branch Ball Mountain Brook	sediment	Development, erosion, polluted runoff impairing aquatic community and habitat
VT11-15L01	Forester Pond	pH	Critically acidified (chronic)
VT11-15L02	Little Pond	pH	Sensitive to acidification (episodic)
VT11-16L01	Stratton Pond	pH	Sensitive to acidification (episodic)
VT11-18L06	Moses	pH	Critically acidified (chronic)

References for Basin 11

1) An Ecological Inventory of the Wetlands of the West River Watershed, Vermont, 1996.

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2) How Clean is the Saxtons River? A Report on the Saxtons River Project: A Citizen Water Quality Monitoring Program at BEEC, 1999. Frances Doyle, Bonnyvale Environmental Education Center.

3) A Guide for Evaluating the Outstanding Rivers and Streams of Vermont: Part II Exemplary Streams in the West River Basin, 1988. Jerry Jenkins for the Vermont Department of Environmental Conservation (DEC).

4) Rare Freshwater Mussels and Significant Natural Communities at Ball Mountain and Townshend Lakes, 1997. Prepared for the U.S. Army Corps of Engineers New England Division by Mark Ferguson, Eric Sorenson and Robert Popp, Vermont ANR, Department of Fish and Wildlife, Nongame and Natural Heritage Program, Waterbury, Vermont.

5) State of Vermont Year 2000 List of Waters: Part A - List of Impaired Surface Waters, July 2000. Prepared for EPA by Vermont DEC, Water Quality Division.

6) A Survey of the Ball Mountain and Townshend Dam Project Areas for Vernal Pools and Rare or Protected Reptiles and Amphibians (Draft Report), 1997. Prepared for the U.S. Army Corps of Engineers New England Division by Jim Andrews, Middlebury College, Middlebury, Vermont.

7) Upper West River Basin Water Quality Management Plan, 1989, Vermont ANR DEC, Water Quality Division, Waterbury, Vermont.

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

9) Water Quality Remediation Plan 2000 Annual Performance Report. Prepared for the Stratton Corporation by Pioneer Environmental Associates.

10) 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.

11) The West River Watch Project Report 1997, 1998, 1999, 2000. Frances Doyle, Bonnyvale Environmental Education Center, Brattleboro, Vermont.

12) West River Tributaries Nonpoint Source Pollution Stream Assessment Report, January 1998. Windham Regional Commission.

13) Whitewater Rivers of Vermont, 1989. Jerry Jenkins for Vermont DEC.

Appendix A

Land Use and Land Cover of the

West, Williams, and Saxtons Rivers Watersheds

Table A.1. Land Use and Land Cover in the West River Watershed[1]

Land Use[2]	Acres	% of Total
Forested	230,431	86
Agriculture	7,579	3
Surface Water	13,064	5
Transportation	10,236	4
Wetlands	3,946	1
Developed Land[3]	3,107	1
Total:	268,363	100

Table A.2. Land Use and Land Cover in the Williams River Watershed[1]

Land Use[2]	Acres	% of Total
Forested	61,081	82
Agriculture	3,018	4
Surface Water	4,674	6
Transportation	3,219	4
Wetlands	967	1
Developed Land[3]	1,857	2
Total:	74,816	99

Table A.3. Land Use and Land Cover in the Saxtons River Watershed[1]

Land Use[2]	Acres	% of Total
Forested	40,780	82
Agriculture	1,699	3
Surface Water	4,149	8
Transportation	1,806	4
Wetlands	802	2
Developed Land[3]	609	1
Total:	49,845	100

1 Vermont Land Cover Classification Project, 1997 (based on satellite photographs from 1991 - 1993).

2 Does not include “brush or transitional land” or “barren land”

3 Developed land = residential, commercial, industrial but not transportation, which is listed separately

Appendix B

Macroinvertebrate Sites in Basin 11 1992 - 1999

Table B.1. Basin 11 River or Stream Macroinvertebrate Sampling Sites 1992 - 1999

WBID	River or Stream	Town	Mile-point	Date	Assessment
VT11-01	Williams River	Rockingham	3.0	9/92	excellent
VT11-03	South Branch Williams River	Chester	1.3	10/93	excellent
VT11-05	Saxtons River	Rockingham	4.5	10/93	good
VT11-05	Saxtons River	Rockingham	6.2	10/93	excellent
VT11-05	Saxtons River	Rockingham	6.2	10/94	excellent
VT11-05	Saxtons River	Rockingham	6.2	10/95	excellent
VT11-07	West River	Dummerston	6.2	10/92	good
VT11-07	West River	Dummerston	6.2	10/94	excellent
VT11-07	West River	Dummerston	6.2	10/95	good
VT11-09	Rock River	Newfane	1.5	10/93	excellent
VT11-13	Turkey Mountain Brook	Townshend	1.0	10/92	excellent
VT11-13	Cobb Brook	Jamaica	0.9	10/94	excellent
VT11-13	Cobb Brook	Jamaica	0.9	10/95	excellent
VT11-13	Cobb Brook	Windham	1.9	10/95	excellent
VT11-13	Cobb Brook	Windham	1.9	10/97	good
VT11-13	Cobb Brook	Windham	2.6	10/94	excellent
VT11-15	North Branch Ball Mountain Brook	Stratton	2.2	10/92	excellent
VT11-15	North Branch Ball Mountain Brook	Stratton	2.2	9/98	good
VT11-15	North Branch Ball Mountain Brook	Stratton	3.9	10/97	good
VT11-15	North Branch Ball Mountain Brook	Stratton	3.9	9/98	good
VT11-15	North Branch Ball Mountain Brook	Stratton	4.3	9/98	excellent
VT11-15	North Branch Ball Mountain Brook	Stratton	4.8	6/98	poor
WBID	**River or Stream**	**Town**	**Mile-**	**Date**	**Assessment**

			point		
VT11-15	Kidder Brook	Stratton	0.9	10/92	good
VT11-15	Sunbowl Brook	Stratton	0.3	10/92	excellent
VT11-15	Sunbowl Brook	Stratton	0.3	10/93	good
VT11-15	Sunbowl Brook	Stratton	0.3	10/94	good
VT11-15	Braser Brook	Stratton	0.7	10/92	excellent
VT11-15	Braser Brook	Stratton	0.7	10/93	good
VT11-15	Styles Brook	Stratton	0.8	10/93	fair
VT11-15	Styles Brook	Stratton	0.8	10/94	fair
VT11-15	Styles Brook	Stratton	0.8	9/98	fair
VT11-15	Stratton Pond Trib 1	Winhall	0.2	10/97	poor
VT11-15	Stratton Pond Trib 2	Winhall	0.1	10/97	good
VT11-16	Winhall River	Winhall	6.3	10/97	excellent
VT11-16	Winhall River	Winhall	7.1	9/96	excellent
VT11-16	Winhall River	Winhall	8.1	10/92	excellent
VT11-16	Winhall River	Winhall	8.1	9/94	excellent
VT11-16	Winhall River	Winhall	8.1	9/95	excellent
VT11-16	Winhall River	Winhall	8.1	9/96	excellent

Appendix C

Population and Housing Unit Growth in the

Three Watersheds of Basin 11

Table C.1. Population Growth in the West River Watershed

Town	Population				Percent Change		
	1970	1980	1990	2000	1970-80	1980-90	1990-00
Brattleboro	12,239	11,886	12,241	12,005	-2.9	3.0	-1.9
Brookline*	180	310	403	467	72.2	30.0	15.9
Dover	555	666	994	1,410	20.0	49.2	41.8
Dummerston*	1,295	1,574	1,863	1,915	21.5	18.4	2.8
Jamaica*	590	681	754	946	15.4	10.7	25.5
Landgrove*	104	121	134	144	16.3	10.7	10.0
Londonderry	1,037	1,510	1,506	1,709	45.6	-0.3	13.5
Marlboro	592	695	924	978	17.4	32.9	5.8
Newfane*	900	1,129	1,555	1,680	25.4	37.7	8.0
Peru	243	312	324	416	28.4	3.8	28.4
Stratton	104	122	121	136	17.3	-0.8	12.4
Townshend	668	849	1,019	1,149	27.1	20.0	12.8
Wardsboro*	391	505	654	854	29.2	29.5	30.6
Weston*	507	627	488	630	23.7	-22.2	29.1
Windham	174	223	251	328	28.2	12.6	30.1
Winhall	281	327	482	702	16.4	47.4	45.6
Watershed	19,860	21,537	23,713	25,469	8.4	10.1	7.4

* The town is wholly within the watershed. For towns not marked a substantial portion of the town's land area is within the watershed.

Table C.2. Population Growth in the Williams River Watershed*

Town	Population				Percent Change		
	1970	1980	1990	2000	1970-80	1980-90	1990-00
Andover	239	350	373	496	46.4	6.6	33.0
Chester	2,371	2,791	2,832	3,044	17.7	1.5	7.5
Grafton	465	604	602	649	29.9	-0.3	7.8
Rockingham	5,501	5,538	5,484	5,309	0.7	-1.0	-3.2
Watershed	8,576	9,283	9,291	9,498	8.2	0	2.2

Table C.3. Population Growth in the Saxtons River Watershed*

Town	Population				Percent Change		
	1970	1980	1990	2000	1970-80	1980-90	1990-00
Athens	159	250	313	340	57.2	25.2	8.6
Grafton	465	604	602	649	29.9	-0.3	7.8
Rockingham	5,501	5,538	5,484	5,309	0.7	-1.0	-3.2
Westminster	1,875	2,493	3,026	3,210	33.0	21.4	6.1
Windham	174	223	251	328	28.2	12.6	30.1
Watershed	8,174	9,108	9,676	9,836	11.4	6.2	1.7

* No towns are wholly within the watershed.

Appendix D

Dams of Basin 11

Table D.1. Dams of the West River Watershed

Dam Name	Stream	Town	Status	Use	Built	Re-built	State ID
Townshend	West River	Townshend	In Service	CR	1961		209.01
Wantastiquet Lake	West River-TR	Weston	In Service	R	1880	1990	237.01
Weston Mill	West River	Weston	In Service	P		1979	237.02
Williams	West River	Londonderry	In Service	O	1900		115.01
Ball Mountain	West River	Jamaica	In Service	RC	1961		105.01
Lowell Lake	West River-TR	Londonderry	In Service	R	1850	1981	115.02
Magic Mountain	West Brook-TR	Londonderry		R	1968		115.05
Thomson	West River-OS	Londonderry			1993		115.06
Gale Meadows	Mill Brook	Londonderry	In Service	R	1965		115.07
Burbee Pond	Turkey Mountain Brook	Windham	In Service	R	1900		247.01
Cole	Ball Mountain Brook	Stratton			1979		201.01
Mahoney Pond	Winhall River-OS	Winhall	In Service	R	1997		249.06
Gulf Brook Reservoir	Gulf Brook	Stratton	In Service	O	1975		201.03
Stiles Brook Reservoir	Gulf Brook	Stratton	In Service		1961		201.04
Hidden Lake	Marlboro Branch-TR	Marlboro	In Service	R	1850	1955	122.03
Kenny Pond	Baker Brook-TR	Newfane	In Service	R	1900		139.01
Hapgood Pond	Flood Brook	Peru	In Service	R	1939	1980	152.01
Lyons Pond	Burnt Meadow Brook	Peru					152.02
Farnum	Farnum Brook	Peru	In Service	R	1973		152.03
Lords Prayer Pond	Mill Brook-OS	Peru	In Serivce		1966		152.04
Newman	Burnt Meadow Brook	Peru	In Service	R	1981		152.05

Bromley Snow Pond	Mill Brook-TR	Peru	In Service	O	1984		152.06
Hapgood Pond	Flood Brook-TR	Peru	In Service	R	1939	1980	152.07
Strattonwald	Red Brook	Winhall	In Service	R	1977		249-01
Stratton Mountain Lake	North Branch Brook	Winhall	In Service	R	1977		249.02
Maud	Bromley Brook	Winhall	In Service				249.03
Gale Meadows Dike	Eddy Brook-TR	Winhall	In Service	R	1965		249.05
Sunset Lake	Stickney Brook	Brattleboro	In Service	S	1930	1974	122.01
Manley	Worden Brook-TR	Marlboro			1956		122.02

Table D.2. Dams of the Williams River Watershed

Dam Name	Stream	Town	Status	Use	Built	Re-built	State ID
Brockway Mills	Williams River	Rockingham	In Service	H		1988	169.08
Trask	Williams River-TR	Rockingham					169.03
Upper Chester Reservoir	Williams River-TR	Chester	Not In Use	O	1915	1971	48.01
Lower Chester Reservoir	Williams River-TR	Chester	Breached	S	1890		48.02
Tomasso	Williams River-TR	Chester			1983		48.05

Table D. 3. Dams of the Saxtons River Watershed

Dam Name	Stream	Town	Status	Use	Built	Re-built	State ID
Lawrence Four Corners	Saxtons River	Windham					247.02
Cambridgeport	Weaver Brook	Rockingham	Breached				169.01
Holbrook	Weaver Brook	Grafton	In Service	R	1978		83.01
Athens Pond	Athens Brook-TR	Athens					6.01

Appendix E

Individual Waterbody Reports

for Basin 11 Rivers and Streams

Note: Waterbody Reports not provided. Contact the Water Quality Division.