# Vermont Agency of Natural Resources

# LAMOILLE RIVER BASIN
# Water Quality Management Plan

## Interim Final Plan

## November, 2008

**Terrill Gorge Kenfield Brook, Morristown**

THE LAMOILLE RIVER BASIN WATER QUALITY MANAGEMENT PLAN WAS PREPARED IN ACCORDANCE WITH 10 VSA 1253(d), THE VERMONT WATER QUALITY STANDARDS, THE FEDERAL CLEAN WATER ACT AND 40 CFR 130.6.

Approved:

_____ _____

Laura Pelosi, Commissioner
Department of Environmental Conservation

Date

_____ _____

George Crombie, Secretary
Agency of Natural Resources

Date

# LAMOILLE RIVER BASIN
# Water Quality Management Plan
# Interim Final Plan

November, 2008

Agency of Natural Resources
Department of Environmental Conservation
Water Quality Division
Waterbury, Vermont 05671-0408

# TABLE OF CONTENTS

## List of Figures



## List of Tables

## Mission

*The Lamoille River Watershed supports an economically vibrant agricultural and forest based working landscape. Conflicts between human activities and the natural functions and values of streams, lakes, and wetlands within the watershed will be minimized whenever possible. Basin residents will be informed and working collaboratively to protect and improve the shared water based resources. Opportunities abound for youth to learn about and appreciate the watershed* (Lamoille Watershed Council, 2004).

Purpose

The principal purpose of this plan is to improve surface water quality and aquatic habitat in the Lamoille River watershed.

## EXECUTIVE SUMMARY

The Lamoille River Watershed Plan describes water quality conditions and water resource opportunities in the basin and recommends actions for the improvement of problems over the next five years. The principal purpose of the plan is to improve surface water quality and aquatic habitat by guiding the Agency of Natural Resources (ANR) in its own work and in collaborative projects with the public, municipalities, and other State and federal agencies. Water quality and aquatic habitat is acceptable when it supports uses that Vermonters deem to be beneficial and it attains or exceeds the criteria in the Water Quality Standards.

There are many identified values of the Lamoille River and its numerous tributaries including but not limited to gorges, waterfalls, cascades, whitewater and flat water boating, swimming holes, fishing, aquatic and riparian area habitat, and significant wetlands. The basin is home to numerous lakes and ponds with scenic and natural features, high water quality, and rare, threatened, and endangered species.

Basin planning is one method for addressing water quality and water resource problems. Its effectiveness depends on the willingness of the local community, landowners, and State and federal entities to undertake projects that will enhance or protect water quality. The planning process facilitates this collaborative effort. The plan enumerates carefully designed actions to achieve goals agreed upon during the planning process. Public concerns about water quality and actions that address the restoration of these waters were the focus of extensive public involvement. Within the next five years, the Agency of Natural Resources will focus its efforts in these areas in collaboration with the community and other partners. Implementation of these actions will address the greatest sources of impacts to water quality and aquatic habitat in the basin. The next basin plan will document work completed and will address any new issues that have emerged.

For this basin plan to be successful, the following water quality issues must be resolved:

*Wetlands*

- Protect wetlands through town and regional plans, zoning, and wetland classification upgrades through petitions submitted to the Water Resource Panel.
- Restore prior converted wetlands on idled agricultural lands.

*Lakes and Ponds*

- Protect high quality lakes and ponds and undeveloped shorelines.
- Enhance developed shorelines by establishing and protecting lakeshore buffer areas.

- Identify and remediate non point source pollution within lake subwatersheds.
- Prevent aquatic nuisance species spread and increase monitoring for lakes and ponds.

*River Corridor Management*

- Use watershed and stream geomorphic assessments in a proactive manner to direct and prioritize stream corridor protection, stream stability restoration projects, municipal pre-disaster mitigation efforts, fluvial erosion hazard mapping, and enhancement of aquatic and riparian habitats for fish and wildlife.
- Use the principles of fluvial geomorphology alternatives analysis to determine the most appropriate restoration methods for degraded stream reaches.

*Flow-altered Waters*

- Eliminate or reduce artificial lake and pond water level fluctuations where unnecessary or not cost effective.
- Identify small dams for stream restoration projects through selective removal or retrofitting that restore fish passage, aquatic habitat, and natural stream functions.

*Conversion of Farm and Forestland*

- Reduce the loss of working farm and forestland by implementing practices such as changes to zoning ordinances, estate-planning and transferring the farm educational workshops, purchase of development rights, and increasing markets for local agricultural and forest products as these land use conversions can have negative impacts to water quality and fish and wildlife habitat.

*Agricultural Land*

- Selectively apply agricultural best management practices to address runoff and streambank erosion associated with intensive agricultural uses.

*Developed Lands*

- Implement new stormwater and construction site permits, increase outreach, and implement restoration projects in priority areas in village centers and urban sectors.
- Conduct bridge and culvert assessments watershed wide to identify stream crossing structures that impede fish passage or contribute to stream instability and flood erosion hazards and upgrade crossing appropriately.
- Develop capital budgets for municipal road improvement projects.
- Assist municipalities in implementing road best management practices.

*Outreach and Education*

- Establish teams composed of local residents, learning institutions, businesses, and municipalities to direct and participate in assessment, restoration, and outreach efforts at the sub-watershed level.
- Build the capacity of Lamoille watershed and lake associations.

*Impaired waters restoration*

- Establish or continue collaborative partnerships in the restoration of waters that currently do not meet Vermont Water Quality Standards with a special emphasis on reducing phosphorous loads to Lake Champlain.

# CHAPTER 1. INTRODUCTION

*Turn your dreams into a goal and decide how to attack that goal. Break it into piece sized chunks that seem possible and then don't give up, just keep plugging away.*
-John Naber, former Olympian

## Purpose of the Basin Plan and the Basin Planning Process

This basin plan describes the strategies necessary to protect and improve the surface waters in the Lamoille River Basin, such that aquatic communities and habitat, swimming and fishing, and the general utility of waters will be maintained and enhanced. The Agency of Natural Resources, Department of Environmental Conservation (DEC) has collaboratively developed these strategies and will collaboratively implement them with watershed residents and other partners.

The collaborative effort started in 2001 with the identification of local concerns about the values and uses of the waters. Strategies were developed to address the local water resource concerns. The strategies in the plan are available to individuals, groups, and the Agency to assist in deciding where to focus resources and where to find resources. The strategies guide the Agency of Natural Resources, citizens, and landowners in their work, including the restoration of waters that do not presently attain the Vermont Water Quality Standards.

Implementation of strategies began during the basin planning process and will continue until the basin planning process begins again.

## Planning at the Watershed Level

A watershed, or basin, is a distinct land area that drains into a particular waterbody either through channelized flow or surface runoff. A watershed is defined by topography instead of traditional political boundaries. Because rivers join to become larger rivers, many watersheds may be considered sub-watersheds of larger watersheds. All of the waters within the Lamoille watershed drain into Lake Champlain, making the entire watershed a component of the larger Lake Champlain Basin.

The quality of surface waters in Vermont is mostly dependent upon the content and amount of surface runoff from activities taking place on surrounding land. Preparing a plan at a watershed level allows for the consideration of all contributing sources of surface water runoff to any one waterbody in the watershed.

The Agency of Natural Resources' planning efforts to improve or maintain water quality at a watershed level has been conducted since the 1970s. The state is divided into seventeen planning basins for this purpose. The Agency is responsible for preparing basin plans for each of the 17 major basins and updating them every five years after the plan is originally approved. A planning basin may include one or more major river watersheds (Figure 1).

## Plan Development as a Collaborative Process

Planning through a collaborative process with the communities in the basin, local, State, and federal governments, and private organizations is one important method to improve water quality. This method works well today because Vermont's water quality problems are, for the most part, the result of runoff from many, dispersed activities on the land (non point source pollution) and not from single point sources.

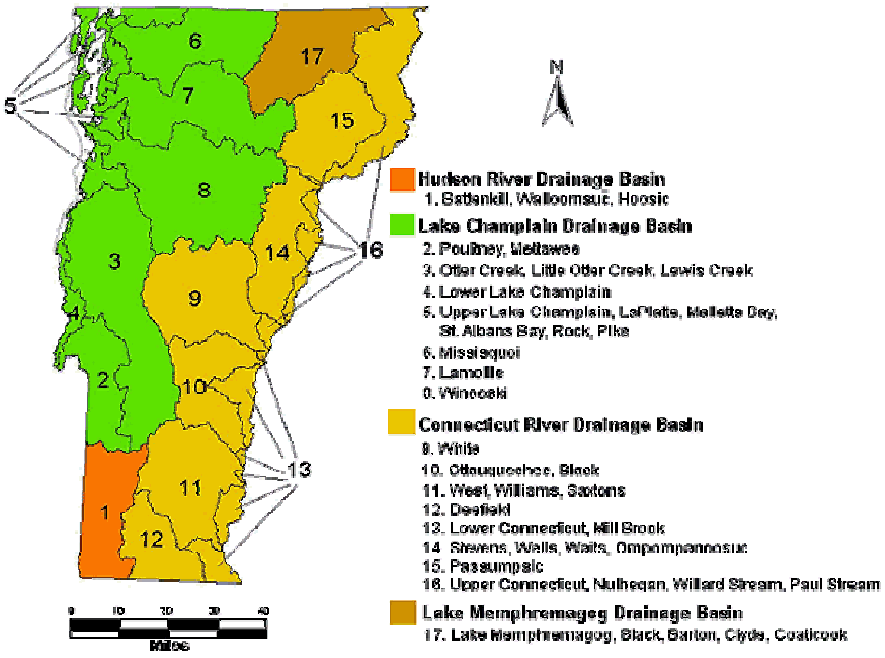



**Figure 1. Major Planning Basins in Vermont.**

The State cannot depend solely on regulations to stem the innumerable sources of pollutants. It must look to the interests and voluntary actions from watershed residents. Vermont already has more than 65 watershed and river groups, many of whom are involved in efforts to address water quality concerns. There are thousands of landowners also working to manage their lands to conserve Vermont's waters. Basin planning can support their efforts by providing technical and financial assistance. By documenting community-voiced problems and solutions, basin planning can better direct the resources of the State and others toward the priorities of local communities and landowners.

Another benefit of a collaborative approach is the sharing of information among resource agencies, groups, and individual citizens. This results in more realistic solutions. The involvement of the community in identifying problems and solutions increases public awareness of opportunities to promote and preserve water quality in the basin.

## Partners in the Lamoille River Watershed Planning Process

Numerous individuals and organizations collaborated in the development of this watershed plan and implementation of water quality improvement projects. Some of these organizations include: Lamoille County, Chittenden County and Northwest regional planning commissions (RPCs) and Northeast Vermont Development Association; Franklin, Lamoille, Orleans, Winooski, and Caledonia Natural Resource Conservation Districts (NRCDs); USDA Natural Resources Conservation Service (NRCS); Lamoille River Anglers Association; Lamoille Watershed Association; Lamoille County Farm Bureau; Vermont Agency of Agriculture, Foods and Markets (AAFM); Central Vermont Public Service Corporation (CVPS); Morrisville Water and Light Department, Hardwick Electric, Smugglers Notch Resort; the U.S. Fish and Wildlife Service; DEC's Water Quality, Water Supply, and Wastewater Management divisions; and the Departments of Forests and Parks, and Recreation and Fish and Wildlife; municipal conservation commissions,

planning commissions, select boards; and numerous watershed residents and landowners.

## Public Participation

*We must engage a broad cross-section of Vermonters in each watershed in developing these action plans and working to implement their own strategies for watershed improvement. The Agency will provide leadership and support this effort, but the best, most successful strategies for managing our waters will come from the people who live, work, and play in each watershed.*

-Canute Dalmasse, former and late Deputy Secretary, Vermont Agency of Natural Resources

### Watershed Plan Development

The premise for the development of this plan is to use a proactive, collaborative, and restoration-oriented approach to identifying solutions that emphasize voluntary actions to improve water quality. The planning process included the following steps:

- Issue identification;
- Issue prioritization;
- Strategy and solution development;
- Identification of resources and funding; and
- Implementation of water quality improvement projects.

The planning process will occur for each river basin on a five-year cycle, incorporating planning, implementation, monitoring, and evaluation. Every 5th year, the renewed plan will guide a continually evolving course of watershed improvement activities for the basin. Appendix A.3 includes a compilation of all public meetings held during the watershed plan development.

### Watershed Council

The Lamoille Watershed Council was formed to represent a diverse mix of stakeholders from within the watershed. The Council members represent watershed constituents from various backgrounds including farmers, foresters, loggers, business owners, municipal officials, anglers, local watershed organizations, environmental groups, teachers, utility companies, regional planners, and a ski area among others. The DEC watershed coordinator and the Watershed Council have developed the watershed plan and will assist in the implementation of watershed restoration projects**.** The Watershed Council met monthly for over two years to formulate a collaborative approach to resolving water quality issues of high priority. Council membership and meeting attendance was continually open to the public. Technical advisors provided the Council and watershed coordinator with information necessary to develop strategies to be included within the watershed plan (see Appendices for a list of Watershed Council membership and technical advisors as well as the schedule of public meetings). The Lamoille Watershed Council was integral in the development of this document. Council members:

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

***Lamoille Basin public forum, Johnson***

*People ..... are inherently capable of making proper judgments when they are properly informed.*
-Thomas Jefferson

**Panel Discussions**

The Watershed Council members held a series of panel discussions, including presentations and question and answer sessions between technical persons and the Council members and residents, regarding the top Lamoille River watershed water quality issues. Panel discussion topics included impaired waters remediation, transportation infrastructure and water quality, accepted agricultural practices (AAPs) and best management practices (BMPs), logging acceptable management practices (AMPs), fluvial geomorphology (stream dynamics), surface water typing, loss of the working landscape issues, and water quality and aquatic habitat issues associated with lakes, ponds, and dams. The Council used water quality assessment information in developing strategies and prioritizing water quality issues.

# CHAPTER 2. GENERAL DESCRIPTION OF THE LAMOILLE WATERSHED

*Any river is really the summation of the whole valley. To think of it as nothing but water is to ignore the greater part.*

***-Hal Borland, This Hill, This Valley***

## Physical Description

The Lamoille River main stem originates in the northwest corner of the Town of Wheelock, along the east side of Vermont Route 16 at the outlet of Horse Pond. It flows 84.9 miles in a generally westerly direction until it empties into outer Mallett's Bay of Lake Champlain ten miles north of Burlington. It is a pool-riffle gravel bottom river for the majority of its length although there are smaller reaches of dune-ripple sand bottom and plane-bed cobble-boulder bottom. From its headwaters to the mouth, the river descends approximately 1,200 feet and drains a 706 square mile watershed, which is 7.5 percent of Vermont's land area. The basin occupies the major part of Lamoille and lesser parts of Franklin, Chittenden, Orleans, Washington, and Caledonia Counties (DEC, 2001). (See Figure 2).

There are a total of 24 lakes and ponds that are 20 acres or larger in the Lamoille River Basin. Caspian Lake, Arrowhead Mountain Lake, and Green River Reservoir are by far the largest with areas of 789 acres, 760 acres, and 554 acres respectively. Major tributaries to the Lamoille River include the Wild Branch (39 square miles), Green River (22 square miles), Gihon River (66 square miles), North Branch (37 square miles), Brewster River (21 square miles), Seymour River (21 square miles), and Browns River (92 square miles).

Forested land is the dominant land cover/land use in the Lamoille River watershed (71 percent). Agriculture is the second largest land use with relatively high percentage coverage of 13 percent. Surface waters cover about 7 percent of the watershed area and wetlands about 3 percent. Transportation uses cover 4 percent of the area and other developed land occupies 2 percent.

## Existing Uses

There are many identified special uses, features, and values of the Lamoille River and its numerous tributaries including waterfalls, cascades, whitewater boating stretches, and swimming holes. All surface waters in Vermont are managed to support uses valued by the public including swimming, boating, and fishing. The degree of protection afforded to these uses is based on the water's management type or class as described in Chapter 6 of this plan. In particular surface waters, however, some uses are protected absolutely if the Agency of Natural Resources identifies them as existing uses under the anti-degradation policy of the Vermont Water Quality Standards (VWQS).

The Agency identifies existing uses of particular waters either during the basin planning process or on a case-by-case basis during application reviews for state or federal permits. During the Lamoille Basin planning development DEC, focused on the following Existing Uses:

- The use of the waters for swimming;
- The use of waters for boating;
- The use of the water for water supply, and
- The use of water for recreational fishing.

During the planning process, DEC has collected sufficient information to identify the existing uses listed in Tables 1-4. The list is not meant to be exhaustive. Existing Uses of specific waters were limited to those waters with public access (Appendix A.9). The public is encouraged to nominate other existing uses, which may be included in the basin plan or catalogued for a more thorough investigation when an application is submitted for an activity that might adversely affect the use.

**Swimming as an Existing Use**
There are a number of popular swimming holes both on the Lamoille River mainstem and on its tributaries. The locations described below are also generally some of the most scenic and aesthetically pleasing spots on the river. All sites listed on Table 1 are rated significant for swimming (DEC, 1992). Sites listed here are accessed through publicly owned lands such as stream crossing right-of-ways. Many locations that are privately owned with private access are not included in Table 1. Landowner permission should be sought before using these resources.

**Recreational Boating as an Existing Use**
A number of locations are good whitewater boating stretches in the basin. The Lamoille main stem is used extensively for flat water canoeing and kayaking by the several local outfitter businesses as well as the general public. All sites listed on Table 2 are rated significant for boating (DEC, 1989) or were otherwise brought to DEC's attention. Many canoe access areas and dam portages have been established on the main stem. Anyone boating these reaches should carefully scout routes before launching.

**Drinking Water Supplies**
There are approximately 84 drinking water systems within the watershed. The source types include impoundments, lakes and ponds, streams, well points, dug wells, gravel and gravel screened wells, gravel open-end casings, rock wells and springs. Currently, only three surface waters within the watershed are designated as drinking water supplies (Table 3). Silver Lake and its tributaries, located in the Town of Georgia, are used as a drinking water supply for the Town of St. Albans. The unnamed tributary to the Brewster River in Cambridge is a drinking water supply for Smugglers Notch Resort. The Town of Greensboro has designated Caspian Lake as a reserve public drinking water supply in the event of an emergency. Most other municipalities in the watershed use ground water wells for drinking water supplies.

**Table 1. Swimming (Contact Recreation) as an Existing Use of Specific Waters within the Lamoille River Watershed.**

| Swimming Site Name | Town | Location |
|---|---|---|
| Lamoille River, Dogs Head Falls- lower pool | Johnson | Patch Road |
| Picnic Ledges | Wolcott | Route 15 east of village |
| Lamoille River, Wolcott Village | Wolcott | Route 15 in village |
| Terrill Gorge-Kenfield Brook | Morristown | Duhamel Road-F&W parking lot |
| Elmore Branch | Wolcott | East Elmore Road |
| Sheep's Hole-Foot Brook | Johnson | Foot Brook Road |
| The Ledges-Foot Brook | Johnson | Cherry Hill Road |
| Power House Bridge Falls-Gihon River | Johnson | School Street |
| Rogers Bridge-Seymour River | Cambridge | Lower Valley Road |
| Brewster River Gorge Swimming Hole | Jeffersonville | Route 108 turn on road south and west of Grist Mill |
| Codding Hollow Covered Bridge-North Branch | Waterville | Codding Hollow Road |
| Calavale Brook Cascades | Eden | Route 118 |

**Table 2. Recreational Boating as an Existing Use of Specific Waters within the Lamoille Watershed.**

| Location | Documentation | Rating | Characteristics that support that use | Put in | Take out |
|---|---|---|---|---|---|
| Lamoille River- Greensboro Bend to Hardwick (7-8 miles) | *Vermont's White Water Rivers* | Highly Important | Class I-III, longest stretch of Class III in northern Vermont | Upstream of Greensboro Bend with portage in East Hardwick | Upstream of Hardwick Village |
| Lamoille River- Wolcott Ledges (1.4 miles) | *Vermont's White Water Rivers* | Highly Important | Class III can be run in wet summers and fall | Behind the Pottersville Dam powerhouse | Downstream of Wolcott Village |
| Lamoille River (34 miles) Morristown to Fairfax | *Vermont's White Water Rivers* | High Importance | Class II-IV, whitewater and general touring | Duhamel Road, Morristown below Cady Falls | Upstream of Fairfax Falls (many portages) |
| Lamoille River (4.6 miles) Fairfax to Georgia | *Vermont's White Water Rivers* | Highly Important | Class II-III, one of two rapids on large rivers in the state | Road southwest of Fairfax Village | Route 104A Georgia |
| North Branch (9 miles) | *Vermont's White Water Rivers* | Not rated | Class II-IV, excellent to outstanding scenery and pristine | Bog Road Bridge, Belvidere | Church Street covered bridge, Waterville |
| Gihon River (1.5 miles) | *Vermont's White Water Rivers* | Not rated | Serious Class IV-V used by expert paddlers | Whitcomb Island Road, Johnson | Pearl Street, Johnson |
| Wild Branch (7 miles) | *Vermont's White Water Rivers* | Important | Fast, twisty, and highly technical Class II-III | North Wolcott Road upstream of Wolcott-Craftsbury line at town bride right-of-way | Route 15 at state bridge |
| Waterman Brook | *Let it Rain* | Not rated | Class IV-V used by expert paddlers | Waterman Road covered bridge, Johnson | River Road East, town bridge Johnson |
| Kenfield Brook | Vermont Paddlers Association recommendation | Not rated | Class IV- outstanding scenery | Tyndal Road, Morristown | Duhamel Road, Morristown |

**Table 3. Water Supply as an Existing Use within the Lamoille River Watershed.**

| Water Body | Location | Documentation |
|---|---|---|
| Silver Lake | Georgia and Fairfax | Silver Lake is the drinking water supply for St. Albans |
| Unnamed Tributary to the Brewster River | Cambridge | This impoundment is a drinking water supply for Smugglers Notch Resort |
| Caspian Lake | Greensboro | This lake is an emergency drinking water supply for the Town of Greensboro |

**Table 4. Recreational Fishing as an Existing Use of Specific Waters within the Lamoille Watershed.**

| Site Name/Waterbody | Location | Documentation |
|---|---|---|
| Fisher Bridge, Lamoille River | Route 15, Wolcott | VFWD access |
| Wolcott F&W Access, Lamoille River | Route 15, Wolcott | VFWD access |
| Town Ball Field | Off Route 15, Wolcott | VFWD access |
| Elmore Pond Road Bridge, Lamoille River | Elmore Pond Road, Wolcott | VFWD access |
| Cady Falls Bridge, Kenfield Brook and Lamoille River | Cady Falls Road, Hyde Park | VFWD access |
| Hog Back Road, Lamoille River | Hog Back Road, Johnson | VFWD access |
| Cambridge Junction Covered Bridge and Greenways Trail Access, Lamoille River | off VT Route 109, Cambridge | VFWD access |
| Horse Pond | Route 16, Greensboro | VFWD access |
| Flagg Pond | Flagg Pond Road, Wheelock | VFWD access |
| Wolcott Pond | Wolcott Pond Road, Wolcott | VFWD access |
| Elmore Pond | Route 12, Elmore | VFWD access |
| VFWD owned riparian lands along Lamoille River in Sheffield, Hardwick, Morristown, Hyde Park, and Johnson and along Porter Brook (direct Lamoille River drainage) in Greensboro and Hardwick, Alder Brook in Hardwick, Greensboro Brook in Greensboro and Hardwick, and Kenfield Brook in Morristown | (see description to left) | VFWD access |

## Fish Habitat, Fisheries, Access, and Water-Dependent Wildlife

### Access

There are many sites in the watershed where concentrated angling occurs. The Vermont Fish and Wildlife Department (VFWD) owns 25 riverbank segments totaling 62,000 linear feet (almost 12 miles), which provide riparian zone protection and direct public access for fishing.

Some of the fishing access areas are Fisher Bridge access in Wolcott, which is handicapped accessible, Town Ball Field access in Wolcott,

Elmore Pond Road Bridge access in Wolcott, Cadys Falls Bridge in Hyde Park, Hogback Road

in Johnson, Cambridge Junction Covered Bridge access and Greenways Trail access in Cambridge among others (Table 4).

VFWD acquired extensive fee ownership along several Vermont rivers from the 1950s into the 1970s. The principal purpose of these acquisitions was to ensure future public access for angling from streambanks at a time when traditional land use and ownership patterns were beginning to change, as large land ownership decreased and land posting increased. The VFWD also envisioned conservation benefits accruing from this type of public ownership: protecting water quality, fish populations, and riparian wildlife habitat by isolating the river from adjacent land uses.

In the 1990s, VFWD initiated a project to inventory the current condition of the lands and, where needed, improve wildlife habitat and public access conditions. The inventory includes identification of property boundaries, assessment of existing habitat and access conditions, and plans for future site-specific needs, such as access improvement, riparian buffer restoration, and resolution of boundary uncertainties. VFWD inventoried its streambank lands in the Lamoille River in 1998 (VFWD, 1998). Beginning in 2000, in partnership with local anglers, the Lamoille County NRCD, and the U.S. Fish and Wildlife Service, VFWD began restoring forested buffers on the Lamoille lands. To date over 2,200 trees have been planted along approximately 7,300 feet (1.4 miles) of riverbank. VFWD continues to work with its partners to monitor and enhance plantings as needed to ensure forested buffers are restored along the Fish and Wildlife Department streambank lands in the basin.

The VFWD owns and manages several wildlife management areas (WMA) within the watershed including East Hill WMA, Wild Branch WMA, Steam Mill Brook WMA, and Sandbar WMA as well as numerous fishing accesses and streambank lands.

The Lamoille River watershed supports a variety of aquatic habitats and fish species, from the cold, high gradient, headwater trout streams in the upper watershed to the warm, low gradient, large winding river and impoundments of the lower watershed. Throughout the watershed, the Lamoille's numerous lakes and tributaries provide a diversity of fishing experiences and public access opportunities.

### Fish Habitat and Fisheries

<u>Upper Watershed (headwaters in Wheelock to Morrisville)</u>

The upper Lamoille watershed is composed of a variety of substrate types originating from its ancient riverine and lake geology (DEC, 2001). The uppermost tributaries of the watershed upstream of the Greensboro Brook confluence are small, moderate gradient upland streams flowing through mainly forested riparian corridors. These tributaries contribute cold oxygenated water into the mainstem and are home to native self-sustaining brook trout populations, as well as slimy sculpins, blacknose and longnose dace, longnose suckers, and creek chubs. Downstream of Greensboro Brook to Hardwick, the fish population expands to include wild and hatchery-origin rainbow trout, white suckers, and brown bullheads. The upper main stem river itself is characterized by riffle-pool

habitat. Angling for brook trout is the most common fishing activity in this area, although overall fishing is relatively low.

As the Lamoille makes its way from Hardwick towards Morrisville, it alternates between short sections of steeper cobble-dominated rapids to the occasional ledge drop to the more dominant low gradient river reaches common to valley-bottom depositional areas. These slower moving, deep river areas support populations of rainbow trout and brown trout and minnows (common shiners, fallfish). Though wild brown trout and rainbow trout dominate the fish community in this stretch of river, some wild brook trout are present and hatchery-origin trout make up a small portion of the fish population. The lower reaches of the main tributaries in this area, such as the Green River and Elmore Branch, serve as important spawning and nursery habitat for main stem resident rainbow trout and brown trout. This reach of river is a popular trout fishing area, with rainbow trout dominating the catch.

The upper Lamoille has a variety of lakes and ponds both natural and man-made dam impoundments. Notable ponds in the upper watershed include: Long Pond and Caspian Lake (Greensboro), Flagg Pond (Wheelock), Nichols Pond (Woodbury), Hardwick Lake (Hardwick), Lake Elmore (Elmore), and Green River Reservoir (Hyde Park). Caspian Lake has populations of brown, rainbow and lake trout, as well as rainbow smelt, longnose suckers, and white suckers, all of which, except lake trout, migrate seasonally into the lakes feeder tributaries to spawn. Some lakes in the upper watershed support populations of yellow perch and pumpkinseed sunfish. These species, not native to or characteristic of upper-watershed systems in Vermont, have also been observed in stream reaches below the lakes.

<u>Lower Watershed (Morrisville to Lake Champlain in Milton)</u>

The first major upstream impoundment on this reach of the Lamoille River is Lake Lamoille, behind the Cadys Falls Dam in Morrisville. Warm water fish such as yellow perch, largemouth bass and pumpkinseed sunfish dominate this expansive, but relatively shallow impoundment. The reach downstream from Cadys Falls through Johnson again becomes cold-water habitat with a gradient, a diverse fish community and angling opportunities similar to those of the Hardwick-Morrisville reach. Elevated summer water temperatures from Lake Lamoille are moderated by several cool, oxygenated tributaries, most notably Kenfield Brook, Waterman Brook, and Foot Brook. These streams have high quality trout spawning and nursery habitat, contributing a significant amount of the wild trout production to the mainstem: they also provide critical cold-water refuges for trout during hot and dry periods. Another tributary, the Gihon River, also has a popular trout fishery, supported mostly by stocking. The Gihon begins at the outlet of Lake Eden, which has a warmwater fish community including smallmouth bass, yellow perch, rock bass and white suckers. A rainbow trout fishery in Lake Eden is maintained by stocking.

The character of the Lamoille River changes substantially when it reaches Cambridge. It becomes a very low gradient and widely meandering river. Trout habitat is more limited and warmwater fish such as smallmouth bass begin to appear. Wild brown trout and rainbow trout are in relatively low abundance. Trout are stocked. The best fishing opportunities are generally near the mouths of cool tributaries such as the North Branch of the Lamoille River and the Brewster River. Much of the North Branch is a moderate to high gradient stream with populations of wild brook, brown and rainbow trout, supplemented with stocked brown trout in the reaches below Belvidere. The upper North Branch and its many high-gradient forested tributaries in Belvidere are dominated by wild brook trout. The lower Brewster River is an important spawning and nursery area for mainstem trout. It also supports a population of burbot.

The Lamoille River from the Fairfax Falls Dam to its mouth at Lake Champlain is primarily

warmwater fish habitat. The river gradient increases again between Fairfax Falls and Arrowhead Mountain Lake, the largest impoundment in the drainage. The channel in this reach is wide, rocky, and relatively shallow. Smallmouth bass, rock bass, and fallfish are common, and walleye are caught occasionally. Two-year-old "trophy" brown trout are stocked below Fairfax Falls, maintaining a popular fishery.

Arrowhead Mountain Lake and the Peterson Dam impoundment are warmwater fisheries, with smallmouth and largemouth bass, walleye, northern pike and various panfish species. The final reach of the Lamoille River below Peterson Dam is largely influenced by Lake Champlain. Many Lake Champlain fish species use this reach for spawning and nursery areas, or for feeding at different times of year. Among the most notable are walleye, smallmouth bass, landlocked Atlantic salmon and the endangered lake sturgeon.

### Water-Dependent Wildlife

*There is a harmonious balance between plants, animals and people; between the domestic and the wild; between utility and beauty.*
-Aldo Leopold

The Lamoille Basin supports an array of wildlife species, all of which are dependent on clean water to survive. Some live all or part of their lives near streams, rivers, lakes, and wetlands, using them for habitat, food sources, and travel and dispersal corridors. Wildlife and the landscape that supports them are vital parts of Vermont's rural culture and character. Throughout Vermont's history, plants and animals have provided food, clothing, tools, endless enjoyment, and a spiritual connection to our landscape. For many people, simply knowing that black bears roam the woods of the Lamoille watershed and that loons nest on watershed lakes and ponds enhances their quality of life. In fact, the results of a 2001 public opinion survey conducted by the U.S. Fish and Wildlife Service, show that Vermont ranked first in the nation with 60 percent of its residents that actively viewed wildlife. Today, over 240,000 Vermont residents engage in wildlife-associated activities including viewing, hunting, fishing and photography. That is 11 percent more than ski in Vermont. In 1996, residents and non-residents spent $341 million dollars in Vermont on wildlife-associated activities. A recent survey of Vermont residents found that the protection of fish and wildlife resources, habitats and lands as well as the opportunity to participate in wildlife-related recreation was important to 97 percent of Vermont residents surveyed. This illustrates the strong connection Vermont residents have to the land and its wild inhabitants. Maintaining high quality surface waters is critical to realizing the continued survival and health of the Lamoille Basin's wildlife (VFWD and CCRPC, 2001).

## Other Uses of Lamoille River and Tributaries

### Irrigation and Animal Watering

Water from the Lamoille River system is an important resource for agriculture. Farms use a combination of drilled wells, springs and surface water for livestock watering. Vegetables, cut flowers, orchards, berries, and nursery stock are all supported by limited irrigation. Recent droughts have caused uncertainty in crop pricing, feed availability and dairy herd health.

### Public Water Source Protection Areas

Public water source protection began in Vermont in the late 1970's with the use of hydrogeologic methods to site new public community water supplies. A more formalized approach began in 1982 with the delineation of Wellhead Protection Areas (then called Aquifer Protection Areas or APA) for most municipal systems. Since 1985, the delineation of Public Water Source Protection Areas (SPAs) has been required for all proposed new sources for public community water systems. In order to provide for better protection of public health, every Public Community Water System, like municipalities and mobile home parks, is required to have an approved Source Protection Plan. Non-transient, Non-community Public Water Systems, like schools and factories with

their own source of water, are also required to have a Source Protection Plan.

Source Protection Plans are an important part of managing and protecting public water supply sources. A Source Protection Plan identifies the potential sources of contamination in a specific area, assesses the risks of these potential sources of contamination, describes how to manage the risk from the potential sources of contamination, and discusses how to handle emergencies. Some potential sources of contamination include fertilizers, pesticides, agricultural nutrients, septic system failures, hazardous chemicals, salt storage sites, eroding streambanks, golf courses, urban runoff, logging activities, landfills, and mineral extraction sites. Separate protocols exist for surface water systems using Lake Champlain as a Source Protection Area. These protocols evaluate the sensitivity of the intake pipes to localized runoff.

The Source Water Assessment Program, a federal requirement, requires the identification of potential sources of contamination and an identification of their risks to Transient, Non-community Public Water Systems (i.e., motels and restaurants with their own source of water), Public Community Water Systems, and Non-transient, Non-Community Public Water Systems.

**Ski Area Water Withdrawals**

Smugglers' Notch Resort currently operates three water withdrawals for snowmaking. They are located on tributaries to the Brewster River. Morse Reservoir, which is also a water supply reservoir and snow making pond, is located on the so-called No Named Brook watershed with a drainage area of 1.91 square miles at 2.3 million gallons. This reservoir is also the Resort's domestic drinking water supply. Another withdrawal is located at the confluence of Sterling and Madonna Brooks with a combined watershed area of 1.27 square miles. The latter withdrawal area has been in operation since 1982 with 6 million gallons. There is also a newer pond below the resort at Edwards Reservoir with 20 million gallons. Water captured at the withdrawals is stored at the resort's three reservoirs capable of containing a combined total of 28.3 million gallons (Smugglers Notch, personal communication, 2003).

Conservation flow requirements at the two water withdrawals are below the current February Median Flow (FMF) standard, having been permitted when the flow standard was much lower. Over the years, Smugglers Notch Resort has increased conservation flows in small increments in association with various projects. Currently, a conservation flow of 0.50 cubic feet per second per square mile (csm) is maintained at all sites.

Future expansion of snowmaking water supply and increases in the conservation flows at the existing withdrawals is expected to be accomplished by a new withdrawal on the Lamoille River in 2008. The Lamoille site combined with the existing withdrawals and storage will provide adequate snowmaking water for the resort for the foreseeable future. Based on permit conditions, Smugglers must increase the conservation flow at all sites to 0.8 csm (FMF) by 2010.

**North Branch of the Lamoille River, Waterville**

# CHAPTER 3. WATER QUALITY IN THE LAMOILLE RIVER WATERSHED

*A river is the report card for its watershed.*
***-Alan Levere, Connecticut Department of Environmental Protection***

## Identifying Water Quality Problems

Water quality is acceptable when it supports uses that Vermonters have deemed to be beneficial and it attains or exceeds the criteria in the Water Quality Standards. Beneficial uses range from recreation to the support of aquatic biota. These "designated" uses have been codified in the *Vermont Water Quality Standards* (Vermont Water Resources Panel, 2008). At times, the preservation of these diverse, multiple uses may be in conflict. The State must seek a balance among conflicting uses while sustaining each use in accordance with the Standards.

The Agency assesses impacts or threats to these protected uses by using chemical, physical, and biological data, and best professional judgment based on knowledge of the waterbody and its conditions. The community is also an important resource to the Agency for identifying problems on individual water bodies or general concerns that reflect problems prevalent throughout much of the watershed.

The following documents prepared by the Agency of Natural Resources describe the results of water quality assessment of the basin:

- The Vermont Department of Environmental Conservation Water Quality and Aquatic Habitat Assessment Reports identify overall and specific water quality conditions.

- Section 303(d) 2008 List of Waters and the List of Priority Surface Waters Outside the Scope of the Clean Water Act Section 303(d) identify specific surface waters with water quality problems.

The water quality problems addressed in the basin planning process are based on information from the above documents and on issues identified during public forums. Water quality information is summarized below.

## General Water Quality Conditions

There are 611 river and stream miles within the Lamoille River Watershed. Approximately 68 percent of the total river miles have been assessed for their physical, chemical, or biologic health. There are 6 water reaches that are listed as impaired and, therefore, do not meet current Vermont Water Quality Standards (see Chapter 5). Most of these waters are located in the lower portion of watershed. Impairments are attributed to various land uses including hydroelectric facility drawdowns, agricultural runoff, residential and urban runoff (stormwater) as well as atmospheric deposition from mid-western power plants. The major pollutants include excessive nutrients such as phosphorous and nitrogen, manure, pesticides, fertilizers, heavy metals, oil, gas, and sediments. Low levels of dissolved oxygen in the water at certain locations cause additional water quality problems. Uses and values negatively affected by these pollutants include swimming, fishing, boating, aesthetics, drinking water supplies, and aquatic biota and habitat.

In 1996 the Lake Champlain Management Conference prepared a pollution prevention, control, and restoration plan called the *Opportunities for Action, An Evolving Plan for the Future of the Lake Champlain Basin*. The plan identifies three priorities for action:

- The reduction of phosphorus pollution,
- The prevention of toxic substance pollution, and
- The management of nuisance non-native aquatic plants and animals

The Lake Champlain Basin Program (LCBP) is a federally funded initiative working in partnership with agencies, organizations, and individuals to develop and implement *Opportunities for Action*.

The Mallets Bay segment of Lake Champlain has been identified as a targeted watershed for phosphorus reduction. Implementation of phosphorus reduction measures are directed at agricultural activities, new construction, and road system best management practices; stream restoration projects; retrofitting stormwater management systems; and shoreline restoration and protection. This Lamoille River watershed plan serves as a guide to implement specific practices at the sub-watershed level.

## Public's Concerns Regarding Water Quality Problems

*Public participation shall be sought to identify and inventory problems, solutions, high quality waters, existing uses and significant resources of high public interest.*

-Vermont Water Resources Panel, 2008

Eight public forums were held throughout the watershed to solicit residents' concerns and visions regarding water quality issues in the Lamoille River watershed. The Nominal Group Process was used to stimulate group participation. The results of a previous series of workshops held by the Browns River Watershed Council and the Lamoille County Conservation District were also considered. The top issues of the eight forums were ranked and used to direct the Watershed Council and DEC in developing basin plan strategies, securing funds, and recruiting technical advisors to improve water quality.

**Watershed residents' top water quality concerns:**

- Stream instability and flooding
- Stormwater management
- Agriculture and water quality
- Transportation infrastructure- including bridges, culverts, rail and road embankments, and driveway accesses
- Dams and water level fluctuation, stream instability and fish passage
- Loss of working farms and forestland

Strategies to address these top water quality issues begin on page 53.

## Wetlands

*Wetlands have a poor public image.... Yet they are among the earth's greatest natural assets... mankind's waterlogged wealth.*

-Edward Maltby

**Introduction**

The Lamoille River watershed contains 2,377 wetlands mapped on the Vermont Significant Wetland Inventory (VSWI) maps, totaling over 18,454 acres (DEC, 2000). Mapped wetlands constitute more than 4% of the watershed area. Of these mapped wetlands, most are between one and five acres, although there are 53 wetlands over 50 acres. Wetland functions and values include: surface and ground water protection; water storage for flood water and storm runoff; fisheries habitat; wildlife and migratory bird habitat; hydrophytic vegetation habitat; threatened and endangered species habitat; education and research in natural sciences; recreational value and economic benefits; open space and aesthetics; and erosion control through binding and stabilizing soil.

The east to west orientation of the Lamoille River Watershed incorporates a number of biophysical regions in Vermont. These include the Northern Vermont Piedmont region to the east, the Northern Green Mountain region in the center of the watershed, and the Champlain Valley region at the western end of the watershed (Thompson and Sorenson, 2000). Each biophysical region contains wetland natural community types characteristic of that area. Functions and values for specific Lamoille Basin wetlands are included in Appendix A.5.

**Wetland Classification**
The Wetland Rules give the State jurisdiction over Class One and Class Two wetlands, which are shown on Vermont Significant Wetlands Inventory (VSWI) maps and are protected by the Vermont Wetland Rules. Class Three wetlands are not mapped and thus not protected under the Vermont Wetland Rules. Class Two wetlands have protected buffers of 50 feet. Class One wetlands incorporate a 100-foot buffer zone, thus ensuring greater protection of the wetland to adverse adjacent land development. Currently, no Class One wetlands exist in the watershed.

**Impacts and Threats to Wetlands**
The Agency of Natural Resources DEC Wetlands Section examines more than 500 new projects a year throughout Vermont that have the potential to alter wetlands. More than 650 wetland projects have been reviewed in the Lamoille River watershed since the implementation of the Vermont Wetland Rules in 1990.

Projects are examined to determine if the functions and values of the wetlands will be lost as a result of the proposed use. Wetlands are recorded as lost when the wetland is permanently destroyed from filling or draining or altered when the wetland is not permanently destroyed but is not functioning at its original level due to ditching, dredging, and partial filling or draining.

Road projects cause the greatest loss to Class Two wetlands, followed by residential development. The expansion of old roads built along river corridors and wetlands, and the construction of new roads over the past ten years has resulted in approximately two acres of known loss to Class Two wetlands in the watershed. Most residential development is at the western end of the watershed in Chittenden and Franklin Counties.

Most of the wetlands affected in the Lamoille River watershed are deciduous scrub-shrub wetlands. Speckled alder or buttonbush usually dominates these types of wetlands. Many of the emergent wetlands are prior converted agricultural fields. Wetlands that were drained and converted to agricultural uses years ago may go straight from wet meadow to residential development because they do not contain as many protected functions and values as they did in their original state. Over two acres of broad-leaved, deciduous forested wetland have been altered by various projects since the Wetland Rules were adopted in 1990. These areas include red maple swamps and black ash swamps.

Threats to many of the important wetlands described above include logging, agricultural conversion, runoff, and residential development associated with an expanding population. In the eastern section of the watershed, the significant northern white cedar swamps are most at risk from logging. The bogs in the Northern Green Mountain region are more vulnerable to small changes in hydrology and nutrient loads.

The rapid urbanization of the landscape pushes the boundaries of natural areas to smaller dimensions, and creates more opportunities for pollution and stormwater runoff. Runoff from agriculture, silviculture, and residential development threaten both Molly Bog in Morristown and Belvidere Bog in Belvidere and Eden. The Champlain Valley region contains the most diverse and abundant wetlands, but also the most threats to these wetlands.

**Lower Lamoille Wetland Inventory, Restoration, and Outreach Project**
A lower Lamoille watershed wetland inventory was completed in late 2007 by the Chittenden Regional Planning Commission (CCRPC), DEC, and the ANR Clean and Clear Wetlands Specialist. The inventory indicated that 150 potential high priority wetlands exist in the Chittenden County portion of the watershed. The first phase of this project would involve working with municipalities and landowners within the Lamoille Watershed in Chittenden County. The municipalities include Milton, Westford, Essex, Jericho, and Underhill. Landowners with potential wetland restoration sites have been identified. Public meetings were held in 2008 to explain the importance of wetland

protection and restoration, landowner benefits, and how landowners can become involved

A second task for this project would be to use the 2004 EarthData imagery (1:1250 scale) and the 2003 NAIP imagery to identify other potential wetland restoration opportunities. Using the imagery mentioned above, CCRPC staff would print large municipal maps and identify potential wetland restoration opportunities (with guidance from the Wetlands Restoration & Protection Specialist). These potential sites will be roughly mapped and landowners will be identified so that outreach and/or field visits may be conducted.

## Lakes and Ponds

*In the spring rain,*
*The pond and the river*
*Have become one.*
-Buson

**Introduction**
The Lamoille River watershed is characterized by numerous lakes, ponds and reservoirs. These provide significant opportunities for public use, recreation, and enjoyment, and they are well used for these purposes. They also support designated uses such as aquatic life, agricultural and drinking water supply, fish consumption, boating, and swimming. While the lakes and ponds of the Lamoille Basin are, in general, of high quality, not every designated use is fully supported at every lake. Uses of some lakes and reservoirs are impacted or threatened due to fluctuating water levels, mercury contamination, low pH, siltation/sedimentation, and invasive exotic species infestations (DEC, 2001). Mercury contamination and acidification of lakes and ponds in Vermont are the result of atmospheric deposition from incinerators, coal plants, and automobile pollution, most of which originate out of the state an out of the region.

**The Vermont Lay Monitoring Program**
The Vermont Lay Monitoring Program (LMP) is a citizen participation program in which volunteers are trained and equipped to conduct weekly summer-time water quality sampling on lakes (DEC, 2002a). The principal objectives of the program have been to accumulate an accurate water quality database on lake nutrient levels and to inform lake residents about lake protection and biology. Currently the LMP is active on the following lakes and ponds in the Lamoille watershed: Nichols Pond in Woodbury, Green River Reservoir in Hyde Park, Caspian Lake in Greensboro, and Lake Eden and South Pond in Eden. Lake Elmore, East Long Pond,

Arrowhead Mountain Lake, and Wapanacki Pond have historically been involved in the LMP program but are now inactive. The importance of volunteer monitors can not be stressed enough in assisting the state and lake watershed residents to better understand conditions of Vermont lakes and long term lake water quality trends.

**Impacts and Threats to Designated Uses in Lake and Ponds**

The Lamoille River watershed is characterized by 79 lakes and ponds, comprising 4,268 acres. The designated use that is most affected by activities or conditions resulting in less than full support is fish consumption due to mercury contamination. Aquatic life is the use with the second largest number of acres not fully supported due to mercury contamination. Swimming and secondary contact use (boating or fishing) are the uses tied at third largest number of acres with less than full support. Swimming, secondary contact recreation, aquatic life use, and aesthetics are stressed on a relatively large number of acres but these areas still currently support the designated uses. Agricultural water supply uses were not assessed.

The principal cause of impacts to lakes in the Lamoille River watershed is the drawdown of water levels, which alters and stresses aquatic life use on 293 acres (Lake Lamoille and Hardwick Lake) and stresses 1,899 acres of several other lakes. Mercury contamination in fish tissue impairs 760 lake acres. Critically low pH in a tiny

pond impairs aquatic life use on one lake acre, but an additional 899 acres on other lakes are threatened by low buffering capacity, which could lead to episodic low pH events. Siltation impairs aquatic life use in the 194-acre Hardwick Lake, and is noted as a threat to uses on 411 additional acres. Infestations of exotic species alter 136 acres and stress an additional 437 lake acres. Appendix A.6 lists the causes of impacts to lakes in this basin.

**Lakes and Ponds Top Water Quality Issues**

- Conservation and protection of undeveloped shorelands and exceptional waters (Figure 2)
- Lake watershed and shoreland land use issues
- Invasive Exotic Species
- Low pH, mercury and lead sinker impacts to wildlife
- Water level fluctuation

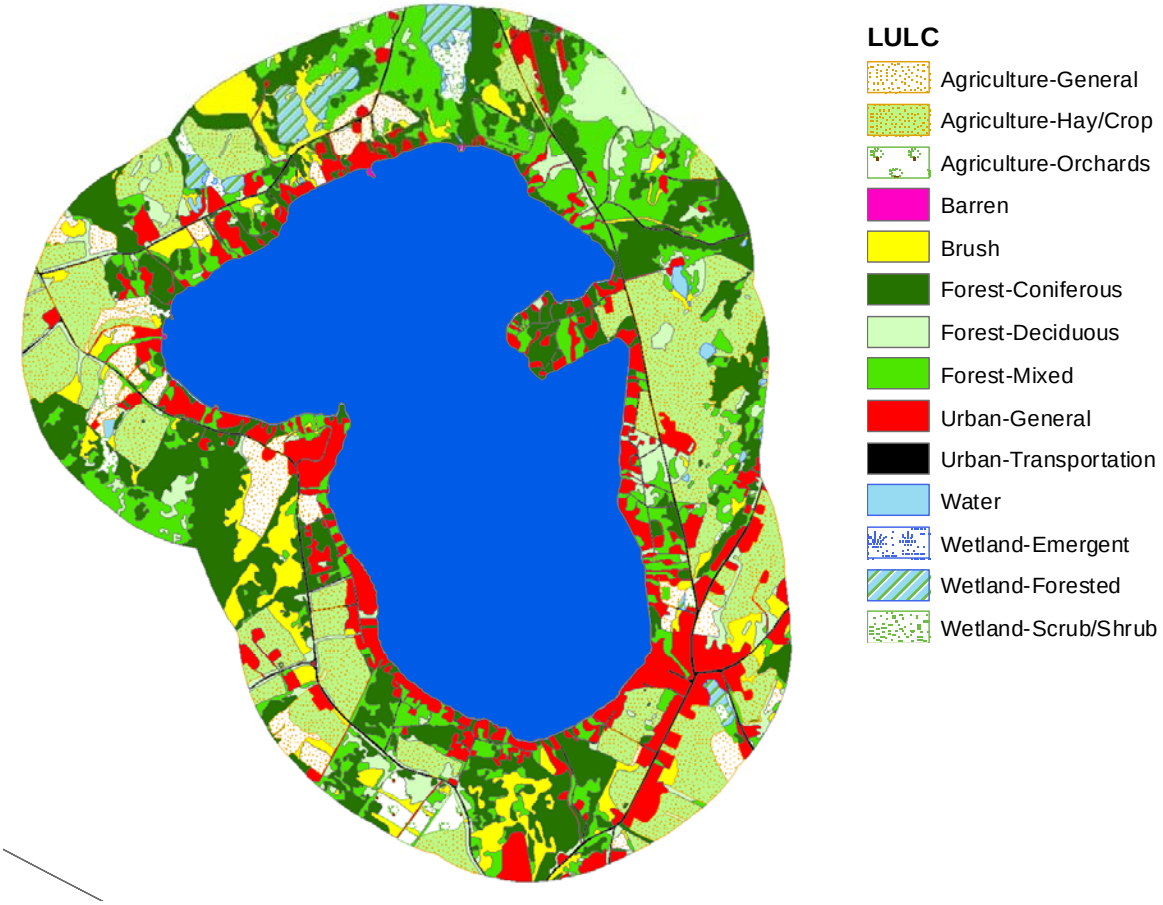
**Conservation and Protection of Undeveloped Shorelands and Exceptional Waters**

While recreational uses abound in the vast majority of Vermont's lakes, Vermonters only have a handful of lakes in which they can experience the recreational opportunities that undeveloped lakes can offer. In order to ensure that today's Vermonters and future Vermonters can have access to lakes that provide a feeling of solitude as well as stretches of undeveloped shoreline on developed lakes, it is important to have a lake protection and conservation strategy. In addition, undeveloped lakeshores provide critical water quality protection, as well as, wildlife and aquatic life habitat. Lakeshore property is highly sought after real estate, so it is only through the work of many that we will be able to ensure that any of it remains intact for all Vermonters and the fish and wildlife species that depend upon it.

Forty-nine percent of the shoreline of Caspian Lake is developed within 25 feet of the waterline. There are no significant (at least 1,000' long and 250' wide) stretches of undeveloped shoreline left (Figure 2).

***Little Elmore Pond, Elmore***

**Figure 2. 2003 Detailed land use land cover map of Caspian Lake-** created by University of Vermont's Spatial Analysis Laboratory.




DEC's Lake Protection Classification System (DEC, 1994) defined five categories of unique lakes; which were wilderness, wilderness-like, ultra-oligotrophic lakes, lakes with unusual scenic or natural features; and lakes with rare, threatened or endangered plants or wildlife species. The LPCS identifies lakes that are unique from a statewide perspective. The current Lakes and Ponds Inventory shows eight lakes in the Lamoille watershed that meet the wilderness-like criteria. There are only nine lakes in the state that meet the highest wilderness-like rating of 10. Two of these are found in the Lamoille watershed: Little Elmore and Zack Woods. This rating means that there are no structures on the shore and that the only structures visible in the watershed are inconspicuous when viewed from the lake. This type of lake provides a real sense of solitude, yet they are not to difficult to access with a 2WD road within 1/3 of a mile of the lake. Since the lakeshores surrounding these ponds are not conserved, they should be a priority for protection efforts. Long Pond in Greensboro and Schofield Pond have the next highest wilderness-like rating of 9. While Schofield will remain this way, Long Pond is vulnerable to development and loss of this unique rating. There are four lakes in the watershed with a wilderness-like rating of 8: Green River Reservoir, Silver Lake, Tuttle Pond, and Wolcott Pond. This

rating applies to lakes that afford a sense of solitude, but they may have some inconspicuous structures along the shore. Silver Lake is a drinking supply reservoir and like Tuttle and Wolcott ponds its shoreline is not conserved. Of the eight Lamoille watershed lakes identified as providing a wilderness-like experience that is unique in Vermont six are well buffered enough so they are not sensitive to the degrading effects of acid rain (Table 3). This make them even more valuable a resource to protect, since many of the other wilderness-like lakes in the state are sensitive to acid rain and are not in full support of aquatic uses.

**Table 5. Wilderness-like Lakes in Lamoille Watershed.**

| Lake | Location | Wilderness-Like Rating | Conservation Status | pH Threat |
|---|---|---|---|---|
| Green River Reservoir | Hyde Park | 8 | C | |
| Little Elmore | Elmore | 10 | P | T |
| Long Pond | Greensboro | 9 | P | |
| Schofield Pond | Hyde Park | 9 | C | |
| Silver Lake | Georgia and Fairfax | 8 | N | |
| Tuttle Pond | Hardwick | 8 | N | |
| Wolcott Pond | Wolcott | 8 | P | |
| Zack Woods Pond | Hyde Park and Wolcott | 10 | N | |

C= Lakeshore Conserved, P=Partial Lakeshore Conserved, N=No Lakeshore Conserved, T=Threatened

DEC's Lakes and Ponds Section has determined the lakes in Table 5 meet the wilderness-like criteria from visits to these lakes. Using GIS and the conserved lands layer provided by University of Vermont's Spatial Analysis laboratory, conservation status of the shoreline was established. It is possible that some of the lakeshores along Little Elmore and the five Threatened lakes in Table 5 have been conserved since the GIS layer was last updated; it is also possible that some of these lakeshores have been developed and that the unique rating no longer applies. Green River Reservoir and Schofield Pond are located in Green River Reservoir State

Park and are entirely conserved and some of the lakeshore around Little Elmore Pond is conserved as well. Silver Lake is part of the St. Albans water supply and may be protected at the municipal or landowner level.

Ground-truthing of each lake's status as identified in Table 5 should be undertaken. DEC and the University of Vermont's Spatial Analysis Laboratory plan to identify significant stretches of undeveloped and unconserved lakeshore that are important habitat for species identified as species of greatest conservation need (SGCN) by Vermont's Wildlife Action Plan. The collaborators will be collecting habitat and species distribution data and using conservation reserve design approaches to identified lakeshore in the Lamoille watershed most critical for conservation. The work is partially funded with a grant from Vermont's Wildlife Action Plan. Priority lakes information will be shared with local landowners, citizens, town planners, lake associations, local and state-wide conservation groups that can investigate potential easement purchases, zoning regulations and other strategies to preserve the wilderness or undeveloped nature of these waterbodies.

**Table 6. Functions and Values of Selected Lamoille Watershed Lakes (DEC, 2008).**

| | Location | Wilderness-like or Scenic | Loon Breeding Habitat | Presence of Rare, Threatened or Endangered Species | Shoreland Wetlands | Ultra-low Phosphorus |
|---|---|---|---|---|---|---|
| Long Pond | Greensboro | ✓ | | | | |
| Silver Lake | Georgia and Fairfax | ✓ | | | | |
| Green River Reservoir | Hyde Park | ✓ | ✓ | | | |
| Little Elmore Lake | Elmore | ✓ | | ✓ | | |
| Tuttle Pond | Hardwick | ✓ | | | ✓ | |
| Wolcott Pond | Wolcott | ✓ | ✓ | ✓ | | |
| Zack Woods Pond | Hyde Park and Wolcott | ✓ | ✓ | | | |
| Schofield Pond | Hyde Park | ✓ | | | ✓ | |
| Hardwick Lake | Hardwick | | | | ✓ | |
| East Long Pond | Woodbury | ✓ | ✓ | | | |
| Nichols Pond | Woodbury | ✓ | ✓ | | | |
| Caspian Lake | Greensboro | | | | | ✓ |
| Flagg Pond | Wheelock | ✓ | | | ✓ | |
| Lake Eden | Eden | | ✓ | ✓ | | |
| Lake Elmore | Elmore | ✓ | | ✓ | | |
| Horse Pond | Greensboro | | | ✓ | | |
| Long Pond | Eden | | | ✓ | | |
| South Pond, Eden | Eden | | ✓ | ✓ | | |

**Lake Watershed and Shoreland Land Use Issues**

Watershed and shoreland land uses can have a significant and negative impact on a lake's health over time. Removal of shoreland vegetation can increase erosion of the lakeshore and reduce or eliminate the infiltration functions of the vegetation. Runoff from roofs, driveways, lawns and uphill development can increase erosion and nutrient and sediment loading to the lake. Improper design and installation of shoreline stabilization measures, such as riprap, seawalls, and grading, can actually increase erosion of that shoreland. Runoff from lawns on which fertilizers, herbicides, and pesticides are used can result in nitrogen, phosphorus, and toxins entering a lake. Runoff from eroding driveways and paths may carry nutrients and sediment to adjacent waters during rain events (DEC, 1990). Modern style lakeshore development contributes seven times the phosphorus, eighteen times the sediment and four times the runoff of an undeveloped forested site (Wisconsin Department of Natural Resources). Ideally, a minimum of a 100 foot wide naturally vegetated buffer is needed between lawns, driveways, and structures and the lake in order to prevent such nutrient pollution.

Many animal species (birds, reptiles, amphibians and mammals) rely on natural shoreland vegetation to breed, feed and over winter. Removal of the natural vegetation along a lakeshore eliminates this habitat. Overhanging branches shade shallow water and provide fish food in the form of fallen insects. Wildlife need wide undeveloped naturally vegetated lakeshores, with some species needing buffers as wide as 600 feet.

By their nature, lakes, ponds, and reservoirs accumulate sediment and nutrients over long periods of time. Human activities in lake watersheds can hasten this process, producing what lake scientists term accelerated eutrophication. This is a very common threat to lake waters throughout Vermont, and the Lamoille Basin is no exception. Excessive phosphorus and/or sediment causes algae blooms, decreased water clarity, "nuisance" growth of native aquatic plants, and a change in the natural habitat values of a lake. Good land use management throughout watersheds protects downstream lakes and ponds from this ever-present threat. Erosion and runoff from paved or unpaved roads, developed areas, logging operations, impervious surfaces, agricultural operations, and construction activities can contribute to sediment and phosphorus accumulation in lakes and ponds. Excessive clearing of lakeshores when constructing camps or homes can significantly affect the lake by removing the filtering native vegetation. Failing septic systems result in either effluent surfacing on the ground or contaminating groundwater. Either situation can cause a human health hazard due to exposure to disease-causing bacteria, and enhances nutrient loading to lakes. Septic systems can fail due to inadequate soils, poor design or construction, inadequate maintenance, or increase from seasonal to year-round use (DEC, 1990). DEC monitors lake nutrient levels throughout the Lamoille River watershed via several projects. Principally, the Spring Phosphorus Program collects spring-overturn nutrient and physical and chemical data on Vermont lakes and ponds 20 acres in size or larger on a rotating basis. Water tests include total phosphorus and total nitrogen, alkalinity, calcium, magnesium, hardness, water transparency, temperature and dissolved oxygen levels.

Lakes with largely developed shores are candidates for shoreland management outreach and restoration projects. Other lakes with lightly developed shores may also be eligible for such projects along limited sections of the shoreland. Education to promote maintaining or restoring a natural lakeshore buffer should be undertaken. High priority lakes for shoreland restoration include: Caspian Lake, Lake Eden, and Lake Elmore.

**Invasive Exotic species**

Eurasian watermilfoil (Figure 3), zebra mussels, and water chestnut are invasive exotic species that currently infest a large number of Vermont lakes.

A number of other problematic exotic species (e.g. *Hydrilla verticillatum*) are literally on Vermont's doorstep. In the Lamoille basin, Eurasian watermilfoil is the only known invasive exotic species at this time. Eurasian watermilfoil is currently found in Arrowhead Mountain Lake in Georgia and Milton, Lake Elmore in Elmore, Elmore Pond Brook, Long Pond in Eden, and in the lower Lamoille River in Milton and Colchester. This plant is known for its rapid growth and ability to spread, which leads to very significant problems within a lake. Commonly found in shallow bays and along shorelines, milfoil forms dense beds that can seriously alter the recreational use of a lake, reduce the availability of fish spawning grounds, out-compete beneficial native plants, and otherwise alter a lake's natural environment. Once milfoil has infested a lake there is no known way to eradicate it.

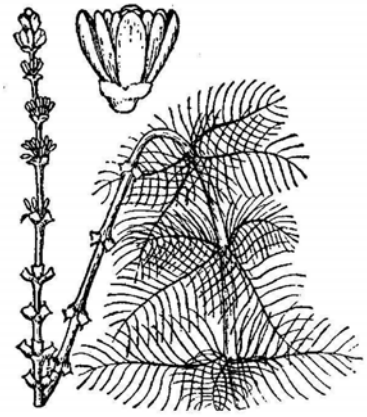


**Figure 3. Eurasian watermilfoil**

Spread Prevention

Two important invasive exotic species spread prevention methods include boat access greeter programs that provide courtesy inspections and public education and early detection programs like the Vermont Invasive Patrollers (VIPs) described below. Caspian Lake is the only lake in the watershed that has a boat access greeter program maintained by local residents.

VIPs monitor a local waterbody for new introductions of invasive species while also learning about native aquatic plants and animals and their habitats. Current certified VIPs lakes include Lake Eden and South Pond in Eden.

VIP participants attend at least one basic training workshop (optional advanced workshops may also be available based on interest) and:

- Sign a Statement of Commitment promising to document survey results in accordance with standardized procedures and report them to Vermont DEC
- Conduct and submit at least two surveys during the summer for the presence of invasive plants or animals in your lake or pond (or a specific section thereof)
- Submit suspicious samples to DEC staff for positive identification

Control Methods

Appropriate Eurasian watermilfoil control methods should be evaluated on a lake-by-lake basis. To date in Vermont, control methods used have included mechanical, chemical, biological methods, habitat manipulation, and physical methods. The use of aquatic herbicides is new in Vermont. The use of the watermilfoil weevil is a potential future biological control. Mechanical methods, the use of benthic matting, and hand pulling via scuba and snorkeling equipment are the methods most often used in the state at this time. Hand pulling is a successful method of removing milfoil where it has been discovered early and densities are limited. An integrated approach using a combination of the above methodologies is recommended for successful control. A permit from the DEC is needed for most control methods with the exception of hand pulling.

**Low pH and other toxins.**

Acid precipitation threatens sensitive ponds in the Lamoille basin. The tiny Lake of the Clouds in Cambridge is the only waterbody that is acid-impaired in the Lamoille Basin. Several other ponds are threatened by acidification. These are Bear Pond, Big Muddy Pond, Green River Reservoir, Little Elmore Pond, Long and South

Ponds in Eden, Slayton Pond in Woodbury, Wapanacki Lake, and Wolcott Pond. Reduction of acid stresses to lakes will depend on reduction of acid-forming pollutants throughout the eastern United States, and is a problem requiring national attention. All of Vermont's acid-impaired lakes are subject to an EPA approved TMDL that identifies necessary reductions from out-of-region sources of acidity to improve the condition of these lakes.

Current gasoline marine engines can emit significant amounts of smog forming air pollution and discharge unburned oil and gasoline directly into lakes and ponds, polluting them with MtBE, benzene, and other toxic chemicals.

The contamination and subsequent mortality of loons from lead poisoning is a leading cause of loon death in Vermont. Loons ingest stray lead sinkers, and one sinker can kill a loon over time. A new state law prohibiting the sale of lead sinkers started January 1, 2006 and the use of lead sinkers is prohibited beginning January 1, 2007.

**Mercury**

Mercury contamination is ubiquitous in Vermont's still waters. Mercury is a metal used in a wide variety of applications ranging from the production of household bleach to the mining of gold. Mercury is released into the environment either directly to water via waste systems, or much more commonly, directly to the atmosphere. It is this atmospheric pathway that is largely responsible for mercury contamination in Vermont. The combustion of coal for energy, and incineration of municipal and medical wastes, produces the majority of mercury deposited onto the watersheds of the northeastern US and eastern Canada. All of Vermont's mercury-impaired lakes are subject to an EPA approved TMDL that identifies necessary reductions from out-of-region sources of mercury to improve the condition of these lakes.

In the atmosphere, mercury undergoes a wide variety of chemical transformations, eventually settling to the landscape as mercury attached to particulate matter such as soot. Once on the ground, mercury migrates through watersheds, arriving eventually into receiving waters (e.g. wetlands and lakes). Mercury that is moving through watersheds is subject to myriad chemical transformations, and these are often biologically mediated. The most important of these biological transformations is the generation of methyl-mercury. Methyl-mercury is a highly toxic form of mercury, which is easily assimilated into tiny planktonic organisms at the base of aquatic food chains.

Through the processes of biomagnification, minute concentrations of methyl-mercury are passed up food chains, increasing to levels that pose a significant threat to those organisms that feed at the top of the aquatic food web. Organisms that are at risk of methyl-mercury exposure include top-level carnivorous fish such as walleye, fish eating birds such as eagles and loons, and, of course, humans. Some fish species accumulate more methyl-mercury burden than others, which is why the Vermont Department of Health (DOH) advisories are species-specific.

In addition, certain lakes appear to have conditions that result in more efficient transfer of methyl-mercury up the food chains. This is why the DOH advisories identify a select few waterbodies as having particularly elevated fish-tissue mercury concentrations, and where eating resident fish therefore carries a greater level of risk. Based on Vermont and regional research, the DOH advisories have been modified to become more lake and species specific. The following factors are associated with increased tissue mercury levels: lake acidity (natural or otherwise) and the levels of tannins in the water; presence of nearshore and upstream wetlands; water level fluctuation; and the rate at which the lake is flushed on an annual basis.

The physiological consequences of methyl-mercury contamination include liver, kidney, and central nervous system dysfunction. A recent study by the National Academy of Sciences

concluded that the children of women who consumed large quantities of mercury-tainted fish during pregnancy showed the clearest evidence of mercury poisoning. Due to mercury contamination, the DOH presently advises that people limit their consumption of a variety of fish found both in Lake Champlain, and in many other lakes statewide. The current fish advisory is available online: http://healthvermont.gov/enviro/fish_alert/fish_alert.aspx

In the Lamoille Basin, DEC has waterbody-specific fish tissue data only from Arrowhead Mountain Lake, Caspian Lake, and Wolcott Pond. However, based on the research studies noted above, DEC can predict those lakes in which fish-tissue mercury is expected to be elevated. These are noted in Table 7, and are good candidates for further measurements of mercury in fish tissue. With regard to mercury pollution, anglers are advised to heed the advisories posted by DOH for all Lamoille Basin lakes.

**Table 7. Lakes in the Lamoille Basin Predicted by DEC to Have Elevated Fish Tissue Mercury Concentrations.**

| Lake Name | Town | Factors enhancing likelihood of elevated fish tissue mercury |
|---|---|---|
| Arrowhead Mountain Lake | Milton | Fluctuating water levels. |
| Hardwick Lake | Hardwick | Fluctuating water levels |
| Green River Reservoir | Hyde Park | Acidic, tannic, and fluctuating water levels. |
| Long Pond | Eden | Large upstream wetland, acidic. |
| Lake Lamoille | Morristown | Fluctuating water levels. |
| Little Elmore Lake | Elmore | Acidic, large proportion of watershed as wetland. |
| Schofield Pond | Hyde Park | Acidic, tannic, large proportion of watershed as wetland |
| South Pond | Eden | Acidic, fluctuating water levels. |
| Lake Wapanacki | Wolcott | Acidic, upstream wetlands. |
| Wolcott Pond | Wolcott | Acidic, tannic, nearshore wetlands. |

## The River Corridor

*We have rearranged the rivers at our pleasure as one might change the apples in a bowl.*
-Thomas Hornsby Ferril

**Introduction**
Over 611 miles of rivers and streams drain the land area known as the Lamoille River watershed. The Lamoille River originates at Horse Pond and flows in a southwesterly direction to Hardwick. A number of brooks flow from the hills, mountains, and ponds of Greensboro, Wheelock and Stannard to join this stretch of river: Morrison, Mud Pond, Paine, Sawmill, Esdon, Flagg, Stannard, and Greensboro Brooks are the main named streams (DEC, 2001).

East of Hardwick, the river flows in a westerly direction where Route 15 now follows the course of the river. In Hardwick Village, the river flows westerly and then northerly. Just outside of the village, there is a dam near the junction of Routes 15 and 14 that impounds the mainstem and its tributary, Alder Brook, forming Hardwick Lake.

West of the village of Hardwick, the Lamoille River meanders westerly then northwesterly through the towns of Hardwick and Wolcott. A number of significant tributaries join the Lamoille River in the town of Wolcott including Elmore Branch, Wild Branch, the Green River, Wolcott Pond Brook, and Elmore Pond Brook.

In Morrisville and just west of the village, there are two dams. The Cadys Falls dam has the biggest effect and results in the formation of Lake Lamoille. Kenfield Brook, Centerville Brook, and Jacob Brook flow into the Lamoille River between Hyde Park and Morristown.

The river continues northwesterly through the town of Johnson and into Cambridge where it changes to a more westerly course. This section resembles the one through Hardwick and Wolcott. Agricultural activities dominate in the river valley and hay and corn frequently come to the top of the riverbank.

The most significant tributary in this stretch is the Gihon River, which enters from the north in Johnson. The Gihon is 14 miles long and drains a watershed of 66 square miles. Other important tributaries include Foote Brook, the North Branch and the Brewster River.

From Cambridge, the Lamoille River continues its meandering course westerly through Fairfax encountering Fairfax Falls dam. Route 104 parallels this stretch of the river. Just west of the village of Fairfax, the Browns River enters from the south and increases the size of the Lamoille River substantially. The Browns River has a length of 24 miles and drains an area of 92 square miles.

From the confluence of the Browns River, the Lamoille flows westerly for almost four miles before becoming Arrowhead Mountain Lake at East Georgia. The dam that impounds the Lamoille is located downstream in Milton. Below Milton village, the river flows westerly, southerly and westerly again encountering two dams and passing through a large wetland system before entering Lake Champlain.

**Impacts to the River Designated Uses**
The major impacts to the Lamoille River and its tributaries involve sedimentation, habitat alteration, and channel instability (DEC, 2001). Nutrients and thermal modifications also affect a number of river miles. Riparian vegetation removal, streambank erosion, floodplain encroachments, floods, and agricultural land uses are the five top sources that affect the water quality and aquatic habitat of the Lamoille River (Ryan, 2000). Agricultural land use in the productive floodplain of the Lamoille resulted in riparian vegetation removal. The habitat alteration and flood damage is greatly exacerbated by disequilibrium stream conditions that have resulted from river channelization and the

resulting loss of flood plain access along the Lamoille and some of its tributaries such as the Wild Branch.

**What is Fluvial Geomorphic Equilibrium Condition?**

Streams are in dynamic equilibrium when they have achieved a "balance" with the water, sediment, and organic debris delivered from their watersheds (figure 4). Streams in equilibrium may still erode their banks, migrate over time across their valleys, and periodically experience small-scale lateral and/or vertical adjustments. Over the last century, many miles of the Lamoille's rivers have been subjected to channel management practices such as armoring, dredging, gravel mining and channelization, for the purposes of containing high flows in the channel and to protect human investments built in the historic flood plains. In addition, flood plains have been filled to elevate land above "design" flood stages. Conflicts arise when the management practices associated with the protection of public and private property are imposed upon a naturally dynamic river system (draft DEC River Corridor Planning Guide, 2008).

***The Lamoille River Valley in Johnson***

***Fluvial Geomorphic Equilibrium*** *is the condition in which a persistent stream and floodplain morphology is created by the dynamic fluvial processes associated with the inputs of water, sediment, and woody debris from the watershed. The stream and floodplain morphology is derived within a consistent climate; and influenced by topographic and geologic boundary conditions. When achieved at a watershed scale, equilibrium conditions are associated with minimal erosion, watershed storage of organic material and nutrients, and aquatic and riparian habitat diversity.* (DEC River Corridor Planning Guide, 2008)

**Phosphorus Loading from Unstable Stream Systems**

Lake Champlain is currently impaired due to an over abundance of phosphorus (Chapter 5). The Lamoille River watershed is a significant tributary to Lake Champlain. The instability of river systems draining the watershed has a significant impact on the level of phosphorus loading (DEC, 2002). Eroding streambank soils may be the largest source of sediment and phosphorus entering the lake. Significant sediment sources from unstable streambanks and streambeds are responsible for some of the impaired waters on the 303(d) list including Deer Brook in Georgia and G-listed Browns River, listed as "Altered by Channel Alteration." Sediment and other pollutants are impairing aquatic life and habitat on both waterways (Chapter 5). An inventory of the approximately 12 miles of riverbank lands owned by Vermont Department of Fish and Wildlife in 1998, found that 37% were actively eroding or slumping into the river. The report noted, "The greater alarm is that this condition appears to be representative of all 170 miles of riverbanks, both public and private, along the Lamoille's 85 mile length." A streambank condition inventory and

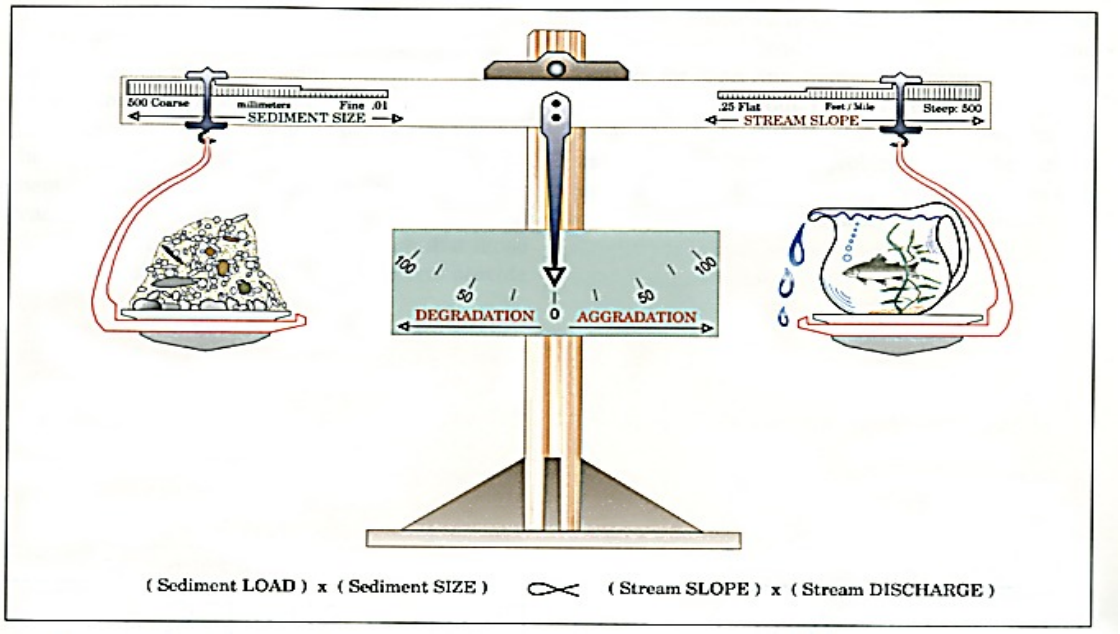



**Figure 4. Lane's diagram (1955) from Rosgen (1996)**

map of the Wild Branch described approximately 80% of the total stream length as suffering from headcutting and/or undercutting, sloughing, or mass wasting of streambanks (LCPC, 2002).

> ***Phosphorus*** *is a nutrient that poses a threat to clear and nuisance free water. Nutrients act as fertilizers, promoting rapid growth of algae and plants. Human activities can greatly increase nutrient inputs to waterways. These cultural nutrient sources accelerate eutrophication, the natural aging process of lakes where biological and chemical materials accumulate, causing lakes to become more productive. When excessive amounts of nutrients enter waterways they produce excessive amounts of algae and other aquatic plants. Algal blooms turn water green, reduce water transparency, deplete the oxygen supply, and create toxic algae and odor problems. Ultimately, these blooms alter fish and wildlife habitat, impair scenic views, reduce recreational appeal, impair water supplies, and lower property values* (Lake Champlain Basin Program, 1996).

Water quality problems resulting from stream instability include:

- Flooding and erosion damage to public and private properties, infrastructure and valuable agricultural land;
- Poor quality aquatic habitat due to excessive sediment deposition, lack of shade and in-stream cover, and channel widening that can result in water temperature increases and loss of deep pool habitats; and
- Eutrophication of Lake Champlain from excessive phosphorus loading.

**Flooding- Catastrophic Water Quality Consequences**

In Vermont, flooding events represent the most frequent disaster and result in the greatest damage to private property, public infrastructure and water quality (DEC, 1999). While inundation-related flood loss is a significant component of flood disasters, the predominant mode of damage is associated with the dynamic, and oftentimes catastrophic, physical movement of stream

channels during storm events due to bed and bank erosion, debris and ice jams, structural failures, flow diversion, or flow modification by manmade structures. Channel adjustments with devastating consequences have frequently been documented. Such adjustments or actually re-adjustments into old alignments are linked to historic channel management activities, flood plain encroachments, adjacent land use practices and/or changes in watershed hydrology associated with conversion of land cover and drainage activities (DEC Municipal Planning Guide, 2008).

The Lamoille River watershed has experienced three large magnitude flood events during the 1990s. These floods were responsible for millions of dollars in damage to both private and public properties and tons of sediment, phosphorus and other pollutants carried to Lake Champlain. Flood events in 1995, 1997, and 1998 destroyed infrastructure such as roads, bridges, culverts, homes, and agricultural lands.

**Riparian Buffers –Losses and River Instability**

Riparian buffers play important roles in maintaining a healthy riverine ecosystem. Vegetated buffers provide shade to reduce surface water temperatures; filter sediments, nutrients, and other pollutants from runoff; provide food, cover and substrate for amphibians, aquatic insects, and other aquatic biota provide; provide habitat to species whose life cycles include water and upland; offer cover for wildlife traveling between habitats and/or dispersing to new habitats; slow floodwaters; and reduce ice damage.

Detailed buffer inventories have been completed on the main stem in the upper watershed, Chittenden, and Franklin County reaches of the main stem. There are significant gaps of woody riparian buffers along the Lamoille and Browns River. The Lamoille County Planning Commission has recently completed a buffer inventory of the Lamoille main stem within Lamoille County. The results concluded that between 0-25 feet from top of bank 57% of the main stem has an existing woody buffer. Out of the remaining 43% of the land use within the 0-25 foot area, roughly 30% was agricultural hay or row crops and 10% was either developed (roads and buildings) or water (lakes and wetlands). Thirty two percent of the upper Lamoille River is devoid of any woody riparian buffer (Caledonia and Orleans County portion) within 0-25 feet of the top of bank. Fifty three percent of the Browns River is devoid of woody riparian buffers within the top of bank area.

**Previous and On-going Assessment and Stream Restoration Projects**

Browns River Watershed Assessment and Restoration
(See Chapter 5)

Riparian Buffer Plantings and Soil Bioengineering Projects

The U.S. Fish and Wildlife Service, Natural Resources Conservation Service, FEMA Project Impact, the Vermont Youth Conservation Corps, local volunteers, and the Lamoille County Conservation District identified, assessed and implemented streamside buffer programs through the *Trees for Streams, Conservation Reserve,* and *Partners for Fish and Wildlife* programs. New buffers were established on 47,000 linear feet or nearly 9 miles of streambank in the last 5 years (Trees for Streams Final Report, 2007). Riparian plant material nurseries have been established in Morristown, Johnson, and Hardwick.

Numerous banks have been treated using soil bioengineering techniques such as tree revetments. Tree revetments are softwood treetops that are installed parallel to flow on the lower portions of eroding banks. Tree revetments are temporary measures that deflect flow and encourage sediment deposition until woody vegetation can be established. A restoration demonstration project following the principles of fluvial geomorphology was implemented on Foot Brook in Johnson.

***Student volunteers planting a Trees for Streams buffer on the Browns River***

**River corridor planning** is conducted in Vermont to remediate the river instability that is largely responsible for erosion conflicts, increased sediment and nutrient loading, and a reduction in river habitat. The Vermont River Management Program (RMP) will provide funding and technical assistance to facilitate an understanding of river channel adjustments and the establishment of well developed and appropriately scaled projects and strategies to protect and restore river equilibrium (draft DEC River Corridor Planning Guide, 2008).

ANR river corridor planning is not intended as a surrogate or replacement for "basin planning" or the consensus-building watershed planning process coordinated by the State. Technical river corridor plans may be adopted or incorporated within basin plans.

**These objectives** include:

- fluvial erosion hazard mitigation;
- sediment and nutrient load reduction; and
- aquatic and riparian habitat protection and restoration.

River protection and restoration programs are established primarily to complete "projects" which meet specific goals and objectives.

Traditionally, this means tangible actions on the ground such as:

- Protecting river corridors
- Planting stream buffers
- Stabilizing stream banks
- Arresting head cuts and nick points
- Removing berms and other constraints to flood and sediment load attenuation
- Removing/replacing/retrofitting structures (e.g. undersized culverts, constrictions, low dams)
- Restoring incised reaches
- Restoring aggraded reaches

The first set of actions (1- 6) may be more readily pursued without an extensive alternatives analysis. The last two actions, restoring vertically unstable streams (incised or aggrading), may require channel management practices, corridor land use changes, more extensive feasibility analyses, landowner negotiations, and time.

**Local Land Use Planning and Regulation**

Town planning and zoning can play a central role in mitigating flood and erosion hazards through avoidance. Towns have the ability to regulate land use, encouraging development in appropriate areas and preventing investment in hazardous areas. Pre-disaster mitigation (PDM) planning, FEH overlay districts, setbacks or buffers, and effective flood hazard zoning are all ways a community can mitigate flood and fluvial erosion hazards (DEC Municipal Planning Guide, 2008).

Economic loss and risks to public safety caused by flood and fluvial erosion hazards are experienced most dramatically by individuals and local governments. Local governments are also the most appropriate entities to guide and implement efforts to mitigate these hazards.

Armed with a better understanding of ongoing river processes, towns can take action to reduce flood and fluvial erosion hazards, which will enhance public safety, save money, and lead to healthier rivers.

## Dams and Flow-regulated Waters

There are over 65 dams of different types, sizes, and condition in the Lamoille River Watershed. Certain dams in the watershed provide renewable energy and recreational opportunities such as boating, fishing, and swimming albeit at the expense of river-based recreation. In some cases impoundments can create unique wetland aquatic communities although somewhat artificial since they are maintained by the presence of the dams. Dams can also impede streams' ability to transport flow and sediment; cause streambank erosion and flooding problems; degrade and alter fisheries habitat; create barriers to migratory fish passage; degrade water quality; and impede river-based recreational activity.

***Cilley Hill Dam Browns River Jericho***

**Dams**

Ten out of 65 dams in the Lamoille watershed are used to generate hydroelectric power directly or impound water to augment hydro flows. This renewable energy source can displace fossil fueled electric generation. Sulfur dioxide and nitrogen oxides are considered prime contributors to the production of acid rain, which adversely affects the Lamoille River watershed. Further, carbon dioxide is a prime contributor to global warming.

Dams also can create wetland habitats for threatened and endangered plant and animal species such as those found in portions of Arrowhead Mountain Lake. This impoundment supports rare quillworts and sedges, and is used by osprey that nest on platforms installed by CVPS and the Vermont Fish and Wildlife Department (CVPS personal communication, 2003).

Major artificial impoundments within the watershed include Green River Reservoir, Lake Lamoille, and Arrowhead Mountain Lake. The dam and impoundment on Lake Elmore augments flow for the hydroelectric facility. Many Lamoille River watershed dams are small, creating ponds on residents' property for aesthetic or recreational values. Some dams in the watershed have cultural significance as they were originally built to run Vermont's early mills. The impacts of dams are described in detail below.

**Impacts of Dams**

Dams and hydroelectric operations change the physical, ecological and social characteristics of a river. Dams have multiple effects on rivers and riverine habitat. These changes range from a minor alteration of depth and velocity in the case of low-head, run-of-the-river dams, to a complete change from river to lake characteristics in the case of large dams. Depending on the characteristics of the reservoir and how water is discharged, downstream changes may be undetectable or significant. In the river reaches between hydroelectric dams and powerhouse tailraces, where the river flows re-enter the channel (the bypassed reach) virtually all of the

flow is diverted from the river for much of the year, unless special provisions are made to provide conservation flows. Downstream of facilities, flows may be managed to enhance on-peak power production. Flow manipulation results in fluctuating flows and, at times, no flows downstream during periods when the water in the reservoir is being replenished (ANR, 2003). Structures that completely span a channel, such as dams, can significantly alter the quantity and duration of water and sediment runoff and may cause a stream to undergo both vertical and lateral channel adjustment processes (ANR, 2003). Sediment is deposited behind dams. Deposited sediments gradually fill impoundments from upstream to downstream, changing aquatic habitats over time. This process is evident in Arrowhead Mountain Lake, where large diverse wetlands are developing on the accumulated sediments in the upstream end of the reservoir. Dams can degrade water quality by interrupting the natural sediment flow characteristics of a river, reducing natural oxygen entrainment, and increasing water temperatures. Together these effects can markedly alter the river ecology, changing the species composition and density of macroinvertebrates, fish, and other aquatic organisms (ANR, 2003). Impoundments and water withdrawals can have an impact on in-stream habitat and biota, especially during naturally low flow periods that occur in Vermont in August, September, and February (ANR, 2003). Dams can flood upstream habitat and act as barriers to upstream and downstream movement of aquatic organisms. Operations alter the natural flow regime in a way that can reduce downstream habitat quality and quantity. In addition to channel adjustments that may affect the structure of in-stream habitat, additional flow diversion from the bypassed reach of the stream can expose streambed substrates, effectively reducing the amount of habitat area available for aquatic organisms. In high-gradient streams, cobble and gravel substrates in riffles are exposed; in low-gradient streams, the decrease in water level exposes logs and snags and lowers the water away from the near-bank cover, thereby reducing available habitat.

Water temperatures within the impoundment sometimes result in summer stratification – that is, warmer water at the surface that does not mix with the cooler water at the bottom. In productive ecosystems, or where there are heavy waste loads, accumulated organic material can deplete the oxygen in deeper waters. As a result of these changes, river plant and animal communities are replaced by those that prefer a more lake-like environment. For example, a resident walleye population has become established in the Peterson impoundment as a result of the change to a more lake-like habitat, making it less habitable for cold-water species such as Brook Trout.

The majority of the major dams in the watershed are listed as *Surface Waters Altered by Flow Regulation* Part F on the List of Priority Waters (DEC 2008). The Part F sites are considered by the state to be priority waters for management action (Table 8).

**Hydroelectric Dams**

From a regulatory standpoint, hydroelectric dams fall into two broad categories. The first consists of those that are regulated by the Federal Energy Regulatory Commission. These facilities operate under a federal license or exemption that specifies flow and reservoir management, fish passage, recreational facilities, and other requirements. The state participates in the license and exemption processes by issuing a water quality certification under Section 401 of the Clean Water Act.

The second category includes unlicensed facilities that are regulated by the State, rather than the federal government. Most of these facilities do not have conservation flow or reservoir management requirements. Larger facilities are regulated by state statute under 10 V.S.A. Chapter 43. In addition, 10 V.S.A. § 1003 authorizes DEC to seek the cooperation of the owner of a dam if the regulation of stream flow appears contrary to the public interest. After conferring with the owner and other interested parties, the department may require the owner to change the way the dam is operated so that the public interest is protected.

In January 2008, ANR released *The Development of Small Hydroelectric Projects in Vermont*, *a Report to the Vermont General Assembly* as interest in renewable energy has surfaced in response to increasing awareness global climate change issues, increases in fossil fuel costs, and uncertainties of long term contracts with Hydro Quebec and Vermont Yankee. The report summarizes current hydroelectric generating operation and potential areas of capacity increases by increasing efficiencies at existing turbines or possibly retrofitting existing dams. The report also outlines the permitting process for hydroelectric development and pre-feasibility studies.

ANR is likely to recommend low impact standards for new or repowered small hydroelectric facilities in Vermont as developed by Hydroelectric Institute in Maine. The low impact standards include:

- No new dam or other barrier to aquatic organism movement and sediment transport
- Run-of-river operation
- Bypass flows necessary to protect aquatic habitat, provide for aquatic organism passage and support aesthetics
- Fish passage, where appropriate
- No change in elevation on an existing impoundment or in water level management
- No degradation of water quality, particularly with respect to dissolved oxygen, temperature, and turbidity
- No change in upstream or downstream flood profile or fluvial erosion hazard sensitivity

CVPS Operated Dams

Four CVPS-operated hydroelectric generating dams are located on the lower Lamoille River. These are the Peterson, Milton, Clark Falls, and Fairfax Falls Dams. The Clarks Falls Dam created Arrowhead Mountain Lake. The Peterson Dam is the first dam located on the Lamoille River approximately six miles from the confluence of Lake Champlain. Currently impaired waters listings of this reach of the Lamoille River include: the mouth to Clark Falls Dam due to elevated mercury in fish, Clarks Falls Dam to the Route 2 Bridge due to low dissolved oxygen, and in the Arrowhead Mountain Lake reach due to mercury (see Chapter 5). These dams are operated under a Federal Energy Regulatory Commission (FERC) license.

Morrisville Water and Light Department Controlled Dams

The Morrisville Water and Light Department owns and operates four dams in the watershed. Two dams are located on the Lamoille River main stem in Morrisville as well as dams on Lake Elmore and Green River Reservoir. These dams are collectively known as the Morrisville Project. The Cadys Falls dam creates the impoundment known as Lake Lamoille. The Morrisville Project is licensed by FERC. The current FERC license is up for renewal in 2015. Morrisville Water and Light has recently sold its land adjacent to Green River Reservoir to the state. This land is currently being used as a primitive state campground. Morrisville Water and Light maintains ownership of land adjacent to this parcel that includes several ponds.

Hardwick Electric Department Controlled Dams

Six dams are owned by Hardwick Electric Department. Two dams are located on the Lamoille River main stem, the Pottersville Dam and Jackson Dam. The Pottersville Dam is the primary hydroelectric generating facility. The Jackson Dam impoundment forms Hardwick Lake and was formerly used to augment flows at Potterville during periods of peak power demand. Hardwick Electric also controls smaller dams on Caspian Lake, East Long Pond, and Nichols Pond. These three waterbodies are natural lakes with artificial outlet structures, which were used to manipulate lake storage to enhance power generation at Pottersville, similar to Jackson Dam's function. The Mackville Pond dam impounds Nichols Brook and is located downstream of Nichols Pond. Substantial repairs on Mackville Pond dam were completed in 2001.

East Long, Nichols, Mackville Pond, Hardwick Lake, and Caspian Lake are no longer used to augment flows at Pottersville. Nichols Pond was drawn down for safety reasons in 2006. Major repairs are planned for 2008. The new lake level would be one foot lower than the historic level. Of the dams owned by Hardwick Electric, only Pottersville is considered a hydroelectric facility, and it is unlicensed by the FERC, which has jurisdiction over most hydroelectric dams in Vermont. Current operation and future management goals of the dams include (Hardwick Electric personal communication, 2003):

- East Long Pond, Nichols Pond, Mackville Pond, and Caspian Lake- maintenance of current level at spillway except for minimal lowering in for dam maintenance projects.
- Hardwick Lake is no longer drawn down in anticipation of large precipitation events. The lake is drawn down annually in the fall to help prevent ice jam flooding in Hardwick Village upstream.
- Pottersville (Wolcott) Dam- this dam is automated to maintain flow over the top of flashboards at approximately 30 inches.

Hardwick Lake Management

Jackson Dam creates Hardwick Lake. The dam's impoundment, which overflows the riverbeds of Alder Brook and the Lamoille River, is drained every year from fall through spring to help avoid ice jams and flooding in the Hardwick Village. This results in a highly unstable aquatic environment that prevents the establishment of a healthy aquatic community of plants, amphibians, aquatic insects and fish. The management objective for Class B waters in Vermont is to achieve and maintain a level of quality that supports aquatic biota and wildlife sustained by high quality aquatic habitat. Because of its fluctuating levels, Hardwick Lake would not be considered high quality habitat as an impoundment or as a free-flowing river (DEC, 2004).

There has been an effort by the Vermont Natural Resources Council and the Lamoille River Anglers Association to remove the Jackson dam. Removal of the dam would restore 4.4 miles of trout habitat, eliminate the extreme water level fluctuations associated with drawdowns, eliminate liability associated with the structural integrity of the dam, and improve the Lamoille River's ability to transport sediment through the impounded reach. A vote by Hardwick citizens favored maintaining the Jackson Dam. Many expressed an opinion that the impoundment plays an important aesthetic and wildlife habitat function in the community. DEC recommends removal of Jackson Dam as the best option available to both alleviate flooding and icing problems and achieve compliance with Water Quality Standards. The current management of Hardwick Lake, with the extensive fall and winter drawdown, results in a significant degradation of water quality to the Lamoille River. DEC recommends that the Town of Hardwick wait for the next cycle of watershed planning in 5 years to decide on the designation for the reach affected by Jackson Dam to give the Town and its citizens the time and opportunity to consider all the options, with DEC's technical assistance (DEC, 2004).

A small privately owned hydroelectric dam is also in operation on the Gihon River in Hyde Park.

Greensboro Brook Small Hydro Proposal

The Town of Greensboro has proposed the development of a hydroelectric facility on the outlet of Caspian Lake on Greensboro Brook. The Town is working with ANR to develop a final design for the project.

**Recent and On-going Dam Related Projects**

Several statewide and Lamoille watershed initiatives are being undertaken to identify dam-related water quality issues. These actions will lead to selective stream restoration projects involving the removal or retrofitting of existing dam structures.

**Legislation Regarding Dams**
State legislation enacted in 2003 and 2004 began to address the ecological, social and financial impacts of dams. Act 63, the 2003 capital construction bill, stated, in part, "State policy should encourage private and municipal dam owners to remove their dams voluntarily, where appropriate. It should provide technical and financial assistance to municipalities to take care of the dams they own and to assume ownership or control of privately owned dams." Further, the legislature directed the Agency of Natural Resources to develop proposed legislation that would address "[a]mendments to existing regulatory programs for dams, permits, inspections, and procedures for emergency responses to hazardous dams" and "the financial implications of a capital budget policy that proposes to promote the removal of dams to address public safety, hazard mitigation, and environmental concerns and that includes incentives for municipalities to own and properly maintain dams."

The Agency submitted the mandated report, but changes to the existing dam statute (10 V.S.A. Chapter 43) were not enacted. However, the 2004 capital construction bill included a provision (Section 66) that established the "Vermont unsafe dam revolving loan fund." The purpose of the fund is to provide grants and loans to dam owners (municipalities, not-for-profit organizations, and private individuals) for dam reconstruction, repair, removal, breaching and other activities to reduce or eliminate hazards associated with unsafe dams. A small amount of funding was appropriated for the fund and the bill set up a mechanism for future appropriations, grants or donations to be added to the fund.

**Vermont Dam Task Force**
The Vermont Dam Task Force is a group whose goal is to "…restore rivers through the selective removal of dams and other man-made obstructions thereby reconnecting Vermont's natural and cultural river communities." It is a statewide cooperative effort among federal and state agencies, and interested non-profit organizations that has been meeting regularly since late 2000. The meetings serve as a forum for discussion of issues related to broad issues affecting dams and dam removal, as well as discussion of specific dam removal projects.

**Lamoille River Watershed Dam Inventory and Assessment**
An inventory and assessment of all dams in the watershed was completed by ANR in the summer of 2002. Information was recorded about the type and condition of each dam, its historic and cultural aspects, and a preliminary assessment of the dam's impact.

**Johnson State College Dam Removal and Stream Restoration**
An earthfill dam was constructed on the campus of Johnson State College (JSC) in the 1960s. The structure was 255 feet long and 31 feet high and located on a small tributary of the Gihon River. The spillway began to fail in 1998 and the impoundment behind the dam had been mostly drained since that time. Beginning in 2002, college authorities decided to remove the dam and worked closely with DEC to plan the project. The dam was removed in the summer of 2003. A natural stream channel was constructed in the area formerly occupied by the dam and impoundment. The project included the establishment of a woody stream buffer corridor in spring of 2004 and planned interpretative nature trail developed by JSC Environmental Science students and instructors, DEC, and the Lamoille County NRCD.

**Table 8. Waters Altered by Regulated Flow in the Lamoille River Basin, 2008 Part F List of Waters.**

| Water Segment and Location | Flow Alteration | Remediation & comments |
|---|---|---|
| Lamoille River immediately below Cady Falls Dam, Morristown | Possible fish passage problem at dam (threat) | FERC re-licensing in 2015 |
| French Brook, Johnson | Lack of flow to support habitat and aesthetics a possible fish passage problem at water withdrawal point | Town of Johnson has developed a groundwater well for drinking water and remove the dam |
| Lamoille River Pottersville Dam, Wolcott | Artificial and poor flow regime downstream impairs aquatic habitat; erosion. Possible fish passage threat. This is an unlicensed facility | Pursue conservation flows through appropriate state regulatory processes |
| Lamoille River below Morrisville Dam | No flow in bypass impairs aesthetics, recreation, and habitat | FERC re-licensing in 2015 will address low flows |
| Lamoille River, Hardwick Lake, Hardwick | Artificial flow regime down river. Possible fish passage problem (threat). Water level fluctuation impairs aquatic habitat and wetlands. Unlicensed facility | See Chapter 4 Actions and Jackson Dam recommendations above |
| Lake Lamoille, Morristown | Water level fluctuation may impair aquatic habitat | FERC re-licensing in 2015 will address this issue |
| Brewster River, Cambridge | Artificial flow condition, insufficient flow below Smugglers Notch snowmaking water withdrawal | See Chapter 2 for the implementation of conservation flows |
| Sterling Brook, Cambridge | Artificial flow condition, insufficient flow below Smugglers Notch snowmaking water withdrawal | See Chapter 2 for the implementation of conservation flows |
| Unnamed tributary to Brewster River, Cambridge | Artificial flow condition, insufficient flow below Smugglers Notch snowmaking water withdrawal | See Chapter 2 for the implementation of conservation flows |
| Nichols Brook- below dam on East Long Pond & Nichols Pond, Woodbury | Artificial flow regulation and condition at 2 dams | Pursue conservation flows through appropriate state regulatory processes. Nichols Pond Dam to be subject to a Chapter 43 dam order (application filed in Dec 2007) |
| East Long Pond, Woodbury | Water level fluctuation by hydro impairs aquatic habitat and endangered species | Use Section 1003 process or Surface Level Rules from the VT Water Resources Panel, or other regulatory process to control how the dams are operated to provide controls to provide for downstream conservation flows and proper lake level management |
| Nichols Pond, Woodbury | Water level fluctuation impairs aquatic habitat | A DEC Dam Order application was filed for repair work |
| Caspian Lake, Greensboro | Water level fluctuation has potential to impair fishery | A formal agreement such as Section 1003 or Surface Level Rules from the VT Water Resources Panel on how the dam is operated is needed to assure downstream conservation flows and proper lake level management |
| Hardwick Lake, Hardwick | Water level fluctuation by hydro impairs aquatic habitat and wetlands | No longer managed for hydro, lake drained for fall/winter ice control. See Chapter 4 Actions and Hardwick Electric controlled dams section above |

## The Working Landscape, Farm and Forestland

*As Vermonters, we're proud of our quality of life. Rapid, unplanned growth leads to traffic congestion, increased travel time, and reduced family time. If we do not pursue smart growth, we risk losing the sense of community, the working landscape, and the environmental quality that makes Vermont special.*

-Former U.S. Senator Jim Jeffords

**Background**

The Lamoille watershed's scenic farm and forestland is a working landscape that defines its heritage, enhances the local economy, and provides residents with a connection to the land. As development encroaches on remaining farm and forest lands, impervious surfaces and stormwater runoff increases, wildlife habitat is fragmented, exotic species are introduced, and fisheries and wetland habitat are degraded (DFPR and CCRPC, 2001).

Natural resource conservation, economic self-sufficiency, and the desires to preserve the watershed's rural-based culture, enhance recreational opportunities, and create aesthetically appealing landscapes are common goals in relation to the watershed's forest and farm lands conservation. Forests and farms are integral parts of a landscape that supports a variety of social and economic values in addition to vital ecological ones (VDFPR and CCRPC, 2001). Sustainable forestry and agricultural land use is a healthy alternative to uncontrolled growth.

> *Sustainable forestry is forest management and planning that is ecologically, economically, and socially responsible and is used to sustain healthy forests and the human communities that depend upon them.* DFPR (2007)

*Sustainable agriculture is a food and fiber production and distribution system that:*

- *Supports profitable production;*
- *Protects environmental quality;*
- *Uses natural resources efficiently;*
- *Provides consumers with affordable, high-quality products;*
- *Decreases dependency on nonrenewable resources;*
- *Enhances the quality of life for farmers and rural communities; and*
- *Will last for generations to come.* (UVM Center for Sustainable Agriculture)

<u>Sprawl</u>

Sprawl is a regional land use pattern of scattered, low-density, single use development. It is a cumulative phenomenon that begins at the edge of traditional village centers and moves outward incrementally into previously rural areas. It is land consuming, automobile dependent, energy and resource-intensive, and sometimes located at a distance from existing infrastructure. Land is being developed in Vermont at about two and a half times the rate of population growth (The Champlain Initiative, 1999).

Sprawl development is occurring in the Lamoille River watershed, especially in the lower portions of the watershed. It carries significant implications for the long-term sustainability of working lands. Chittenden County is changing rapidly from a primarily agricultural community to a landscape dominated by urban and suburban development. Between 1950 and 1992, Chittenden County has lost 70 percent of its farms with only 24 percent remaining in farmland. Once farmland has been converted into houses, parking lots and shopping malls, it is fragmented and is difficult to recover for agriculture or wood products. Meanwhile, the region's best farmland is being converted to commercial and residential development at an accelerating rate. Nearly 40 percent of the land newly developed was formerly cropland and pastures. There is an increasing pressure on

farmers to sell their valuable land (CCRPC and UVM, 2001).

Effects of Development on Natural Resources
The destructive environmental impacts of sprawl-type development are many and varied. There are biological impacts such as loss of terrestrial and aquatic wildlife habitat species, human health impacts such as degraded air or water, and loss of connections to the land.

The most significant threat to wildlife and their forest habitats is parcelization and fragmentation. Fragmentation occurs when large areas of forest are made smaller or divided by roads, development or land conversion to non-forested uses. Land conversion leads to loss in natural diversity, disruption of movement, and increase in the presence of exotic species. Parcelization refers to the division of forestland into increasingly smaller parcels; some remain forested, while others are developed. Forestland may be divided because of a death in the family, burdensome taxes, and lifestyle changes (CCRPC and DFPR, 2001).

Roads fragment habitat and affect the movement of fish and various wildlife species. Roads can isolate populations of species such as black bears, stopping them from moving to fall feeding areas, or new ranges, and reducing their chances of finding mates. Vehicle collisions with wildlife kill 2,500 deer and moose annually on Vermont roads. In-stream culverts create barriers to fish migration and, can prevent access to vital spawning areas (FWD, 2000).

Forest cover, and more generally, any well-vegetated landscape, can have a significant positive influence on water quality. Trees help keep pollutants from reaching groundwater, reduce erosion, reduce stormwater runoff, aid in recharge of aquifers, regulate water temperature, supply critical nutrients, and provide an environment in which aquatic and riparian wildlife can flourish. Increases in impervious surface area from the development of roads, parking lots, sidewalks, rooftops, patios, and compacted soils alters the storage and transportation of water which, in turn, affects the surrounding stream biology. Polluted runoff is caused from rain or melting snow flowing into waterways. Runoff becomes polluted with silt from eroding soils, oil and metals from roads and automobiles, and chemicals and animal wastes from residential lawns and farms (The Champlain Initiative, 1999). The increase in pavement and other impervious areas can increase runoff and carry toxic pollutants into waterways.

Increased development means greater disturbance to soils, greater impact on natural resources and greater stress on the capacity of existing farmland to both produce more on less land and to maintain the pastoral nature of the landscape. When managed properly, farms protect streams and water quality, and produce far less pollution per acre than developed land (Hegman et al, 1999). While urban development represents only 3% of the total land within the basin, it contributes 18% of the phosphorous loading to Lake Champlain (The Champlain Initiative, 1999).

**Agriculture in the Lamoille River Basin**
(agricultural statistics provided below from AAFM personal communication, 2008).
One hundred eight dairy farms are located in the Lamoille Basin. Some dairy farms are active producers, currently shipping milk, while the remaining inactive farms are still in business but not currently shipping milk to a bulk handler. Inactive producers who are out of business may be functioning as heifer barns or calf nurseries for neighbors, or leasing their land or buildings to other active dairy producers.

Non-dairy farms in the Lamoille Basin are well represented. The combined value of non-dairy agricultural products in the Lamoille Basin is nearly $7 million. Agricultural processors and support industries are present in the basin because of the increased market demand for locally grown produce. Two fiberworks support the numerous sheep and llama producers. There are four farmer's markets and three poultry processors in the basin. There are also 42 Vermont-certified

organic farms, of which two are designated Community Supported Agriculture (CSA) farms, whose market area covers the entire Lamoille Basin and much of surrounding counties. These organic farms produce smaller quantities of a much greater diversity of agricultural commodities, ranging from apples to yogurt.

Horse farms are a strong presence, accounting for an estimated 2,500 horses in the basin, and maintain an estimated 10,344 acres of pasture and open land. Livestock operations, primarily beef cattle, are often profitable replacements for marginal dairy operations, especially in the higher elevation terrain where pasture and hay land are more prevalent than row crop tillable acreage.

**Table 9. The Number of Agricultural Producers (farms) in the Lamoille Basin.**

| Type of Producer | Total Producers |
|---|---|
| Dairy | 108 |
| Beef | 27 |
| Sheep | 20 |
| Deer Herd | 4 |
| Llama/alpaca | 21 |
| Maple sugar | 125 (estimated) |
| Horses | 30 (estimated) |
| Poultry | 2 |
| Vegetable | 3 |
| Orchard | 2 |
| CSAs | 2 |
| Certified organic | 42 |

Trends for the Future in the Lamoille Basin

Farmland is a slow but steadily shrinking resource in the basin. Each of the counties of the Lamoille Basin experienced a net loss of farmland, averaging 560 acres a year over a ten-year period, with Franklin, Chittenden, Lamoille, Caledonia and Orleans ranked first to last in lost farmland. This is due to the more rapid development of the I-89 corridor from Burlington to St. Albans, and the slower eastward expansion of development along Route 15 (AAFM, 2003).

Of the five counties that make up the Lamoille Basin, there is some variability in the extent of change in farm numbers; for example Lamoille County gained 84 new farms and Chittenden County 4 new farms in the Basin, while Orleans, Franklin, and Caledonia lost a combined total of 34 farms within the basin over a 10 year period. The increase in farm numbers in Lamoille and Chittenden can be attributed to start-up vegetable, horse and non-dairy livestock farms, as well as consolidation among larger dairy operations. However, on average, the Lamoille Basin lost the equivalent of a 400 acre dairy farm a year, every year over the last 10 years, to a combination of rising production costs, lowered milk prices, farmer demographics and development pressure.

Continued access to and a sufficient amount of row crop corn land are vital to the survival of most of the current dairy operators in the Lamoille basin. Farmland shares a narrow corridor of space mostly in river bottom farmland that competes with transportation, utility and residential needs. Farmers use the land available to them as intensely as possible, in some cases planting and cultivating right up to the river's edge because of economic necessity.

The retirement of older farmers, increasing land and production costs, low food prices, competing land uses, the lack of incentives for young people to enter farming, and the fundamental restructuring of the local, national, and global economy all combine to make farming and local food production in the U.S. an increasingly difficult task. There are two general trends occurring in agriculture both at the national and local level. One is toward larger operations that produce commodities. The other direction is

toward niche and specialty food markets; toward farmers adding value to their crops with their own processing ventures; and toward locally grown agricultural products (Cantrell, 2002).

On-going Efforts to Preserve Farmland

Coalitions of state agencies and private conservation organizations have purchased conservation easements and development rights on over 36 farms in the Lamoille Basin to preserve viable farms and prime agricultural soils. The conserved acreage allows a farmer to operate more profitably with lower taxes and a decreased debt burden. The Vermont Land Trust, acting alone or in concert with the Vermont Housing Conservation Board and the Vermont Agency of Agriculture, Food and Markets (AAFM) has conserved over 3,238 acres of farmland in the basin. The VAAFM Farmland Preservation Program currently has two abutting farm properties [totaling 491 acres] in Georgia involved in pre-application for conservation easements (AAFM, 2003). Most watershed towns acknowledge the importance of working farm and forest land in their municipal plans.

Broad Strategies to Address Loss of the Working Landscape

Many farmers nearing retirement face succession choices that affect not only themselves but also the entire watershed they farm in. Joint efforts are needed to effectively address all the issues affecting Lamoille Valley farmers. To effectively manage non-point source pollution, the continued economic health of the farm is critical. Farmers must explore non-traditional funding to leverage federal and state cost-share funds. Assistance with business plans, value-added processing, succession and retirement planning, land conservation easements and other farm-related opportunities must be customized to each farmer's needs and timetable.

In the changing economic and demographic conditions of the Lamoille Basin, agriculture should be seen as a "patchwork quilt" of multiple and diverse farming systems, instead of a single farming "monoculture." Market forces offering higher prices for vegetables, nursery crops, and organic produce of all kinds are signaling a demand that could be profitably supplied by farmers willing to implement new and diverse operations as a supplement to, or eventual replacement for, traditional dairy operations. Maintaining a meaningful farm and forestland base for the future dairy economy in the watershed may depend heavily upon non-dairy diversified farm and forest activities, that are far more profitable than the land area they take up, thus subsidizing the greater area of pasture, hay and row crop land. All activities that keep land open and in active use should be considered important to the future of the "quilt" of the Vermont landscape.

**Agriculture and Water Quality**

*Farmers are stewards of the land. If we're not keeping the water clean, we're not doing our job.*

-Loren C. Wood, Woodnotch Farm, Shoreham, VT (AAFM, 2000)

While significant strides have been made to reduce agricultural non point sources of pollution through voluntary implementation of soil, manure, and fertilizer management practices, agriculture remains one of the most significant potential sources of water pollution.

With some exception, dairy farms throughout the Vermont and the Northeast are moving towards more intensified operations and expanded herd size. Corn silage has been the row crop of choice because it is high yielding and can provide the additional forage dry matter per acre required for increased herd sizes. Growing high yielding forages is crucial in Vermont since quality cropland is often limited. Corn silage is also a significant crop because of its high-energy content, high intake potential, and optimum dry matter at harvest. Corn silage is appealing because it's relatively low labor and machinery requirements due to a single harvest activity and because of its ability to be grown in marginal areas. In addition, since so few annual forage

crops with the superior yield potential and forage qualities of silage corn can be grown in Vermont, the opportunities for crop rotation have been limited.

Although the integration of corn silage has increased productivity and efficiency, the lack of rotation out of corn has led to a number of potentially detrimental economic and environmental consequences, ranging from increased use of pesticides, increased cost of production, decreased yields, rapid erosion of topsoil, and reduced soil health all of these factors contributing to lowered water quality. Increased erosion is often seen in silage fields because a large area of soil between corn rows is left uncovered. In addition, silage harvest results in the entire plant being removed from the field leaving little to no crop residue during the off-season. Poor soil coverage can lead to the loss of sediment-bound nutrients – especially phosphorus - and pesticides into near by surface water (Sharpley and Beegle, 2001). When fields are planted to corn silage, generally manure is applied during hydrologically sensitive periods (early spring and late fall). Spreading manure at these sensitive times increases the risk of manure run-off because soils are more easily compacted (reduces infiltration). Since up to 90% of the phosphorus transported from cropland is attached to sediment, the reduction of soil erosion would be of prime importance in minimizing phosphorus loss from agricultural land (Sharpley and Beegle, 2001). Designing cropping systems that reduce phosphorus release by minimizing soil erosion would ultimately benefit water quality.

With increased herd sizes and more year round confinement of dairy comes a greater dependence on imported phosphorus-rich grains. Increased use of grains has led to higher phosphorus levels in the soil and the increased risk of contaminated run-off. Pasture-based farms are alternative systems and have a much greater percentage of land under permanent sod which has significantly less potential for erosion and associated phosphorus run-off and use minimal phosphorus-containing grains, soluble fertilizers, and herbicides. Similarly, these farms have increased flexibility regarding the timing of manure spreading since most of it can be applied to sod-covered hayland with multiple windows for application. However, unrestricted livestock access to surface water from pasture-based farms is a water quality concern because of pathogens, manure nutrients, sedimentation, and increased erosion of unprotected streambanks.

Inadequate animal waste structures and nutrient management results in nutrient loading to surface and ground waters and is a source of agricultural nonpoint source pollution. Of the 168 operating dairy farms in the Lamoille River watershed, 18 lack waste management systems or an improved barnyard. Older waste management systems that were installed by farmers may or may not be up to VAAFM and NRCS cost share standards. (The following information provided by AAFM personal communication, 2008)

**Table 10. Waters in the Lamoille Basin that are affected by Agriculture.**

| | Total River Miles | Lake and Pond Acres |
|---|---|---|
| High | 8.5 | NA |
| Moderate | 92.3 | NA |
| Sub total | 100.8 | NA |
| Threatened | 26 | 64 |

Accepted Agricultural Practices

Accepted Agricultural Practices (AAPs) are statewide restrictions designed to reduce nonpoint discharges through the implementation of improved farming techniques rather than investment in structures and equipment. AAPs are basic practices that all farm operators must follow as a part of their normal operations. The law requires that the practices must be technically feasible as well as cost effective for farmers to implement without government financial assistance. Changes to the AAPs (AAFM, 2005a) related to surface waters include:

- Streambank vegetation is to be protected from livestock trampling and equipment damage;
- Streambank areas are to be left in a natural state;
- Manure will not be stacked on unimproved sites within 100 feet of surface waters;
- All fields receiving manure applications must be soil tested at least once every 5 years;
- Manure shall not be applied within 10 feet of surface waters or within 35 feet of surface waters at points of runoff or applied in such a manner as to enter surface waters;
- Livestock will not be pastured nor manure applied within 50 feet of private wells without landowner permission;
- Animal mortalities burials must be at least 150 feet from surface waters;
- A buffer zone of perennial vegetation shall be maintained between annual cropland and surface waters of 10 feet and an additional 25 feet at points of runoff to surface waters;
- No tillage or manure spreading is to occur within the vegetative buffers;
- Wherever feasible, stabilization of farm field streambanks shall be constructed in accordance to USDA and the Secretaries of ANR and AAFM standards and specifications and shall recognize the need to reduce fluvial erosion hazards.

General and Individual Permits for Medium and Small Farms

The VAAFM has developed new rules for medium and small farms (AAFM, 2005b). The general permit is designed to ensure that all medium farms generating animal wastes comply with Vermont Water Quality Standards. Medium farms (200-699 mature dairy cows and equivalent weight of other types of livestock) are required to operate under coverage and terms of the general permit. Small farms may be required to operate under the coverage and terms of an individual permit at the Secretary of AAFM's discretion. Requirements of the individual and general permit include proper design and storage capacity of waste storage structures, nutrient management plans, and milkhouse and leachate runoff systems. BMPs will be required to assure that there are no direct discharges of agricultural wastes to waters of the state.

Conservation Practices In Place In The Watershed

The USDA Natural Resources Conservation Service (NRCS), AAFM, and Vermont's 14 NRCDs provide technical assistance to landowners in the planning and application of conservation practices or BMPs to address natural resource concerns. Best Management Practices (BMPs) are more restrictive than AAPs and are site specific practices to correct a problem on a specific farm. Of the 108 dairy farms currently in operation in the Lamoille River watershed, 94 have completed or are presently implementing 515 BMPs. Each year between two and eight farms are provided with cost-share funds for BMP implementation. Contributions of federal and State dollars combine to decrease the cost for the farmer/landowner to as little as 15 percent.

Conservation practices in the Lamoille Basin date back to the 1960s. Before 1996, prior to the State providing additional cost share funds, many improvements were implemented by farmers on their own or with only Federal assistance. Since 1996, over $7,700,000 of federal, state, and landowner funds have been invested in non point source pollution control on farms in the Lamoille River basin. This investment reduced agriculture's contribution to phosphorus in the watershed by an estimated amount of 17,000 pounds per year. Additionally, these practices will reduce pathogen loading of waterways and assist farmers in better managing nutrients on their farms.

Some of the BMPs installed include: waste storage facilities, improved barnyards, roof runoff management systems, fencing animals out of waterways and providing them with stream

crossings and alternative watering systems. At the current rate of three waste management systems per year it will take approximately six years to complete implementation. In the Lamoille Basin, 135.8 acres of Conservation Reserve Enhancement Program (CREP) practices have been funded in 2002-2003, with the majority of these practices as filter strips (13), riparian buffers (6), and tree/shrub establishment (5).

Participation in these conservation programs is voluntary and not all producers are willing or financially able to invest in BMPs so there may never be full participation. Field practices are the most cost effective BMPs for their use. Storage systems contain wastes produced during the winter spreading ban or when animals are confined. Designated stacking sites for winter storage of manure, diligent investigation of nonpoint source complaints, and farmer education/outreach are the proven management strategies that AAFM and NRCD technical staff are pursuing.

It will take several years to treat all the remaining dairy farms at current funding levels for BMP installation. In that time, systems now in use will need upgrading as well. Water quality should gradually improve over time as more farms have systems in place, however. Levels of phosphorus and nitrogen in surface waters should decrease but will not be eliminated. Greater improvement over time should come now that nutrient management is a requirement of participation in Federal programs. Further near-term improvement could take place if the cost share funding programs are refocused on other types of farms and on annual practice implementation of all appropriate BMPs. The combination of BMPs such as structures, riparian treatments and buffer installation will have the greatest benefit. A "whole farm fix", customized to each operator's needs and land situation will better achieve the desired affect.

Equine Industry Participation

Horses lead in non-dairy agriculture animal numbers, farm numbers, and acreage. Horse farms follow and establish quickly on farmland and pasture abandoned by dairy agriculture, particularly in the urban shadow. Horses are also kept in suburban or developed areas. Although some NRCDs have in the past presented workshops for horse owners, there is a need for watershed wide awareness of the impact of horses on water quality.

Small grazing ruminants

Sheep, llama and alpaca farms together are similar in number to horse farms, but are often smaller operations representing fewer animal units. Pasture maintenance, manure management and composting, and buffer issues are also concerns for this group of farmers.

***Livestock exclusion from a Lamoille waterway***

**Forestry and Water Quality**

Forestland covers 71% of the Lamoille River Basin. Uses of the forest include, but are not limited to, recreation, wildlife habitat and timber harvesting. Outside of areas in federal or in State ownership, forestland is owned by individuals with diverse goals allowing for a variation in management in terms of uses, strategies, timeframes, and intensity.

Larger tracts of state-owned forest land include the Mount Mansfield State Forest, Long Trail State Forest, Elmore State Park, Green River Reservoir State Park, Johnson State College's Babcock Nature Preserve, and several wildlife management areas. The federally-owned Underhill

Firing Range encompasses 11, 200 acres within the Lamoille and Winooski watersheds. Large privately owned woodland tracts include land managed by CVPS, Hardwick Electric, Morrisville Water and Light, and the Nature Conservancy. In 1997, the Nature Conservancy and the Vermont Land Trust established the Atlas Timberlands Partnership (ATP) to purchase land from the Atlas Timber Company and manage these forest holdings in the future for jobs and the environment. Over 26,700 acres of ATP land are located in north central Vermont including this basin.

Most erosion from logging operations occurs from runoff from logging roads, log landings, and stream crossings and not the logging itself. Erosion occurs when logging roads are laid out poorly on steep and wet areas and when streams are crossed at inappropriate locations. Erosion also occurs when logging occurs during wetter times of the year. Occasionally oil, gas, and hydraulic fluids leak from poorly maintained logging trucks and skidders.

Acceptable Management Practices (AMPs) For Maintaining Water Quality on Logging Jobs

In 1986, the Vermont Legislature passed amendments to Vermont's Water Quality Statutes Title 10 V.S.A. Chapter 47: Water Pollution Control. The amendments declared that "it is the policy of the state to seek over the long-term to upgrade the quality of waters and to reduce existing risks to water quality." The revised state law requires permits for discharges of "any waste, substance or material into the waters of the state." However, individual permits are not required for any discharges that inadvertently result from logging operations if responsible management practices are followed to protect water quality.

"Acceptable Management Practices (AMP's) For Maintaining Water Quality on Logging Jobs in Vermont" was developed and adopted as rules to Vermont's water quality statutes and became effective on August 15, 1987. The AMP's are intended and designed to prevent any mud, petroleum products and woody debris (logging slash) from entering waters of the state. They are scientifically proven methods for loggers and landowners to follow for maintaining water quality and minimizing erosion.

The AMP's contain twenty-four suggested practices for loggers and landowners to follow during and immediately after logging. A violation occurs when there is a discharge and the AMP's are not in place. The AMP's have the force of law and violations can result in substantial penalties. Since adoption of the AMP's, the Department of Forests, Parks and Recreation (FP&R) has worked with representatives from the Vermont forest industry to support the Agency of Natural Resource (ANR) Enforcement Division in an effort to reduce the number and severity of discharges resulting from logging operations.

The AMP Program has been successful in keeping water quality violations from logging activity to a level that has been manageable given the number of logging operations. There is a high level of cooperation and voluntary compliance among loggers to bring their operations into compliance with Vermont's Water Quality Statutes. An MOU between the Department of Forests, Parks, and Recreation and the ANR Enforcement Division

has been an effective guide to refer to when investigating AMP cases. AMP cases referred to the ANR Enforcement Division remains low in comparison to the total number of water quality cases investigated. Vermont loggers attend AMP workshops hosted by the Logger Education to Advance Professionalism (LEAP) Program and supported by the Department of Forests, Parks & Recreation and the Vermont Forest Products Association.

AMP Activities in the Lamoille Watershed

The Department of Forests, Parks and Recreation tracks AMP case investigations state-wide. From 1999 to present, sixty-four AMP cases have been investigated by FPR field staff in the Lamoille River Basin. Thirty-three of those cases showed evidence of discharge and thirty-one did not. This means that over this approximate ten-year time span, there were an average of six cases investigated each year with half of those cases (3) showing evidence of discharge. To put this into state-wide perspective, from 1999 through 2007, the average number of cases investigated was forty-three and the average number of cases showing evidence of discharge was twenty. There is no apparent upward or downward trend in the number of cases investigated statewide. The number of statewide cases investigated range from a low of twenty-seven in 2005 to a high of fifty-eight in 1999. This is most likely due to a variety of weather and market conditions as well as social factors. Although there is not an apparent downward trend in overall numbers of cases investigated, the severity of water quality impairments associated with logging has diminished greatly since the AMP Program was established in 1987. This has been documented in the individual case reports and through observations made by the FPR District Forestry staff investigating these cases.

Lamoille Portable Skidder Bridge Program

Sediment is the major pollutant associated with logging. The AMPs allow loggers to use culverts, bridges, or poled fords to cross streams during logging. Brushed-in stream crossings are also allowed but only under frozen winter conditions. These are temporary structures that must be removed once the logging operation has been completed. Previous studies, audits as well as AMP case reports from 1987 to present indicate that when sedimentation does occur it is usually associated with temporary stream crossings. Portable skidder bridges, when properly installed and used as temporary stream crossing structures, will reduce streambank and streambed disturbance as compared to other alternatives, thus minimizing the potential for sedimentation.

The Lamoille Portable Skidder Bridge Rental Program was initiated in 2007 and included the initial construction of three bridges. A fourth bridge was constructed during the summer of 2008. This program is a joint venture between the DEC Basin Planning Program, DFPR Forest Watershed Program and the Lamoille County NRCD. Vocational high school forestry students from the Green Mountain Technology and Career Center in Hardwick were actively involved with sawing materials for the bridges and provided manpower in assembling them. A "hands-on" bridge building workshop was held at the Green Mountain Technology and Career Center during the spring of 2007 and was attended by the forestry students as well as area loggers.

The bridges are available for rental at low costs for loggers and landowners working on privately owned lands within the watershed. Bridge materials were sawn, milled, and constructed locally which will enhance efforts to preserve the working landscape of the Lamoille watershed.

***Portable Skidder Bridge construction workshop, Hardwick***

## Developed Lands and Water Quality

*Rain does not fall on one roof alone.*
***-Proverb from Cameroon***

### Population and Housing Growth in Basin Towns

The rate of growth, and especially housing growth, has been very high in the towns of the Lamoille River watershed. The population grew 32 percent for the watershed between 1970 and 1980 and 20 percent between 1980 and 1990 (DEC, 2001a). The housing units increased 28 percent between 1980 and 1990. The towns with the highest population and housing unit increases were in the lower part of the watershed. Several upper Lamoille watershed towns also had high population increases when measured as a percentage of the earlier census.

The towns of Georgia, Fairfax and Fletcher saw the fastest rate of growth from 1980 and 1990 both in terms of population and housing units. All three towns have become bedroom communities for people traveling originally just to St. Albans and Burlington for work, but now also to Milton. Although almost all of the towns in the watershed have experienced high rates of growth from 1970 to 1990, other towns in the lower Lamoille watershed have seen especially high growth include Cambridge, Essex, Jericho, Milton, and Underhill (DEC, 2001a).

### Construction Site Erosion

Although construction activities are usually temporary, erosion from construction sites can cause significant amounts of sediment to enter adjacent waterbodies. Construction activities result in the disturbance of vegetation during the building of homes, roads, bridges, and businesses. Erosion from construction activities can cause loss of topsoil and phosphorus pollution and algae blooms in lakes and ponds. Excessive sedimentation in streams leads to stream instability as the channel beds build up or aggrade and to habitat loss due to embeddedness. Construction is more widespread in the lower sections (Chittenden and Franklin Counties) of the Lamoille watershed where development pressure is greatest.

"*On a unit area basis, construction sites export sediment at 20 to 2,000 times the rate of other land uses. Suspended sediment can reduce plankton and aquatic plant growth, decrease native fish populations and species diversity, increase water treatment costs, and affect recreational activities. Deposited sediments can smother macroinvertebrate communities, destroy fish spawning and habitat areas, deplete dissolved oxygen, reduce storage and lower design life for reservoirs impoundments and ponds, increase channel aggradation (bed build up), increase streambank erosion, reduce channel conveyance capacity under bridges and culverts, and diminish recreational and aesthetic uses of waterways"* (The Center for Watershed Protection, undated).

***Construction site erosion and sedimentation***

Construction site erosion is the first pulse in sediment load associated with urban development. A second and possibly greater sediment pulse occurs as stream banks begin to erode in response to the greater volume and frequency of stormwater flows generated by impervious cover. Typically, as a watershed is urbanized, construction activities generate more sediment when compared to natural conditions. The first response of the channel is to fill with sediment. As urbanization progresses and new construction sites are replaced with pavement and structures, sediment loads to streams diminish and flow discharges from the area increase above their original levels because of the increase in storm sewers and impervious surfaces. The channels increase their widths and depths with accelerated bank and bed erosion (Riley, 1998).

Erosion Prevention and Sediment Control

Erosion prevention should be the first priority at construction sites. Erosion prevention (seeding, erosion control matting, and vegetation) involves keeping soil in place and is far more effective than sediment control (silt fence). Construction permits require erosion prevention and sediment control plans. These plans should reduce the erosion of disturbed land and prevent the discharge of sediment and other construction-related pollutants to waters of the State. Major components of the plan include: fitting the development plan to the site, preservation of natural drainageways, minimization of soil disturbance and vegetative cover removal, and water and runoff management.
Examples of erosion prevention techniques include:

- Preserving or establishing vegetative cover
- Erosion control blankets, or matting
- Mulch
- Minimizing disturbed areas and exposed soils
- Phasing of project disturbance and stabilization
- Clearly defining the limits of disturbance
- Preserving or enhancing riparian areas

Examples of sediment control include:

- Properly installed silt fence
- Stabilized construction entrances
- Sediment basins
- Street sweeping

State Regulations

A revised Construction General Permit (CGP) 3-9020 was issued in 2006, for discharges from construction activities involving one or more acres of land disturbance. The CGP establishes requirements, standards, prohibitions and management practices for discharges of storm water from construction activities. Permit requirements under CGP 3-9020 are based upon the risk of erosion and sediment discharge from the construction activities.

There are two categories of projects that may be authorized under the CGP 3-9020, Low Risk and Moderate Risk. Owners and operators of intended construction activities must submit a Notice of

Intent (NOI) that includes a determination of the appropriate risk category.

Applicants for projects that qualify as Moderate Risk must submit a completed NOI and an Erosion Prevention and Sediment Control Plan developed according to the newly issued manual, *The Vermont Standards and Specifications for Erosion Prevention and Sediment Control.* Applicants for projects that qualify as Low Risk must submit a completed NOI and certify that the practices in the Low Risk Site Handbook for Erosion Prevention and Sediment Control will be implemented.

In addition, approximately 700 projects a year across Vermont require Act 250 permits which ask the applicant to demonstrate that the project will not cause unreasonable soil erosion or reduce the capacity of the land to hold water so that a dangerous or unhealthy condition may result.

Outreach and Education

Current formal DEC Education and Outreach efforts related to EPSC are limited due to staffing reductions. The Stormwater Section focuses primarily on training individual designers in the context of project review, and developers and contractors during pre-construction and construction site visits.

DFPR's Urban and Community Forestry Program provides information and training for towns regarding vegetation options in urban settings. Information includes managing trees at construction sites, site assessment, and structural soils education. The Community Involvement coordinator and urban and community foresters provide assistance regionally. For the Lamoille watershed there are offices in Barre and Essex Junction.

**Impervious Surfaces and Stormwater Management**

Background

Development can seriously alter the local hydrologic cycle. The hydrology of a site changes during the initial clearing and grading that occurs during construction. Having lost its natural storage capacity, a cleared and graded site can no longer store rainfall and stormwater runoff. With this increase in runoff volume comes an increase in sediment load that can significantly affect the receiving water health (DEC, 2002c).

Rooftops, roads, parking lots, driveways and other impervious surfaces no longer allow rainfall to soak into the ground. Consequently, most rainfall is directly converted to stormwater runoff. The volume of stormwater runoff increases sharply with impervious cover. A one-acre parking lot can produce 16 times more stormwater runoff than a one-acre meadow each year (DEC, 2002c). Similarly, conversion of agricultural lands to impervious surfaces has a corresponding increase in surface runoff.

Impervious surfaces accumulate pollutants deposited from the atmosphere, leaked from vehicles, or windblown from adjacent areas. During storm events, these pollutants quickly wash off, and are rapidly delivered to downstream waters. Some pollutants associated with stormwater runoff include sediment, phosphorus, organic carbon, bacteria, hydrocarbons, heavy metals, pesticides, chlorides, trash and debris. These pollutants enter waterways from streambank erosion associated with urbanizing watersheds, lawn runoff, pet and wildlife waste, sanitary and combined sewer outfalls, wastewater, vehicle oil and grease, and road salt.

Stormwater runoff pollutants can adversely affect aquatic life, cause eutrophication (nutrient enrichment), lower levels of dissolved oxygen, and increase surface water temperatures. Stormwater has the potential to cause short and long-term source water contamination for public

water supplies. Excessive amounts of phosphorus can cause algae blooms that deplete oxygen levels of the water, impair aquatic biota populations, and diminish recreational opportunities such as fishing, swimming, and boating. Lake Champlain and several other water bodies across the State are currently impaired due to excess amounts of phosphorus, excess sediment loads, and/or toxic pollutants.

Collected snow poses a challenge to municipalities and businesses as roads, parking lots, bridges, and sidewalks are cleared. Collected snow is often contaminated with road salt, sand, litter, and automotive pollutants such as oil, gasoline, and antifreeze that can threaten public health and water quality.

Stream channel widening and channel instability as a result of increased flows from impervious surfaces cause culvert surcharging, property damage, and significant sediment loading or erosion to waters and lands of the state. Another problem associated with improving the condition of stormwater-impaired streams involves correcting years of neglected infrastructure maintenance. Stormwater infrastructure includes catch basins, storm drainage piping, road ditches, flood control basins, swales, ponds and sand filters.

Phosphorus and other pollutants in stormwater runoff are addressed to some extent for new developments in Vermont that must receive state stormwater discharge permits or state land use (Act 250) permits. Erosion control and stormwater management requirements are generally included as conditions in these permits, and these practices help limit new sources of sediment and phosphorus loading caused by land development. However, these permits are required primarily for large projects, and many small developments may have a significant cumulative effect on pollutant loading to Lake Champlain (DEC, 2002c).

<u>Stormwater Discharge Permitting</u>
DEC's Stormwater Management Program is a regulatory program charged with issuing permits for stormwater discharges statewide, and restoring acceptable water quality in stormwater impaired watersheds. A 25 year backlog of expired stormwater has been significantly reduced. State of the art standards for stormwater treatment systems are required for all newly permitted discharges.

DEC developed an enhanced stormwater management program in 2002, including the development of a new Stormwater Management Manual (DEC, 2001b). This manual emphasizes the importance of innovative site design, stormwater credits, and non-structural means of minimizing stormwater runoff from newly developed sites. In addition, a new Stormwater Management Rule in 2005 lowered the threshold for requiring a State Stormwater Discharge Permit to one acre of impervious surface.

DFPR, UVM's Sea Grant program, and VLCT are working collaboratively to assist communities plan for and divert stormwater runoff using vegetation and trees as interceptors.

*Stormwater Impaired Waters*
There are approximately seventeen streams in Vermont that are impaired primarily due to urban stormwater runoff, none of which are located in the Lamoille River Basin.

<u>Federally mandated permits administered by the state</u>
In 1987, Congress amended the Clean Water Act and directed EPA to develop a two-phased comprehensive national program for addressing stormwater discharges. EPA issued "Phase I" regulations in 1990 authorizing a NPDES permitting system for stormwater discharges from several categories of private industrial activities and municipal industrial activities serving populations of 100,000 or more. EPA issued "Phase II" regulations in 1999 that included the same categories of industrial activities but now includes smaller municipalities in urban census

areas of at least 100,000 people and expanded erosion control requirements to sites disturbing between 1 and 5 acres of land. As an EPA-delegated state under NPDES program, the DEC has the responsibility to administer the NPDES permit program.

There are three National Pollutant Discharge Elimination System general permits required by the Clean Water Act.

*(1) Multi-Sector General Permit for Industrial Activities*
The Multi-Sector General Permit (MSGP) was issued in 2006 and is a five-year permit that covers new and existing discharges of stormwater associated with certain types of industrial activity within the state of Vermont. The permit is required for private and municipal industries that have a stormwater discharge to either a separate storm sewer system or to receiving water. Typical municipal industries that will require coverage under the MSGP include wastewater treatment facilities with permitted flows greater than 1 mgd. Typical private industrial activities that will require coverage under the MSGP include auto salvage facilities, paper mills, food processing factories, manufacturing plants, and landfills. Industrial facilities that keep all of their materials and activities protected by a storm-resistant shelter in order to prevent exposure to precipitation may be eligible for a "No Exposure" conditional exclusion from permitting requirements. If a facility is not able to meet the criteria for "No Exposure" certification, then a Stormwater Pollution Plan (SWPPP) must be prepared that evaluates the potential threat of their operations to stormwater quality, develops management procedures to minimize polluting stormwater runoff, and periodically reports on the implementation of the procedures. Industrial sectors determined to have a higher potential to pollute will also be required to perform water quality monitoring of their impacts on stormwater.

*(2) Phase II Municipal Separate Storm Sewer Systems*
The Federal Clean Water Act requires that the U.S. Environmental Protection Agency address urban stormwater runoff in a phased approach starting with the largest urban areas in the country based on population census data. In 2003, the U.S. Environmental Protection Agency, and the Vermont Agency of Natural Resources as the federally delegated authority issued the Phase 2 Municipal Separate Storm Sewer System (MS4) general permit.

This permit applies to the nine largest municipalities in the greater Burlington area and to other entities with separate storm sewer systems such as the University of Vermont and VTrans. The permit requires the affected communities to address six minimum measures. The measures are:

(1) Public Education and Outreach
(2) Public Participation/Involvement,
(3) Illicit Discharge Detection and Elimination,
(4) Construction Site Runoff Control,
(5) Post-Construction Runoff Control and,
(6) Pollution Prevention/Good Housekeeping.

These communities have filed a notice of intent with ANR describing a stormwater management plan that meets the 6 measures. In the Lamoille River Watershed, the towns of Milton, Colchester, and Essex are subject to the MS4 general permit. All of the towns have developed stormwater management plans. VTrans controlled sections of Routes 7 and 15 also fall under the MS4 designation. The MS4 plans include stormwater education and outreach, adopt-a-stream projects, storm drain stenciling, and waterway cleanups. These activities are compatible with the watershed plan goals of water quality improvement in urban areas.

*(3) CGP-Erosion and Sediment Control (see above)*

<u>Local stormwater management opportunities</u>

*Wilkins Ravine, Morrisville*
Wilkins Ravine is a small ephemeral stream located in Morrisville (figure 5). In the late 19th

century, the stream ravine near Lake Lamoille was dammed and diverted into a stone box culvert as a result of construction of the Lamoille Valley Railroad. As commercial and industrial development has occurred in the north end of Morrisville, stormwater runoff to the ravine has increased dramatically. Over the years the ravine has been used for dumping and has become severely eroded from stormwater runoff. Trash, sediment and, during rainstorms, large volumes of water became trapped behind the stone box culvert before passing through it and into Lake Lamoille. In addition, the unregulated discharge of stormwater has caused considerable property damage including undermining of a parking lot and the exposure of a sewer line. Approximately 76 cubic yards of sediment per year were being discharged into Lake Lamoille and the Lamoille River from the ravine (The Transcript, 2005). In 1998, a VTrans culvert upgrade on Route 100 greatly accelerated the movement of sediment into the Lamoille River. In June, 2002, the 80 feet high Lamoille Valley Railroad embankment began to fail.

The town, working in cooperation with DEC, has developed a comprehensive restoration plan for the ravine. The plan has 3 basic elements:

(1) Stabilize and clean up the Wilkins Ravine area.
(2) Install stormwater quality treatment controls and, where possible, quantity treatment controls in the developed area drainage network upstream of the Ravine.
(3) Reduce the overall volume of stormwater discharging to the Ravine by retaining water on-site and infiltrating to groundwater as much clean runoff as possible.

The plan also has 12 identified tasks. As of February 2008, 11 of the tasks were completed or funded. Tasks include construction of three stormwater swirl separators in the watershed (to remove trash, oil and sediment), stormwater detention and infiltration structures, improved drainage and landscaping, and cleanup and erosion control in the Wilkins Ravine. The town has adopted a zoning regulation to require basic stormwater controls such as the infiltration of roof tops for all new development that is not required to obtain a state stormwater permit. The plan is the result of work done by the Town of Morristown, DEC, VTrans, USDA-NRCS, Forcier, Aldrich & Associates, and many local property owners.

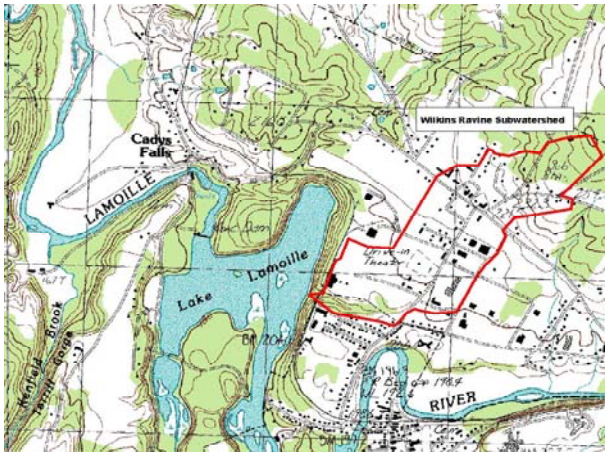


**Figure 5- Wilikins Ravine, Morrisville**

<u>Morrisville Village</u>
As a result of mapping work done by the Vermont Youth Conservation Corp (VYCC) a comprehensive map of the stormwater outfalls and drainage for the Village of Morrisville as well as the growth areas in the north end outside of the Village has been compiled (The Transcript, 2005). This work will allow for a future assessment of these outfalls for illicit discharges of wastewater and sediment and phosphorus loading to the Lamoille River. The survey also collected data on the maintenance and overall condition of the street catchbasins.
All basin towns with substantial drainage infrastructure should compile similar maps and conduct these sanitary surveys.

Morrisville, Johnson, Hardwick are currently considering a collaborative partnership to purchase a catchbasin vactor truck for cleaning storm and sewer lines. Maintenance of the basins will significantly reduce sediment and trash

pollution from the drainage system to the Lamoille River on an annual basis.

Snow Disposal Runoff, Morristown

While finding a location to dispose of collected snow poses a challenge to municipalities and businesses as roads, parking lots, bridges, and sidewalks are cleared, collected snow is often contaminated with road salt, sand, litter, and automotive pollutants such as oil, gasoline, and antifreeze that can threaten public health and water quality. Simple modifications to snow removal practices go a long way toward addressing these issues. The Town of Morristown has recently identified an alternative location for the town's snow disposal in an effort to reduce this nonpoint source pollution discharge. The present site snow disposal site is on the banks of the Lamoille River in the Oxbow Park area. Relocation of the snow disposal site away from the waterway could serve as a model to other watershed towns. DEC, NRCS, and the Town of Morristown are developing a comprehensive plan for Oxbow Park that includes the establishment of a woody riparian buffer and streambank stabilization.

**Transportation Infrastructure**

Background

Transportation infrastructure includes roadways and embankments, road drainages, rail systems, driveways, bridges, recreation paths, airport runways, and culverts. In Vermont, the transportation infrastructure is owned and maintained by the Vermont Agency of Transportation (VTrans), municipalities, and private citizens. Municipalities maintain the majority of gravel road miles in Vermont. Vermont towns average about 46 road miles each. Vermont's town roads effectively become part of the stream network during a storm or snowmelt events due to the proximity of roads to waterways. Roadside ditches often discharge directly into streams, lakes, or wetlands.

Transportation infrastructure that is improperly designed or installed, or that has become structurally unsound or functionally deficient over time, can lead to catastrophic failures during flood events. During the flood events of 1995, 1997, and 1998, numerous culverts and bridges failed catastrophically in the watershed. Enormous quantities of sediment entered the watershed in several towns including Hyde Park, Johnson, Wolcott, Craftsbury, Cambridge, Elmore, Stannard, and Eden. Affected streams include the Wild Branch, Rodman Brook, Foot Brook, Elmore Branch, Bunker Brook, Kate Brook, Stannard Brook, and Gihon River. Most of the damage occurred on private and municipality-owned transportation infrastructure.

Over 60 percent of infrastructure damage from the Vermont 1990s flood events was avoidable (DEC, 1999). Millions of federal, state, and private dollars have been spent on remediation of flood damage to transportation. During high water events, flood waters out-flank structures and wash out road embankments. Undersized culverts and bridge spans cause debris jam blockages and stream sediment transport discontinuity. High steep bank mass failures located along unstable stream reaches can contribute excessive amounts of sediment to waterways and, when located in close proximity to bridges and culverts, can also create debris jams responsible for catastrophic structure failures. The development of large point (gravel) bars upstream of stream crossings are indicators of an undersized structure and sediment transport discontinuity.

The state-owned transportation infrastructure has generally faired better against catastrophic failure than municipal and privately owned infrastructure due to higher flow designs, better construction and maintenance, and location in the lower portions of the watershed where valleys are wider and slopes are less steep. Private and municipal transportation infrastructure is more typically located in the upper portions of a watershed where valleys are narrower and slopes are steeper. These roads historically used as farm and logging roads, have been widened to accommodate residential growth in the higher elevations. With

new homes also come additional driveway, culvert, and bridge installation. Culverts that once were sufficient to accommodate historical land uses are undersized with development and increased impervious surfaces. As roads have been widened, they encroach upon the river's active floodplain and the river's energy is no longer dissipated on the floodplain but becomes concentrated within the channel. This causes channel instability and erosion.

Transportation-related Remediation and Outreach Efforts

The very solutions that will protect a town's investments in their roads will also prevent sediment and phosphorus pollution of surface water. Good transportation infrastructure maintenance can decrease road problems and untimely repairs, and save money.

Vermont Local Roads Program

The Vermont Local Roads Program emphasizes a 3-step process for addressing municipal transportation infrastructure for each municipality. This process includes: transportation inventory, a capital budget, and implementation of best management practices. Examples of best management practices include: road crowning, grassed and rock lined road ditches, culvert headwalls and outlet energy dissipaters, and road embankment stabilization. The *"Vermont Better Backroads Manual"* (Windham Regional Commission 1995) describes the maintenance practices that will achieve this result. The Vermont Local Roads Program has been providing technical training, information, and on-site assistance to town road managers for many years. A series of workshops for road managers and crews has been offered around the state since 1995. Many of the needed maintenance activities will prevent or reduce erosion and thus reduce water pollution and degradation of aquatic habitat.

The Capital Budget Planning Process includes the following steps:

- Inventory municipal road systems
- Assess type and cost of improvements necessary
- Determine cost effectiveness
- Prioritize sites
- Develop a 5-10 year capital inventory budget
- Update the plan annually

The 4 Principles of Better Backroads include:

1. Get water off the roads as soon as possible.
2. Stabilize and revegetate disturbed areas.
3. Divert water into vegetated areas.
4. Good maintenance saves money

***A completed Better Backroads project, Walden***

*ANR's Bridge and Culvert Survey Protocols*

ANR's bridge and culvert survey protocols (ANR, 2007 Appendix A) and database can be used for watershed-wide assessments of stream crossing structures. Survey results can be used to "red-flag" those structures that are potential barriers to fish and wildlife movement and/or flood or erosion hazards. Bridge and culvert surveys have recently been completed in the Browns River watershed and mid and upper Lamoille watershed.

ANR's Culvert Screening Tool and Stream Crossing Design Guidelines- The Vermont Culvert Compatibility Screening Tool (ANR 2007) is a specific querying tool to be used in conjunction with recently completed bridge and culvert surveys. The screening tool has been

developed based upon rating five variables including percent bankfull width, sediment and debris continuity, slope, approach angle, and bank erosion. This screening tool should be helpful in assisting natural resource planners and municipalities in prioritizing stream crossing projects.

The Guidelines for the Design of Stream/Road Crossings for Passage of Aquatic Organisms in Vermont (Malone and MacBroome, 2007) provides technical guidance in the design and construction of stream and road crossings where the passage of aquatic organisms has been identified as a concern.

Vermont Interagency Bridge and Culvert Team
The Vermont Interagency Bridge and Culvert Team was recently created to develop consistency in the methods and procedures used to collect and manage highway infrastructure data inventories. An integrated training and software package is being developed that will assist municipalities in managing their road infrastructure.

VTrans Transportation Infrastructure Maintenance and Improvement
The Vermont Agency of Transportation (VTrans) maintains state owned bridges and roadways as well as railroads, airports and public transportation facilities. VTrans developed a culvert and ditching procedure in 1997, which was updated in 2002. This procedure promotes best management practices to maintain infrastructure while addressing water quality issues. The erosion control standards are being updated currently and there is an erosion control team which monitors construction sites for proper erosion control and compliance of permit conditions.

Regional Planning Commission (RPC) Bridge and Culvert Inventories
Over the years, Regional Planning Commissions (RPCs) have assisted towns with inventorying and planning for maintenance and replacement of culverts and small structures for which the town is responsible. Although many towns have had a difficult time implementing formal infrastructure management systems due to lack of staff and/or resources and funds, it will be increasingly important to do so.

Federal Emergency Management Agency (FEMA) Project Impact
Project Impact is FEMA's initiative to make communities as flood proof as possible. Lamoille County's Project Impact program involved working with several municipalities to inventory roads, bridges, and culverts, assess stream stability, identify threats to infrastructure, stabilize severely eroding stream channels, and establish riparian buffers. This project has also begun fluvial erosion hazard mapping to assist municipalities to better protect existing infrastructure and plan for future structure locations. Lamoille County was the first county in the state to become a FEMA Project Impact area.

Lamoille Rail System
The Lamoille Rail Corridor extends from St. Johnsbury to St. Albans and runs parallel to the Lamoille River for the majority of its length. Scientific assessments (Ryan, 2000 and USDA, 2001) had identified the rail corridor as contributing to the instability of the Lamoille River. The rail embankment is a floodplain encroachment at several locations within the Lamoille Valley, most notably in the towns of Hardwick and Wolcott. The rail division at VTrans is in the process of submitting its request for discontinuance of service and to railbank the length of the corridor to the Federal Surface Transportation Board. Railbanking describes the process of transitioning the current corridor from a rail to a recreation trail while allowing for the possibility of conversion back to rail if necessary. A Lamoille Rail Corridor Consortium has been formed to oversee any changes in the corridor for rail and recreation purposes. Consortium representatives include three regional planning commissions, VAST, VTrans, and other recreation and rail interests.

DEC in conjunction with its partners VTrans, NRCS, and LCNRCD have removed over 8,600

linear feet of rail bed fill since 2006 to reconnect the Lamoille River to its historic flood plain. Riparian shrub plantings in conjunction with this project include 34,600 linear feet of willow installation along the rail corridor adjacent to the Lamoille River.

VAST, DEC, VTrans, LCPC, NWRPC and other partners are implementing a Lamoille Valley Railroad Rail Trail Flood Plain Encroachment Mitigation project (photo below). This project has been successful in addressing several water quality and aquatic habitat improvement objectives including:

- To mitigate floodplain encroachments, where possible, along the Lamoille River mainstem and Black Creek caused by the Lamoille Valley Railroad embankments.
- To reduce the potential of catastrophic maintenance costs due to flood and erosion.
- To provide flood and erosion mitigation benefits to private property owners and public infrastructure within the Lamoille River and Black Creek watersheds.
- To provide for the greatest hydrologic attenuation, reduction of erosion by creating a better balance between stream power and channel boundary conditions, and maximizing sediment capture and nutrient uptake

***Lamoille Valley Rail flood plain encroachment removal, Wolcott***

# CHAPTER 4. WATER QUALITY PROTECTION AND RESTORATION OPPORTUNITIES

Chapter 4 includes all the actions that will help achieve the goals of this plan prepared by DEC, its watershed partners, and the Lamoille Watershed Council except for those actions directly related to impaired waters, which are presented in Chapter 5. These actions are not necessarily listed or enumerated in any order of importance.

## Actions to Protect and Enhance Wetlands

The wetlands in the Lamoille River watershed are essential to the health and quality of the watershed. Protecting wetlands will ensure that there are fish, wildlife, recreation opportunities, and biological diversity in the Lamoille River and its tributaries.

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

**1. Action- Protect wetlands at the municipal level through compiling wetland inventories, strengthening local zoning and stormwater regulations, and increasing outreach.**
Encourage watershed towns to map all the wetlands in the municipality and update zoning to protect these areas and provide adequate setbacks and buffer areas. Towns can also help protect wetlands by checking the wetland maps found in each town office when development projects arise. Encourage towns to use wetland areas for education, low-impact recreation, and natural areas for residents.

**Lead Partner(s):** Watershed RPCs, municipalities and DEC
**Potential Funding Sources:** DEC staff time, Clean and Clear Initiative, 604(b) grants
**Timeline:** 200-2013/Initiated

**2. Action- Identify and restore idle (fallow) prior converted agricultural wetlands.**
Increased farm herd size and milk production numbers has led to the idling of marginal hay and pastureland that may have been previously converted from natural wetlands. Prior converted wetlands that have become fallow should be identified and pursued for wetland creation and protection programs. Impaired sub-watersheds, areas under pressure for residential development, and formerly high value wetlands should be considered high priorities for restoration.

**Lead Partner(s):** DEC, NRCS, VAAFM, watershed NRCDs, USFWS, USDA FSA, farmers, and RPCs
**Potential Funding Sources:** WHIP, WRP, Clean and Clear Initiative, Partners for Fish and Wildlife Program
**Timeline:** 2009/Initiated

## Actions to Protect and Enhance Lakes and Ponds

Comprehensive lake protection or restoration depends on managing whole watersheds and diverse land uses, and influencing individual behaviors. Some comprehensive lake protection and management strategies are discussed below, followed by actions related to specific lake water quality issues.

**Goal:**
**Protect natural lake shorelands from unplanned development and encourage better management of highly developed lake shorelands. Minimize adverse land use activities in lake watersheds, within the lake shoreland, and within lakes and ponds themselves.**

**3. Action- Map wilderness, wilderness-like and undeveloped lake and pond shorelands.**
Comprehensive mapping of undeveloped shorelands will be essential in development of protection actions of these areas.

**Lead Partner(s):** DEC Lake Assessment Program, VFWD, USFWS, and VFPR
**Potential Funding Sources:** DEC
**Timeline:** 2009/Initiated

**4. Action- Review regional and town plans and zoning bylaws information relating to lake protection issues**– Identify towns in basin with inadequate protection as plans and bylaws come up for review and revision. Much water resource protection will occur at the municipal level as Vermont does not have statewide shoreland protection. Through the on-going local planning and zoning processes, town programs can be updated to provide increasing protection of valuable shoreland resources.

**Lead Partner(s):** DEC, municipalities, VLCT Municipal Assistance Center, watershed RPCs, and lake associations
**Potential Funding Sources:** 604(b) grants and DEC and VLCT staff and volunteer time
**Timeline:** 2009-2013

**5. Action- Conduct lake watershed surveys in selective watershed lakes and ponds to identify nonpoint sources of pollution and the actions needed to control them.** Conduct Lake and Watershed Surveys and develop a plan including a list of non-point source problems in need of addressing, education needs, and town program needs. Correct identified non-point source problems through demonstration or implementation projects.

**Lead Partner(s):** DEC, lake associations, residents, and municipalities
**Potential Funding Sources:** DEC staff time, lake associations, Vermont Watershed Grants, and Clean Water Act (CWA) Section 319 grants
**Timeline:** 2009-2013

**6. Action- Promote regular maintenance of lakeshore camp septic tanks.** Encourage lake homeowners to pump out septic systems on a regular basis. Inadequate and failing lakeshore septic systems can contribute to discharges of phosphorus and E. coli to adjacent waterways.

**Lead Partner(s):** lake associations and lakeshore homeowners
**Potential Funding Sources:** Individual camp owners and lake associations
**Timeline:** 2009-2013

**7. Action- Conduct camp/landowner education, shoreland property management workshops, outreach to new lake and pond landowners**

**Lead Partner(s):** DEC, shoreland property owners, lake associations, Federation of Vermont Lakes and Ponds
**Potential Funding Sources**: Vermont Watershed Grants, New England Grassroots Environmental Fund
**Timeline:** 2009-2013

**8. Action- Expand Lamoille County NRCD's** Trees for Streams **Program to include lake and pond riparian areas.**

**Lead Partner(s):** Lamoille NRCD and lakeshore residents
**Potential Funding Sources:** Vermont Watershed Grants, LCBP
**Timeline:** 2009/Initiated

**9. Action- Initiate the Lay Monitoring Program at lakes where the program has been idle.** Lake Elmore, East Long Pond, Wapanaki, and Arrowhead Mountain Lake should be considered for the LMP. Other watershed lakes and ponds could also be added depending on local interest.

**Lead Partners:** DEC, lake organizations and/or lake residents
**Potential Funding Sources:** NA
**Timeline:** 2009-2013

**10. Action- Sample mercury levels on basin lakes predicted to have high mercury levels** (Table 7)

**Lead Partner(s):** DEC Lakes Section and VFWD
**Potential Funding Sources:** DEC and VFWD staff time
**Timeline:** 2009

**11. Action- Increase participation of watershed lake associations in the Federation of Vermont Lakes and Ponds**. Joining the Federation is a good way for lake associations and residents to keep abreast of lake protection and management activities statewide. An annual meeting in July provides both speakers on relevant lake topics, but also a chance to network and learn about other groups' experiences and successes.

**Lead Partner(s):** DEC and watershed lake organizations
**Potential Funding Sources:** no cost
**Timeline:** 2009-2013

**Goal:**
**Control the spread of aquatic invasive exotics in both infested and nearby lakes and ponds through inventories, outreach, and appropriate control measures.**

**12. Action- Conduct outreach efforts to lake residents and day users of lakes about the threats invasive exotic species pose and applicable state laws prohibiting their transport**. Use public service announcements, handouts, posters, and workshops to reach lake users. Ensure adequate information is available at public boat accesses. Develop boater education at public accesses by establishing boat access greeter programs where appropriate and hand out literature and conduct voluntary boat inspections.

**Lead Partner(s):** Lake associations/residents with technical and materials assistance from DEC
**Potential Funding Sources:** DEC and State Parks staff time, volunteer time, LCBP staff time, Aquatic Nuisance Control Grants-in-Aid (VTDEC)
**Timeline:** 2009-2013

**13. Action- Establish Vermont Invasive Patroller Programs.** Establish *Vermont Invasive Patrollers Programs* on lakes without known infestations. High priority for lakes with public access, downstream from known population, or located within a 10 mile radius of an infestation. Lakes and ponds with documented populations of Eurasian Water Milfoil could also benefit by monitoring any sudden expansion of existing populations and to monitor other species not already established such as zebra mussels, hydrilla, and water chestnut.

**Lead Partner(s):** DEC, and lake volunteers
**Potential Funding Sources:** DEC staff time, volunteer time, Aquatic Nuisance Control Grants-in-Aid (DEC)
**Timeline:** 2009-2013/Initiated

## Actions to Enhance and Protect River Corridors

Watershed and stream geomorphic assessment results can guide and prioritize stream corridor protection, stream stability restoration projects, pre-disaster mitigation efforts, erosion hazard mapping, and enhance aquatic and riparian habitats for fish and wildlife.

**Goal:**
**Use stream geomorphic and fish habitat assessments (ANR, 2007) in a proactive manner to direct and prioritize stream corridor protection, stream stability restoration projects, pre-disaster mitigation efforts, fluvial erosion hazard mapping, and enhancement of aquatic and riparian habitats for fish and wildlife**

**14. Action- Complete ANR's Phase 1 geomorphic assessments of major Lamoille Basin sub-watersheds**. The Phase 1 Remote Sensing Assessment results provide baseline scientific data needed to assist communities in various river corridor protection and management goals.

**Lead Partner(s):** DEC, RPCs, watershed volunteers, and consultants
**Potential Funding Sources:** DEC River Corridor Grants, LCBP, CWA Section 319 grants
**Timeline:** 2009/Initiated

**15. Action- Initiate or complete Phase 2 geomorphic assessments at selective sub-watersheds.** Sub-watersheds that are impaired, reaches vulnerable to fluvial and erosion flooding hazards, and waterways exhibiting reference reach qualities should be first priorities for this assessment.

**Lead Partner(s):** RPCs, consultants, NRCDs, and DEC
**Potential Funding Sources:** DEC River Corridor Plans, LCBP, and Vermont Watershed grants
**Timeline:** 2009-2013/Initiated

**16. Action- Assist communities with river corridor management plans and fluvial erosion hazard plans and mapping in pre-disaster mitigation efforts**. Proactive river corridor planning can prevent catastrophic flooding damage to infrastructure and the degradation of water quality and aquatic habitat. Use the DEC River Corridor Management Alternatives Analysis to determine if and what type of restoration technique approach to use for reaches undergoing adjustment process (DEC, 2002*). Fluvial Erosion Hazard Mapping is currently underway in Craftsbury, Wolcott, and Underhill.

**Lead Partner(s):** DEC, municipalities, and RPCs
**Potential Funding Sources**: DEC River Corridor Funds and PDM funds
**Timeline:** 2009-2013/Initiated

**17. Action- Increase the establishment and enhancement of woody riparian corridors along watershed streams**. Proactively establish and enhance riparian corridors using riparian corridor inventories and geomorphic assessment results. Sections of corridor that connect existing high quality riparian corridors should be given priority to ensure long-term stream stability, especially where such riparian areas also offer known or potential wildlife travel corridors and/or protect important aquatic habitats.

**Lead Partner(s):** DEC, RPCs, Lamoille River Anglers Association (LRAA) and municipalities
**Potential Funding Sources:** DEC River Corridor Grants, WHIP, CREP, and Partners for Fish and Wildlife Program
**Timeline:** 2009-2013/Initiated

**18. Action- Continue the pilot effort of the expansion of the** Trees for Streams **program to other parts of the watershed through NRCDs.** Only the Lamoille NRCD has such a program. Encourage NRCDs to purchase locally grown stock material for riparian corridor projects whenever possible. Establish local volunteer planting crews at the subwatershed level.

**Lead Partner(s):** watershed NRCDs
**Potential Funding Sources:** LCBP, CWA Section 319 grants, Vermont Watershed Grant
**Timeline:** 2009-2013/Initiated

## Actions to Improve Flow-regulated Waters

The principal alteration to lakes and ponds in the Lamoille watershed is drawdown of water levels that affects aquatic life. In-stream impoundments can degrade water quality and fisheries habitat. In many cases, dams are abandoned or not maintained by their owners.

**Goal:**
**Identify and restore stream reaches where dams impede fish movement, are responsible for decreased stream transport capacity, and/or degrade water quality.**

**19. Action- Selectively restore dam-altered reaches of streams within the watershed.** Continue on-going coordination of identifying dams for removal, partial breaching, and/or improved fish passage. Provide technical assistance and landowner outreach regarding dam ownership liability; identify funding opportunities; and coordinate dam removal projects, if necessary.

**Lead Partner(s):** DEC, Vermont Dam Task Force, VFWD, American Rivers, and consultants
**Potential Funding Sources:** Partners for Fish and Wildlife Program, WHIP, NOAA and American Rivers-Community-Based Restoration Program Partnership, and DEC River Corridor Grants
**Timeline:** 2009-2013

**20. Action- Hardwick Electric should consider alternatives including the removal of Jackson Dam and the restoration of the affected section of the Lamoille River and Alder Brook or other alternative measures that will result in ice jam flood protection and to comply with Vermont Water Quality Standards.**
**Lead Partner(s):** DEC, VFWD, Town of Hardwick, and Hardwick Electric Department
**Potential Funding Sources:** Partners for Fish and Wildlife Program, WHIP, Fish America grant
**Timeline**: 2009-2013

## Actions to Address the Loss of the Working Landscape

Conversion of working farm and forestland to fragmented smaller parcels can result in increased impervious surface areas, stormwater runoff, streambank and bed erosion, altered hydrology, and wildlife habitat fragmentation.

**Goal:**
**Protect existing productive forest and farmland from unplanned development that can adversely impact wildlife and aquatic habitat, water quality, and stream equilibrium.**

**21. Action- Hold Transferring the Farm/Forest and/or Estate Planning Workshops throughout the watershed.** Estate planning information will provide current farm and forest landowners with the information necessary to encourage a smooth transition of their lands to their heirs or other persons interesting in maintaining an open landscape.
**Lead Partner(s):** UVM Extension Service, Regional Planning Commissions, County Foresters, Vermont Land Trust, farm and forest landowners especially those approaching retirement age, and VAAFM
**Potential Funding Sources:** UVM Extension
**Timeline:** 2009

**22. Action- Develop a Lamoille Valley Farm and Forest Directory and website that exhibits local farmers and secondary wood product producers and mills, farmers markets, and watershed agricultural and forest-related events.** The web site would link to the agriculture and forest products programs to promote awareness and increase local participation.
**Lead Partner(s):** DEC, Economic Development Councils, local Chambers of Commerce, Vermont Fresh Network, Vermont Development Council, VAAFM, Vermont Forest Products Council, NOFA, primary and secondary producers of farm and forest products, retail markets, and NRCDs.
**Potential Funding Sources:** SARE grant and Sustainable Futures Fund
**Timeline:** 2009/Initiated

**23. Action- Hold a Lamoille Valley Farm and Forest Roundtable.** The goal of the forum will be to investigate how various existing statewide programs can be most effectively applied within the watershed. Some statewide organizations and programs that can enhance efforts to protect the working landscape include: the Vermont Fresh Network, the VAAFM Buy Local program, Vermont Land Link, the Farmer-School program, NOFA FEED program, Community Supported Agriculture (CSAs) and the Vermont Land Trust.

**Lead Partner(s):** DEC, VDFPR, Vermont Land Trust, Economic Development Councils, Vermont Fresh Network, Vermont Forest Products Council, Woodnet, primary and secondary producers of farm and forest products, retail markets, and VAAFM.
**Potential Funding Sources:** SARE grant, DEC staff time
**Timeline:** 2009/Initiated

**24. Action- Protect agricultural diversity by matching prime farmland conservation efforts with smart growth development.** Assist municipalities in strengthening town plan language and zoning to protect prime and statewide significant agricultural soils from development.

**Lead Partner(s):** VAAFM, NRCS, Regional Planning Commissions, Vermont Forum on Sprawl, Vermont Land Trust, Vermont League of Cities and Towns (VLCT), Town Planning & Conservation Commissions in the lower Lamoille watershed.
**Potential Funding Sources:** VAAFM Farmland Preservation Fund, Land Trusts, and local partners
**Timeline:** 2009-2013

## Actions for Agricultural NPS Reduction

Agricultural non point source pollution can result in nutrient and sediment discharges to adjacent waterways negatively affecting water quality, fisheries, and aquatic habitat.

**Goal:**
**Selectively apply best management practices and increase outreach programs to reduce non point source pollution from agricultural sources.**

**25. Action– Hold equine industry workshops to increase participation in non point source pollution prevention.** These workshops are especially needed in Lamoille and Chittenden Counties.

**Lead Partner(s):** NRCDs, NRCS, VAAFM, UVM Extension**,** horse owners, and equine industry-related businesses.
**Potential Funding Sources:** EQIP, Partners for Fish and Wildlife, and local partners
**Timeline:** 2009-2013/Initiated

**26. Action – Hold regular sheep and goat farmer workshops to increase participation in non point source pollution prevention.** Small ruminants management workshops are especially needed in Lamoille and Chittenden Counties.

**Lead Partner(s):** NRCDs, NRCS, VAAFM, UVM Extension, and sheep and goat farmers
**Potential Funding Sources:** EQIP, Partners for Fish and Wildlife, and local partners
**Timeline:** 2009-2013

**27. Action- Develop a compost materials exchange and hauler directory to increase watershed participation in composting projects.** Composting can be a tool used to improve water quality by reducing soil erosion, pathogens, soil compaction, and nutrient volume while increasing soil biological activity and organic matter. Beef, sheep, goat, horse, vegetable, and organic and grass-based dairy operations are most conducive to composting operations.

**Lead Partner(s)-** Composting Association of Vermont, Highfields Institute, NRCS, and VAAFM.
**Potential Funding Sources-** CWA Section 319 grants
**Timeline-** 2009/Initiated

**28. Action- Develop a cover crop and crop rotation demonstration project for farmland planted to continuous corn within flood plains.** Cropland susceptible to annual flood inundation and adjacent to waterways adversely affected by excessive nutrients and sediment should be priority areas for this project.

**Lead Partner(s):** NRCS, VAAFM, NRCDs, and UVM Extension
**Potential Funding Sources:** CWA Section 319 grants, SARE
**Timeline:** 2009-2013

**29. Action- Reduce erosion and nutrient runoff from cropland and farmsteads.** Erosion reduction techniques include filter strips, riparian buffers, cover crops, conversion to grass based operations, and addressing farm buildings runoff. Livestock exclusion from waterways is a high priority practice for this basin. Cropland susceptible to annual flood inundation and adjacent to waterways adversely impacted by excessive nutrients and sediment should be priority areas for this project.

**Lead Partner(s):** NRCS, VAAFM, farmers, NRCDs, and UVM Extension
**Potential Funding Sources:** EQIP, CREP, Partners for Fish and Wildlife Prgoram and CWA Section 319 grants
**Timeline:** 2009-2013

## Actions to Address Logging Practices and Water Quality

Conservation easements, long term management plans, and timber sale contracts are some tools that can be used to encourage the sustainable management of woodlands.

**Goal:**
**Increase sustainable management of watershed woodlands with a special emphasis on water resource protection.**

**30. Action- Increase the amount of privately owned forestland under active stewardship management.** Encourage landowners to develop long term management plans for woodlands with the assistance and under the direction of a forester. The management plan should include measures for the protection of forest water quality and erosion control.

**Lead Partner(s):** County foresters, private consulting foresters, non-profit forestry organizations (Vermont Coverts-Woodlands for Wildlife, Vermont Woodlands Association, and Northern Woodlands), VLT, and woodland owners (especially new and out-of-state owners).
**Potential Funding Sources:** NA
**Timeline:** 2009-2013

**31. Action-Provide educational materials to forest landowners that promote responsible management of forest resources.**

**Lead Partner(s):** County foresters
**Potential Funding Source:** DFPR staff time
**Timeline:** 2009-2013

**32. Action- Hold workshops to encourage forestland owners to develop written contracts for logging operations and follow low-impact harvesting practices.** Timber sale contracts should incorporate provisions that address protection of water quality and erosion control as outlined in AMP's. Focus efforts by encouraging winter logging on sensitive sites prone to erosion (steep slopes and wet soils), properly selecting stream crossing locations and proper design and location of trucks roads and skid trails.

**Lead Partner(s):** County foresters, UVM Extension Service, private consulting foresters, LEAP, and woodland owners.
**Potential Funding Sources:** NA
**Timeline:** 2009-2013

**33. Action- Promote the use of Portable Skidder Bridges at stream crossings during timber harvesting operations.** Promote the Lamoille Portable Skidder Bridge Rental Program to loggers and private forestry consultants.

**Lead Partner(s):** County foresters, private forestry consultants, loggers, NRCDs, RCD, and forest landowners
**Potential Funding Sources:** Clean and Clear ecosystem grant and DFPR staff time
**Timeline:** 2009-2013/Initiated

## Actions to Address Construction Site Erosion

Although construction activities are usually temporary, erosion from construction sites can cause significant amounts of sediment to enter adjacent waterbodies.

**Goal:**
**Increase construction contractor, developer, municipality and landowner awareness regarding construction site best management practices.**

**34. Action- Continue to hold erosion control workshops for area contractors/developers**

**Lead Partner(s):** DEC and AGC
**Potential Funding Sources:** NA
**Timeline:** 2009-2013/Initated

**35. Action- Create an outreach program for landowners, contractors, and municipalities that are about to embark on construction projects covering erosion and sediment control site plans, necessary permits, Low Impact Development (LID) practices, and technical assistance that may be available for such projects.**

**Lead Partner(s):** DEC, AGC, developers, contractors, and landowners and municipal officials
**Potential Funding Sources:** NA
**Timeline:** 2009-2013

**36. Action- Assist municipalities with comprehensive town plans and zoning regulations that address erosion prevention and sediment control from construction sites under 1 acre in size**.

**Lead Partner(s):** DEC, watershed RPCs, VLCT, and municipal officials
**Potential Funding Sources:** 604(b) grants, DFPR Urban and Community Forestry Program, DEC and VLCT staff time
**Timeline:** 2009-2013

## Actions to Improve Water Quality from Stormwater

Increased flows associated with development following land clearing and creation of impervious surfaces can be responsible for increased bank erosion and stream instability. Runoff from impervious surfaces can convey various pollutants to adjacent waterways impairing aquatic habitat and organisms and posing risks to health

**Goal:**
**Assist municipalities in implementing stormwater management practice implementation and outreach efforts.**

**37. Action- Implement Morristown's comprehensive plan to improve water quality within Wilkins Ravine.** Full implementation of the Wilkins Ravine restoration project will address several sources of stormwater runoff and sedimentation within Morrisville.

**Lead Partner(s):** Town of Morristown**,** DEC, VTrans, NRCS, the Lamoille County Solid Waste District, and Morristown north end business district and citizens
**Potential Funding Sources:** VTrans Enhancement grant, CWA Section 319 grants, Vermont Watershed Grants, Lake Champlain Basin Program grant, and local funds
**Timeline:** 2009/Initiated

**38. Action- Assist municipalities in adopting Low Impact Development language in town plans and LID bylaws especially for development of sites less than 1 acre in size.**

**Lead Partner(s):** Municipalities, RPCs, VLCT, UVM Seas Grant program, and DEC
**Potential Funding Sources:** 604(b) grants, and DFPR Urban and Community Forestry Program
**Timeline:** 2009-2013/Initiated

**39. Action-Assess municipal snow disposal sites in the watershed for water quality protection.** Map watershed municipal snow disposal sites and work with municipalities to locate alternate sites if current sites are in close proximity to waterways or flood plains.

**Lead Partner(s):** Municipalities, watershed RPCs, and DEC
**Potential Funding Sources:** local funding, 604(B)
**Timeline:** 2009

**40. Action- Assist municipalities in the development and/or implementation of stormwater management plans required by the MS4 stormwater management rules**.

**Lead Partner(s):** DEC, Towns of Milton, Colchester, Jericho, and Essex
**Potential Funding Sources:** EPA stormwater grants
**Timeline:** 2009-2013/Initiated

**41. Action- Assist municipalities in the development of stormwater infrastructure maps, maintenance inventories and illicit discharges and detection (IDDE) surveys. Encourage municipalities to purchase new and/or more efficient street sweeping and catchbasin cleaning equipment.**

**Lead Partner(s):** DEC, VTrans, VYCC and municipalities
**Potential Funding Sources:** VTrans SAFETEA, VTrans Enhancement, Section 319 Grants
**Timeline:** 2009-2013/Initiated

## Actions to Address Transportation Infrastructure and Water Quality Issues

**Goal:**
**Minimize conflicts between natural stream functions and existing and proposed transportation infrastructure.**

**42. Action- Conduct bridge and culvert assessments at stream crossings throughout the watershed using ANR's methodology.** A comprehensive bridge and culvert database will enable natural resource planners and transportation infrastructure managers the ability to better maintain and protect these structures from catastrophic failure.

**Lead Partner(s):** DEC, VFWD, RPCs, municipal highway departments and landowners and municipalities
**Potential Funding Sources:** DEC River Corridor Grants, Vermont Watershed Grants, LCBP, CWA Section 319 grants and Better Backroads grants
**Timeline:** 2009-2013/Initiated

**43. Action- Replace or retrofit stream crossing structures that pose significant passage limitations to improve fish and/or wildlife passage, sediment transport and/or stream stability.** After bridge and culvert assessments are complete use *The Vermont Culvert Compatibility Screening Tool* (Milone and MacBroom, 2007) and *Guidelines for the Design of Stream/Road Crossings for Passage of Aquatic Organisms in Vermont* (VTFW and K.K. Kozmo, 2007) documents to prioritize sites and design appropriate treatments. Retrofitting crossings can include installing culvert headwalls, armored culvert outfalls, increasing culvert sizes, upgrading round culverts to arches and bridges, and reducing culvert outlet distances to water surfaces.

**Lead Partner(s):** DEC, VFWD, RPCs, and municipalities
**Potential Funding Sources:** Town Highway (TH) Structures (bridges and culverts), TH Interstate Culverts, TH Class 2 Roadway, Better Backroads grants, and TH Emergency (man-made or natural disasters) funding programs.
**Timeline:** 2009-2013/Initiated

**44. Action-Identify and remediate beaver-road conflicts.** As part of the bridge and culvert surveys, identify stream crossings and roads threatened by beaver activities. Selectively install beaver baffles or culvert fences as needed to remediate conflicts.

**Lead Partner(s):** DEC, VFWD, municipal road managers, VTrans, NRCDs, and RPCs
**Potential Funding Sources**: Better Backroads, WHIP, and Transportation Enhancement grants
**Timeline**: 2009-2013

**45. Action- Hold regular Better Backroads Workshops in the watershed.** Focus training on water quality issues such as bridge and culvert design and installation and road ditching.

**Lead Partner(s):** Local Roads Program, DEC, regional planning commissions, municipalities (select boards and highway superintendents) and VTrans
**Potential Funding Sources:** Local Roads Program
**Timeline:** 2009-2013/Initiated

**46. Action- Increase town participation in inventories and assessment of transportation infrastructure using a Capital Improvement Budget process.** A Capital Improvement Budget will inventory and prioritize transportation related projects for municipal officials, ultimately reducing maintenance, improving water quality and aquatic habitat, and saving funds for towns. (Also See Chapter 5 for more specific recommendatins).

**Lead Partner(s):** DEC, VTrans, Local Roads Program, Northern Vermont RC&D, RPCs , and municipalities (select boards and highway superintendents)
**Potential Funding Sources:** Better Backroads grants, municipal budgets
**Timeline:** 2009-2013/Initiated

**47. Action- Assist towns in the development of minimum standards for the design, construction, and maintenance of driveways and driveway structures within town plans and ordinances.** Driveway ordinances can reduce erosion, sedimentation, and catastrophic failure of privately owned transportation infrastructure ultimately impacting municipally owned property.

**Lead Partner(s):** RPCs, VTrans, RCD, Local Roads Program, DEC, municipal officials (select boards, planning commissions, highway departments), VLCT Municipal Assistance Center, and RPCs
**Potential Funding Sources:** FEMA grants
**Timeline:** 2009-2013

**48. Action- Identify and address specific water quality issues and conflicts associated with the Lamoille Rail Corridor and the Lamoille River during the transition from rail to recreational use.** Provide technical assistance and secure funding for projects that will improve stream stability, remove flood plain encroachments, reestablish flood plain connection, increase woody riparian buffers, and provide for waterway crossings that effectively transport both stream flow and sediment.

**Lead Partner(s):** DEC, VTrans, RPCs, recreation corridor users, and VAST
**Potential Funding Sources:** VAST and VTrans corridor funds, River Corridor Grants, EPA Watershed Grants, and CWA Section 319 grants
**Timeline:** 2009-2013/Initiated

## Outreach and Education Actions

**Goal:**
**Increase water resource awareness among watershed residents through outreach and active participation in assessment, restoration, and protection efforts.**

**49. Action- Build the capacity of the new Lamoille Watershed Association**. Recruit watershed volunteers for the new Lamoille Watershed Association to undertake collaborative watershed assessment, restoration and outreach projects.

**Lead Partner(s):** DEC, Lamoille Watershed Association (LWA), Lamoille River Anglers Association, and watershed NRCDs and RPCS.
**Potential Funding Sources:**
**Timeline:** 2009-2013/Initiated

**50. Action- Establish Stream Teams at the sub-watershed level.** Each Stream Team will be composed of local citizens, school groups and businesses acting collaboratively. Stream Teams will conduct assessments, develop restoration plans, implement protection and restoration measures, and provide outreach and education to watershed residents.

**Lead Partner(s):** municipalities, LRAA**,** LWA, area schools and businesses, RPCs, and residents
**Potential Funding Sources:** NA
**Timeline:** 2009-2013

**51. Action- Compile and exhibit chemical, physical, and biological data collected by watershed organizations and residents.** Develop a watershed water quality database and website of volunteer compiled assessment data.

**Lead Partner(s):** DEC, watershed schools, LWA, VFWD, and watershed NRCDs and RPCs
**Potential Funding Sources:** LaRosa Lab Monitoring, Vermont Watershed Grants, and LCBP grants
**Timeline:** 2009/Initiated

**52. Action- Provide educational information regarding the stream dynamics, watershed ecology and fluvial geomorphology to various watershed organizations, schools, landowners, and state and municipal government officials throughout the watershed to provide residents with information necessary to better understand and manage basin streams.** Develop stream dynamic curriculum for watershed schools.

**Lead Partner(s):** DEC, LWA, and consultants
**Potential Funding Sources:** staff time
**Timeline:** 2009/Initiated

**53. Action- Install appropriately designed signage at select high profile locations along the Lamoille River and major tributaries indicating waterbody names at road crossings.** Signage will improve public awareness and could promote local stewardship of waterways.

**Lead Partner(s):** DEC, VTrans, Municipal Highway Departments, and VFWD
**Potential Funding Sources:** Vermont Watershed grant
**Timeline:** 2009-2013

# CHAPTER 5. LISTED WATERS REMEDIATION AND WATER QUALITY ASSESSMENT NEEDS

*Water is the most critical resource issue of our lifetime and our children's lifetime. The health of our waters is the principal measure of how we live on the land.*

***-Luna Leopold***

## Introduction

The Agency of Natural Resources is responsible for maintaining water quality in each waterbody in accordance with the Vermont Water Quality Standards. Water quality is determined using biological, physical, and chemical criteria. The Agency, through the Department of Environmental Conservation, monitors surface waters for conformance with these criteria, assesses use attainment, and documents violations. Plans for remediation of water quality problems are developed and carried out by the Agency and, where appropriate, AAFM.

In the Lamoille River watershed, the Agency has identified impaired waters (Table 12), waters in need of further assessment (Appendix A.10) and waters with altered flow (Table 8). An impaired water has a measured violation of at least one criterion of the Vermont Water Quality Standards. To be called "impaired," the violation of the Vermont Water Quality Standards must be substantiated by data collected through chemical, physical and/or biological monitoring and included in the EPA- Approved List of Impaired Surface Waters. In addition, DEC or members of the public have identified threats to a number of other river or stream reaches; however, available data on these waters are insufficient to conclusively demonstrate a violation of Water Quality Standards. The Agency has and will continue to gather more data on these waters.

## Part A. Impaired Waters in Need of a TMDL

Under federal regulations and guidelines, waters impaired by a pollutant must be identified by the State and reported under Section 303(d) of the Clean Water Act. In the following section, the Agency and other State agencies propose strategies for restoring waters in the basin based largely on voluntary efforts. These efforts should be sufficient to correct the impairment, achieve Water Quality Standards, and make it possible to remove the water from the 303(d) list. If these actions fail to restore the impaired waters, the Agency will require additional actions for determining sources of pollution loads and their reduction by the date noted in the strategies listed below. One method of estimating the necessary pollutant loading reduction is by calculating a Total Maximum Daily Load (TMDL). The TMDL program is described in Appendix B.

The Vermont Center for Geographic Information (VCGI) is undertaking an ANR-funded project to delineate a number of impaired sub-watersheds throughout Vermont, primarily those that are affected by agricultural activities. The delineation of the contributing area to the sub-watershed will be characterized using digital layers for soils, slopes, roads, topography, land use-land cover datasets, and the Vermont Hydrography Dataset. This data will assist DEC in the assessment of non point pollution sources and restoration efforts by defining the spatial extent of lands that influence the impaired waters. The impaired segments of Deer Brook, Mill Brook, and Browns River sub-watersheds will be incorporated into this study.

**Lake Champlain Phosphorus TMDL**

Section 303(d) of the Federal Clean Water Act requires each state to identify impaired waters that do not meet water quality standards, and to establish total maximum daily loads (TMDLs) for such waters for the pollutant of concern (Vermont DEC and New York DEC, 2002). The TMDL establishes that allowable pollutant loading from all contributing sources at a level necessary to attain the applicable water quality standards. A TMDL has recently been developed for phosphorus in Lake Champlain. Phosphorus enters Lake Champlain from multiple point and non-point sources in Vermont, New York, and Quebec. Lake Champlain is divided into 13 segments for phosphorus management purposes. The Lamoille Basin is included in the outer Mallets Bay segment that has phosphorus levels in the low-mesotrophic range, 0.009 milligrams per liter (mg/l).

The Long-Term Water Quality and Biological Monitoring Project for Lake Champlain surveys the quality of Lake Champlain waters on a bi-weekly basis at 14 locations throughout the lake. Eighteen major tributaries are sampled on an event-basis as well, including the Lamoille River. The program's large physical and chemical parameter list includes: species of phosphorus, nitrogen and organic carbon; chlorophyll-a; base cations and alkalinity; TSS; dissolved oxygen; conductivity; and pH. The program also includes biological sampling, which is primarily aimed at assessing phytoplankton, zooplankton, and macroinvertebrate communities.

Point source pollution reduction described in the Lake Champlain Phosphorus TMDL is targeted at wastewater treatment facility upgrades to decrease phosphorus loads (Appendix B). The non point source phosphorus load reductions focus on three land uses including developed land, forestry/logging, and agriculture sources. The developed land category includes all permitted stormwater discharges and other non point source loads from residential and other developed areas, gravel roads, small construction sites, and erosion of streambanks and stream channels caused directly or indirectly by land development in the watershed. The forest category includes naturally occurring background loadings, as well as non-point source runoff from forest harvesting and associated road building.

**Table 11. Non point Source Phosphorus (P) Loads and Proposed Reductions for the Mallets Bay Segment (DEC, 2002).**

| Land Use | 1991 Total Non point P Load in metric tons per year (mt/yr) | Percent P Contribution | P Load Reduction Responsibilities in mt/yr |
|---|---|---|---|
| Forestland | 2.4 | 8.1% | 0.00 |
| Agricultural Land | 13.1 | 43.7% | 2.14 |
| Developed Land | 14.4 | 48.2% | 2.35 |

This plan for the Lamoille basin is laid out to follow the format of the Lake Champlain Phosphorus TMDL as closely as possible. Chapter 4 includes the identification and remediation of water quality concerns from forest, agricultural, and developed lands as well as surface waters. Chapter 5 includes strategies to improve water quality from impaired waterways throughout the watershed. This watershed plan will be used as an implementation guide for reducing phosphorus sources to Lake Champlain from the Lamoille watershed.

Lamoille Basin Phosphorus Trends

The Vermont ANR tracks phosphorus loading to Lake Champlain from major tributary rivers using data obtained from the Lake Champlain Basin Program's Long-Term Monitoring Program and from U.S. Geological Survey stream flow gages. Phosphorus loads to Lake Champlain from the Lamoille River during 1991-2006 (in metric tons per year) are shown in Figure 6. For comparison, the average river flow rates for each time interval (in millions of cubic meters per year) are also shown. Average phosphorus loads and flows were calculated for two-year time intervals (after 1991).

Phosphorus loads from the Lamoille River have exceeded the target level of 28.6 mt/yr established for the Malletts Bay watershed in the Lake Champlain Phosphorus TMDL during each two-year time interval since 1991. Wastewater discharges are a relatively small proportion of the total loads. Non point source loads are driven by rainfall and snowmelt events, and higher phosphorus loads are seen during the wetter time periods, such as 1997-1998. A statistical analysis that removed the effect of flow variations found no significant trend either upward or downward in flow-adjusted phosphorus concentrations over this time period in the Lamoille River (provisional analysis by the U.S. Geological Survey). **Figure 6-**

In summary, phosphorus loads from the Lamoille River are well above the acceptable target levels, in part because of wetter years recently. Substantial reductions in phosphorus loading are necessary throughout the watershed, particularly for non point sources.

**54. Action – Meet regularly with relevant partners to determine whether implementation of the Lamoille watershed plan is achieving needs specified by the Lake Champlain Phosphorus TMDL**

**Lead Partner(s):** ANR, Lake Champlain Basin Program and other relevant partners
**Potential Funding Sources:** staff time
**Timeline:** annually

Lamoille River Phosphorus Loading to Lake Champlain

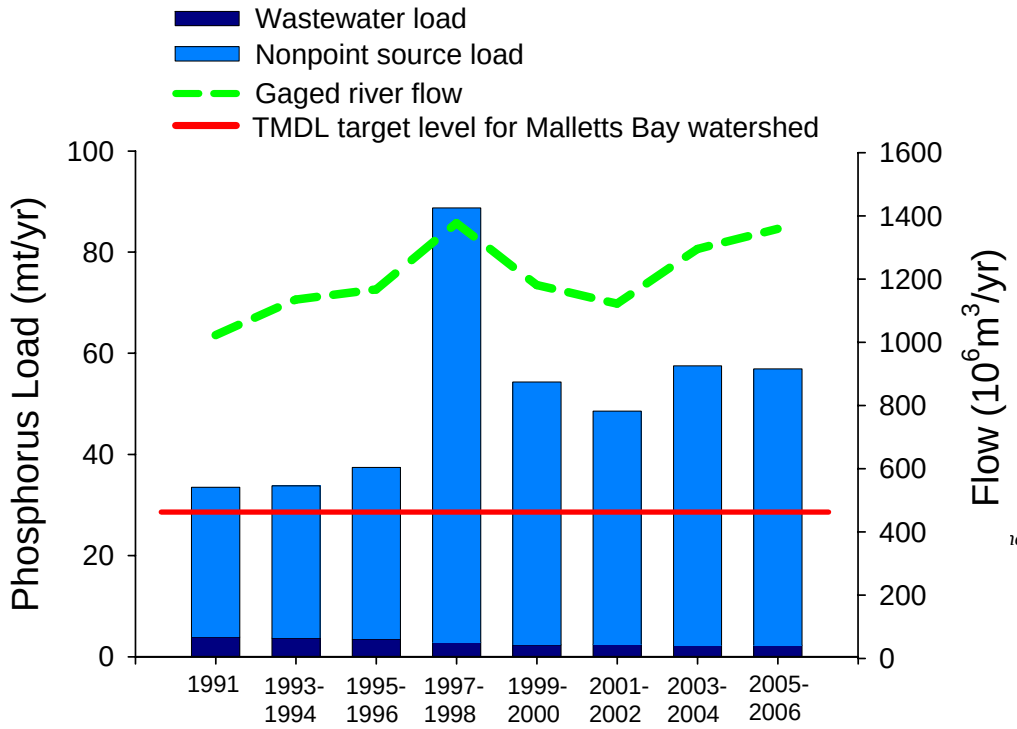


**Table 12. Year 2008 List of Impaired Waters in Need of a TMDL in the Lamoille River Watershed.**

| Segment | Pollutant | Problem |
|---|---|---|
| Deer Brook, mouth to 2.5 miles upstream | Sediment | Industrial Park stormwater discharge; sand pit; and corroding road culverts |
| Mill Brook in Fairfax, mouth to 5.0 miles upstream | Sediment, nutrients | Algae growth |
| Stevensville Brook (upstream from river mile 2.1 to headwaters) | Acid | Acid deposition; extremely sensitive to acidification |
| Trib to Brewster River (1 mile) | Metals (Iron) | Iron seeps on streambank |
| Hutchins Brook Tributary #4, mouth to river mile 0.3 | Sediment | Asbestos mine tailings erosion, asbestos fibers |
| Hutchins Brook, river mile 2.0 to 3.0 | Sediment | Asbestos mine tailings erosion, asbestos fibers |

**Deer Brook, Georgia**

Deer Brook is a tributary to Arrowhead Mountain Lake in Georgia. Numerous site visits and meetings were held in a collaborative effort to identify and remediate non point source pollutants to Deer Brook, which is an impaired stream. Georgia and Milton town officials, VTrans, local business owners, and DEC technical staff from Wetlands, Stormwater, Planning, and Hydrology have been involved in this process. Two pollutant discharges to Deer Brook, iron and sediment, were documented. The source of the iron discharge appears to be corrosion from two upstream 600-foot long culverts. The bottoms of the culverts are corroded and being undermined as surface water is entering below the pipe. VTrans has completed temporary repairs to one of the interstate culverts contributing to the discharge of iron to the stream. Sediment discharges were documented from an adjacent industrial park. Stormwater BMP practices and erosion control measures have already been implemented to divert stormwater runoff from an intermittent stream to a detention pond and stabilize an eroding gully.

A Phase 1 geomorphic assessment has recently been completed by the Northwest Regional Planning Commission. The assessment results will be used to direct future stream corridor restoration and protection measures by the Town of Georgia along Deer Brook.

**55. Action– Complete remediation efforts in the Deer Brook watershed including replacement or repair of the interstate culvert, gully stabilization, and stormwater best management practice implementation throughout the watershed.** Reassess the water quality and remove from the List of Impaired Waters when appropriate.

**Lead Partner(s):** DEC, adjacent landowners, VTrans, and Town of Georgia
**Potential Funding Sources:** VTrans Enhancement and CWA Section 319 grants
**Timeline:** 2009-2013/Initiated

**56. Action- Inventory landslide hazard areas within Deer Brook watershed.**

**Lead Partner(s)**: DEC, NWRPC, and Town of Georgia
**Potential Funding Sources**: CWA Section 319 grants and DEC staff time
**Timeline:** 2009-2013/Initiated

**57. Action- Assist the Town of Georgia with changes to the town plan and zoning ordinances in recognizing the inherent risks to developing within erosion hazard areas.**

**Lead Partner(s):** DEC, VLCT, NWRPC, and Town of Georgia
**Potential Funding Sources:** CWA Section 319 grants and DEC staff time
**Timeline:** 2009-2013

**Mill Brook, Fairfax**

Mill Brook is located in Fairfax and is impaired by sediment and nutrient pollutants. Sediment and nutrients from agricultural activities within the watershed appears to be the cause of the water quality impairment. Possible sources of erosion from gravel pit extraction operations have also been documented.

A collaborative work group was formed for the Mill Brook watershed. Partners includes the DEC, the U.S. Fish and Wildlife Service, the St. Albans NRCS field office, the Franklin County Natural Resource Conservation District, the Composting Association of Vermont, and the Vermont Agency of Agriculture, Food and Markets. The Franklin County Natural Resources Conservation District distributed letters to farmers summarizing the watershed water quality issues and identified voluntary cost share programs that are available. A round table meeting of landowners within the Mill Brook watershed occurred in spring of 2003. Some potential water quality problems have been identified and farmers have signed up for BMP implementation practices through federal and state cost share programs. One dairy farmer in the watershed sold a milking herd resulting in a one hundred animal unit reduction in the watershed.

The Composting Association of Vermont (CAV) and its partners were awarded a Clean Water Act Section 319 grant to initiate a pilot composting project. Initially, project partners will develop and implement a series of local meetings to educate farmers in the Lamoille River basin on the benefits of composting their manure and managing their nutrients. Participating farms will receive technical composting assistance throughout the project period. Several Mill Brook watershed farmers will be assisted in the initiation and enhancement of on-farm composting. Some landowners have already been identified as potential participants for composting projects.

The results of this project will be primarily evaluated by calculating phosphorus removed or reduced from the watershed by land application of compost by the demonstration project farmers in the Mill Brook watershed. Participants will report on the tons of manure composted per year and the amount of compost sold versus land applied. These data will be used to determine tons of phosphorus removed from the watershed. Runoff reduction evaluations will also be calculated from data that shows compost decreases in nutrient solubility.

Another goal will be to increase market demand for composted dairy manure. As part of their in-kind cost share of the project, CAV will assist participants in regional market development for their compost products to ensure project success.

**58. Action –Implement agricultural and Stormwater BMPs that reduce nutrient and sediment non point sources in the Mill Brook watershed.** Implement practices such as woody riparian buffers, filter strips, livestock exclusion from waterways, nutrient management, composting, LID practices, and cover crops with watershed farmers. Reassess the water quality and remove from the List of Impaired Waters when appropriate.

**Lead Partner(s):** DEC**,** NRCDs, CAV, NRCS, VAAFM, UVM Extension, landowners, and VLCT.
**Potential Funding Sources:** EQIP, Partners in Wildlife, and CWA Section 319 grants
**Timeline:** 2009-2013/Initiated

**59. Action- Develop capital budgets for the Town of Fairfax for stream crossings and road improvement projects.** Remediation measures may include bridge and culvert upgrades, road crowning, and stone and grass lined road ditches.

**Lead Partner(s):** DEC, Northern Vermont RC&D, consultants, and watershed towns
**Potential Funding Sources:** Better Backroads and DEC River Corridor grant
**Timeline:** 2009-2013

**Unnamed tributary to the Brewster River, Cambridge**

Smugglers Notch Resort installed underground monitoring wells to determine possible sources of pollutants to an impaired tributary to the Brewster River in Cambridge. The assessment has determined that the source of the iron discharge is from the adjacent road. Iron precipitation occurrences are typically associated with areas where low pH, iron-rich glacial till soils have been disturbed and placed as fill materials at/or beneath the water table. It had been initially determined that a failing septic system was responsible for the discharge. A meeting between DEC's watershed coordinator, Smugglers Notch Resort, and VTrans was held to develop a remediation proposal. The Cambridge Conservation Commission was awarded Section 319 grant funds to remediate the iron discharges with a lime injection treatment. The lime injection treatment was completed in 2005. Smugglers Notch Resort has also initiated plans to restore the natural stream channel of this channelized and impounded waterway. A parking lot adjacent to the stream will be relocated and grass filter and riparian buffer installed in its place. Conceptual plans also include stormwater best management practice retrofits, removal of the pond dam, replacement of culverts with a bridge or arch culvert, and restoration of the natural stream channel.

**60. Action- Monitor the success of the recent treatment of iron bacteria discharge to the unnamed tributary to the Brewster River.** Assist the Cambridge Conservation Commission and Smugglers Notch Resort in any additional needed remediation of the iron seep discharge. Reassess the water quality and remove from the List of Impaired Waters when appropriate.

**Lead Partner(s):** DEC, Smugglers Notch Resort, and Cambridge Conservation Commission
**Potential Funding Sources:** CWA Section 319 grants
**Timeline:** 2009-2013/Initiated

**61. Action- Complete additional restoration efforts of the unnamed tributary to the Brewster River.** Assist Smuggler Notch Resort in additional remediation efforts such as the implementation of stormwater best management practices, buffer plantings, and stream channel stabilization.

**Lead Partner(s):** DEC, Smugglers Notch Resort, and Cambridge Conservation Commission
**Potential Funding Sources:** CWA Section 319 grants, Partners for Fish and Wildlife Program, WHIP
**Timeline:** 2009-2013

**Stevensville Brook, Underhill**

The Stevensville Brook is a tributary to the Browns River located in Underhill Center. The watershed is mostly forested with low density residential homes and some gravel roads. Stevensville Brook is impaired due to high acidity. A TMDL will be developed for this waterway but critical loads have not yet been determined. Causes of impairment are similar to the low pH lakes and the methodology to develop the TMDL will be similar to that of the Lake of the Clouds TMDL.

**62. Action- Develop a TMDL that determines critical loads for Stevensville Brook.**

**Lead Partner(s):** DEC and EPA
**Potential Funding Sources:** DEC and EPA staff time
**Timeline:** 2009

**Hutchins Brook and Tributary and Downgradient Wetlands, Eden**

The Vermont Asbestos Group (VAG) mine is an inactive asbestos mine comprising 650 acres at the headwaters of Hutchins Brook as well as the Burgess Branch of the Missisquoi River in Lowell. This summary will only focus on the impacts to Hutchins Brook watershed. Hutchins Brook is a tributary to the Dark Branch in the Gihon River watershed located in the town of Eden. The mine operated from the early 1900s to 1993 producing chrysotile asbestos leaving behind over 72 million tons of tailings. The VAG property contains asbestos dusts and fibers on the ground, in the surface waters, and in the old mill and processing buildings.

The mine tailings piles are eroding and significantly impacting Hutchins Brook and Burgess Branch as well as downgradient wetlands. The "old mine's" 12 million ton tailing piles are impacting Hutchins Brook watershed. The wetlands complex associated with Hutchins Brook is approximately 25 acres in size, located approximately one mile downgradient of the waste pile. The wetland area appears to be reaching its storage capacity and threatening to adversely affect adjacent water bodies.

The degree and extent of the contamination has not yet been defined. So far, the DEC's Water Quality Division and Waste Management Divisions, Vermont Geological Survey, and the USGS have worked collaboratively to collect water, sediment, and tailings and to conduct fish and benthic studies. In 2007, these entities performed a major monitoring effort. This included 13 monitoring sites within the Gihon River watershed. All monitoring points were either on the mine site or within 4 miles downstream of the site. The results from the 2007 monitoring effort are still pending. However, previous monitoring efforts, primarily by the Water Quality Division, indicate an impairment of benthic community and fish populations in Hutchins Brook and down gradient wetlands.

Additional monitoring is expected to take place in 2008 to better define the degree and extent of contamination in downstream waters. The scope of the 2008 monitoring will depend on the 2007 results, which should be finalized in the next few months. Furthermore, additional data collection, such as meteorological and air-borne dust sampling, is being planned in 2008 to better evaluate the potential threat to human health.

Given the magnitude of this site and limited resources at this time, the overall scope and duration of characterization and mitigation efforts is unknown at this time. It is likely that these efforts will span over multiple years. Right now, State agencies are at the beginning stages of characterization and mitigation efforts at this site. EPA is starting the process to determine whether this site eligible for listing on the National Priorities List (i.e., Superfund). It will be at least two years before this determination can be made.

Immediate mitigation efforts to date have focused on implementing erosion prevention and sediment control measures that provide the greatest reduction in sediment load to downstream waters with the funding resources (private and public) available. In the spring 2007, VAG installed diversions in spring of 2007 to mitigate erosion along one of the tailings piles in the Hutchins Brook watershed to minimize the amount of tailing material heading downstream toward the wetlands. In October of 2007 EPA's Emergency Rapid Response Services contractor mobilized to the site and began work installing interim measures to stabilize the site and prevent further migration of mine waste.

*EPA Removals* are planning to return to the site in the spring/summer of 2008 to continue erosion prevention and sediment control measures. The

2008 activities will focus on measures in the old mine area within the Gihon Watershed. EPA Removals anticipate to be completed in July 2008. At this time, there are no specific mitigation efforts planned after EPA removals are completed.

**63. Action- Fully implement the DEC and EPA supervised remediation plan for the VAG site to stabilize erosion of the asbestos tailing pile runoff to the Hutchins Brook watershed and associated wetlands.** Determine the feasibility of restoration to the impacted waterways. Inform local residents and local government of the remediation plan and potential human health or wildlife impacts from the site.

**Lead Partner(s):** DEC, EPA, VAG property owners, and local government officials
**Potential Funding Sources:** DEC, EPA, and VAG
**Timeline:** 2009-2013/Initiated

## List of Waters outside the Scope of the Clean Water Act Section 303(d)

## Part B. Impaired Waters not requiring a TMDL

### Lamoille River- Clarks Falls Dam to Route 2

The Clarks Falls Dam to Route 2 reach of the Lamoille River is located within the town of Milton and is impaired due to low dissolved oxygen. No TMDL is necessary for this segment as DEC has the authority and legal means to address the dissolved oxygen problem found below Clark Falls hydroelectric facility. The authority and legal means that are available to DEC are sufficient to attain Water Quality Standards in the near future.

The new federal license for the Lamoille Hydroelectric Project was issued in June 2005. Articles 407 and 408 address post-licensing water quality monitoring and dissolved oxygen enhancement, respectively. The new license provides for conservation flows that may improve the dissolved oxygen regime sufficiently to obviate the need for specific mechanical enhancements, such as turbine aspiration.

Future operation of the four stations as described above will comply with and meet federal and state clean water act requirements. Implementation of these measures will resolve water quality issues identified by the ANR in the List of Priority Waters.

**64. Action – Implement the approved FERC license conditions to address water quality impairments for CVPS operated dams and affected waters.**

**Lead Partner(s):** ANR and CVPS
**Potential Funding Sources:** CVPS
**Timeline:** 2009-2013/Initiated

## Part C. Waters in Need of Further Assessment. See Appendix for a table of these waters

## Part D. Surface Waters with a Completed and Approved TMDL-

### Lake of the Clouds

This water was included in the Acid Lake TMDL submitted and subsequently approved by EPA in September 2003. Monitoring is on-going to track this impairment. (Note this water body was previously listed on the Part A. List of Impaired Waters in Need of a TMDL in 2002).

Lake of the Clouds is a small, high elevation pond located in Cambridge. Aquatic life use is impaired on this waterway from acidification due to the water's low buffering capacity and/or atmospheric deposition. It has long been understood that the deposition of strong mineral acids and acid forming compounds, sulfur and nitrogen compounds, from the atmosphere have been the primary source of the acidification of hundreds of lakes throughout the Northeast United States as well as other regions across the country. A Total Maximum Daily Load (TMDL)

document determines annual loading limits for 30 of the acid impaired lakes identified on the Vermont 2002 List of Impaired Surface Waters (303d List) including Lake of the Clouds in Cambridge. Vermont anticipates that the ultimate source identifications and control will be spearheaded at the regional and national level.

**Lamoille River- mouth to Clarks Falls Dam, Arrowhead Mountain Lake and All Surface Waters- Mercury**

Vermont currently has a fish consumption advisory in effect for all state waters due to the presence of elevated mercury levels in fish tissues. Arrowhead Mountain Lake and the mouth to Clark Falls section of the main stem are impaired due to elevated levels of mercury in walleye. The combustion of coal for energy and the incineration of municipal and medical wastes produces the majority of mercury deposited onto the watersheds of the northeastern US and eastern Canada. The Agency of Natural Resources will continue pressuring US EPA to reduce emissions from out-of-state sources. The Agency's Environmental Assistance Division in the Department of Environmental Conservation will also continue its work to reduce in-state sources of mercury in the environment. Implementation of CVPS settlement agreement will reduce water level fluctuations on these waters and can reduce mercury levels influenced by drawdowns.

**65. Action- Re-sample the mercury-impaired waters within the basin to update data.**
**Lead Partner(s):** DEC and VFWD
**Potential Funding Sources:** staff time
**Timeline:** 2009

## Part E. Waters Altered by Exotic Species-

- **Arrowhead Mountain Lake, Milton-** Eurasian Watermilfoil is locally abundant

- **Lake Elmore, Elmore**- Eurasian Watermilfoil is locally abundant

For Additional information See Chapter 3 Lakes and Ponds Section for background and Chapter 4 for Actions.

## Part F. Waters Altered by Flow Regulation- see Table 8 in Chapter 3 Dams and Flow Regulated Waters Section for additional information and Chapter 4 for Actions.

## Part G. Surface Waters Altered by Channel Alteration

**Browns River (lower-mid) miles 3.5-18.5 (15 miles), Essex and Westford.** Severe streambank erosion from agricultural encroachments and the effects of historic in-stream gravel extraction. (Note this water body was previously listed on the Part A. List of Impaired Waters in Need of a TMDL in 2002).

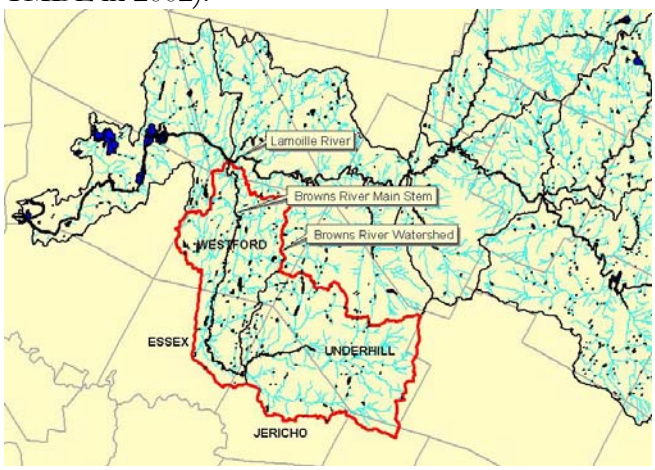



**Figure 7.- Browns River Watershed**

The Browns River is listed as altered approximately through the towns of Westford and Essex (figure 6). Sedimentation and channel alterations, which are the result of former channel gravel mining, loss of riparian vegetation, streambank erosion due to agricultural encroachments, and flood events that exacerbated already unstable conditions, are listed as the problems in DEC's Lamoille Watershed Assessment (2001). The altered reach runs through predominately agricultural land that is currently in corn, hay and pastureland. The river

is a meandering riffle-pool sand bottom system with a wide valley and broad flood plain. These stream systems are extremely susceptible to instability when natural vegetation is removed. Aerial photos indicate that woody riparian buffers are sparse in much of the defined reach. Streambank erosion dominates on the outside bends even where buffers exist. There has been significant lateral movement of the channel that may be an indicator of system-wide, rather than local, instability.

A collaborative partnership has been developed between DEC, Chittenden County RPC, and relevant agricultural partners to formulate strategies to improve water quality in the impaired waters of the Browns River. Other project partners include U.S. Fish & Wildlife Service, Vermont Department of Fish and Wildlife, the Williston and Berlin USDA NRCS field offices, Winooski Natural Resource Conservation District, and Vermont Agency of Agriculture, Food and Markets. The Winooski Natural Resources Conservation District distributed letters to farmers discussing the impairments and voluntary cost share programs that are available.

A watershed assessment using the Agency of Natural Resources Phase 1 protocols is complete. The assessment identifies existing stream conditions at the watershed scale using GIS tools and ground truth methods. Sixty-eight reaches of the main stem were delineated and evaluated on the Browns River main stem and larger tributaries. Twenty-two of the evaluated reaches, or 32%, were highly impacted by the lack of woody riparian buffers (75% of the reach had a 0-25 buffer). The assessment also identified channelization and gravel extraction as significant contributors to streambank erosion.

Bridge and culvert assessments have been completed to identify structures contributing to stream instability and hindering fish passage. Results from this assessment indicate that over 50% of the stream crossings on the Browns River and major tributaries are significantly undersized and could fail during a flash flood event. Stream crossing failures can be significant sources of sediment to waterways. Many structures were found to impede fish passage. These failing structures will be targeted for removal or repair.

A Phase 2 geomorphic assessment has recently been completed. This assessment indicates that reaches in between Underhill Center and the Cilley Hill Dam in Jericho are undergoing channel adjustment processes such as aggradation, degradation, widening, and planform adjustment. The channel adjustments are in response to disturbances such as gravel extraction, channelization, riparian vegetation removal, and dam influences. A River Corridor grant has been secured to develop a comprehensive river corridor plan for the entire Browns River; initiate the purchase of easements along key riparian areas; prepare a fluvial erosion hazard plan for the Town of Underhill; and develop capital budgets for stream crossings in watershed towns.

There are nine farms in the Browns River watershed including six dairies and three non-milking facilities. In 2002 and 2003, CREP was implemented on cropland along approximately 3 miles of the Browns River bank. A grass filter strip and bank armoring practices have been implemented by NRCS.

**66. Action–Develop a river corridor protection plan for the Browns River.** A river corridor management plan will provide the basis for an alternative analysis of appropriate restoration and protection measures.

**Lead Partner(s):** DEC, Winooski NRCD, NRCS, VAAFM, CCRPC, landowners, and watershed towns.
**Potential Funding Sources:**
**Timeline:** 2009-2013/Initiated

**67. Action- Implement river corridor restoration and protection projects in the Browns River watershed.** Remediation measures may include floodplain encroachment removals, establishment of woody riparian buffers, livestock exclusion from waterways,

riparian corridor easement purchases, crop rotations and cover crops, and the use of active and passive geomorphic-based stream restoration measures.

**Lead Partner(s):** DEC, Winooski NRCD, watershed towns, VAAFM, landowners, and NRCS.
**Potential Funding Sources:** EQIP, DEC River Corridor grant, CWA Section 319 grants, Partners for Fish and Wildlife Program
**Timeline:** 2009-2013/Initiated

**68. Action- Develop and implement capital budgets for Browns River watershed town for stream crossings and road improvement projects.** Remediation measures may include bridge and culvert upgrades, road crowning, and stone and grass lined road ditches.

**Lead Partner(s):** DEC, Northern Vermont RC&D, consultants, and watershed towns
**Potential Funding Sources:** Better Backroads, and DEC River Corridor grant
**Timeline:** 2009-2013/Initiated

**69. Action- Develop a Fluvial Erosion Hazard Plan and Map for the Town of Underhill.** Underhill Center is located at the confluence of several large tributaries and the Browns River and has been adversely impacted by flood erosion damage. A fluvial erosion hazard plan and map will assist the community in identifying areas adjacent to waterways that may not be suitable for development and reduce future flood erosion damage.

**Lead Partner(s):** DEC, Winooski NRCD, CCRPC, and Town of Underhill
**Potential Funding Sources:** DEC River Corridor grant
**Timeline:** 2009-2013/Initiated

# CHAPTER 6. MANAGEMENT GOALS FOR SURFACE WATERS

## Background

The protection or improvement of water quality and water-related uses can also occur by establishing specific management goals for particular bodies or stretches of water. The management goals describe the values and uses of the surface water that are to be protected or achieved through appropriate management. Management goals can be established through the following processes:

- Classification of waters and designation of water management types,
- Designation of existing uses of a water (Chapter 2),
- Classification of wetlands.
- Classification of waste management zone,
- Designation of waters as warm and cold water fisheries,
- Lamoille Basin Biological Reference Sites, and
- Designation of waters as Outstanding Resource Waters,

The Agency of Natural Resources is responsible for designating existing uses on a case by case basis or through basin planning and the Vermont Water Resources Panel is responsible for adopting the other designations by rule. Once the Agency or the Panel establishes a management goal, the Agency manages State lands and issues permits to achieve all the management goals and designated uses established for the associated surface water.

Before the Agency recommends, or the Panel establishes, management goals through a classification or designation of surface waters by rule, input from the public on any proposal is required and considered. The public is also able to present a proposal for establishing management goals for the Board to consider at any time.

When the public develops proposals regarding management goals, the increased community awareness can lead to protection of uses and values by the community and individuals.

## Typing and Classification

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

Presently, in all basins, waters above 2,500 feet in elevation are classified A (1) by Vermont statute. The management objective for A(1) waters is to maintain their natural condition. Waters used as public water supplies are classified A(2). All the remaining waters are Class B waters. As part of the Water Quality Standards revisions in 2000, the system was changed to allow Class B waters be divided into three management types: B1, B2 and B3. This change was made to furnish a greater level of protection to existing higher quality waters and to recognize attainable uses that could be supported by improvements to existing water quality. The revised Water Quality Standards require that all basin plans place Class B waters into one of the three water management types.

Once the Vermont Water Resources Panel adopts the water management type designations for specific waters, it is the responsibility of the Agency of Natural

Resources, individuals and all levels of government to work to achieve or maintain the level of water quality specified by the designations.

In was with great effort that the Lamoille Watershed Coordinator working closely with ANR staff and the Lamoille Watershed Council developed a Proposal for All Water Management Types in the watershed including all B waters. Watershed municipalities were given the opportunity to provide input to Water Management Type proposals for within their towns.

Biological monitoring data for fish and macroinvertebrate communities from reference sites listed in the following table were included in a statewide database used to determine measures of biological integrity describing the range of attainable biological conditions for three categories of wadeable stream (DEC, 2001). There is no implication that conditions upstream or downstream of these sites demonstrate comparable conditions. Additionally, many other stream reaches within the Lamoille River watershed are likely to be in or close to reference condition.

**Description of Proposed Water Management Types**

**Identification of Bodies of Water**

**1. Class A Waters**
**A. Description of proposed water management type one waters. Includes all tributaries to named waters and associated wetlands within described reaches.**

- All waters located above 2,500 feet in elevation by statute (see Appendix A.9). No additional waters are proposed for A1.

**B. Description of proposed water management type two (A2) waters.**

- **In the towns of Georgia and Fairfax**- Silver Lake

- **In the town of Cambridge**- unnamed tributary to Brewster River (Smugglers Notch Resort drinking water supply)

**70. Action- DEC recommends that the Town of Johnson file a Petition with the Vermont Water Resources to re-classify French Hill Brook from the upstream end of the impoundment to the confluence of Waterman Brook from an A2 Water to a B water.** The Town of Johnson does not currently use this water as a public drinking water supply or have any plans to do so since transitioning to a ground water supply in 2006.

**Lead Partner(s):** DEC and the Town of Johnson
**Potential Funding Sources:** NA
**Timeline:** 2009

*see narrative above and corresponding plan appendices

## Waste Management Zones

In addition to their present classification of B, the river reaches that receive treated affluent from wastewater treatment facilities in Hardwick, Morrisville, Jeffersonville, Fairfax, and Milton have one-mile long Waste Management Zones downstream of each facility's outfall. This zone is designated to accept the discharge of properly treated wastes that prior to treatment may contain organisms pathogenic to human beings. Throughout the zone, numeric water quality criteria for Class B waters must be achieved, but increased health risks exist.

## Fish Habitat Designations

**Warm Water Fish Habitat**
All wetlands and the following waters are designated as warm water fish habitat for purposes of the Vermont Water Quality Standards:

- Arrowhead Mountain Lake, Milton/Georgia
- Flagg Pond, Wheelock
- Green River Reservoir
- Halfman Pond, Fletcher
- Hardwick Lake, Hardwick
- Horse Pond, Greensboro
- Lake Elmore, Elmore
- Lamoille River from the Peterson Dam in Milton to its confluence with Lake Champlain - June 1, through September 30, only.
- Long Pond (Belvidere Pond), Eden
- Long Pond, Greensboro
- Tuttle Pond, Hardwick
- Wapanaki Lake, Wolcott

**Cold Water Fish Habitat**
All waters not designated as warm water fish habitat above are designated as cold water fish habitat for the Lamoille River basin in the Vermont Water Quality Standards, 2008.

## Outstanding Resource Waters

Outstanding Resource Water (ORW) designation identifies waters that have exceptional natural, recreational, cultural, or scenic values. Depending on the values for which designation is sought, ORW designation may protect exceptional waters through the permits for stream alteration, dams, wastewater discharges, aquatic nuisance controls, solid waste disposal, Act 250 projects and other activities. Presently, there are no ORWs designated in the Lamoille watershed. ORW is one of many tools that can be used to protect exceptional waters. Other tools include municipal zoning ordinances, easements, fee simple purchases, and Class 1 wetland designation among others.

A citizen group can propose Outstanding Resource Waters designations under 10 V.S.A. §1424a or assist the Agency in designating existing uses. DEC will work closely with local entities in pursuing ORW designation. Possible waters to consider for ORW designation could include waters that: demonstrate significant fisheries spawning and habitat areas; gorges, rapids and waterfall areas; scenic areas; rare and irreplaceable natural areas; historic resources and archeological sites; aquifer protection; habitat for threatened and endangered plants; areas having recreational, educational, and research values.

Biological reference sites (Table 13) are examples of reference aquatic biota compiled by DEC's BASS Lab. Biological reference sites are an indicator sites of high quality water quality and can be used by ANR and its partners in prioritizing high quality waters for protection or to compare with other waters.

**Table 13. Watershed Biological Reference Sites**

| Location | Station | Drainage Area | Elevation | Macroinvertebrate Category[1] | Fish IBI[2] | Town | WBID |
|---|---|---|---|---|---|---|---|
| Lamoille River | 15.7 | 1754.8 | 300 | WWMG | MW | Georgia | VT07-02 |
| Lamoille River | 80.8 | 55 | 1164 | MHG | MW | Greensboro | VT07-22 |
| Lamoille River | 83.5 | 20 | 1339 | MHG | MW | Greensboro | VT07-21 |
| Browns River | 0.5 | 225 | 351 | WWMG | MW | Fairfax | VT07-10 |
| Browns River | 26.8 | 47 | 761 | MHG | MW | Underhill | VT07-11 |
| Browns River | 31.0 | 6.1 | 1400 | SMC | CW | Underhill | VT07-11 |
| Lee River | .4 | 39.8 | 499 | MHG | MW | Jericho | VT07-11 |
| North Branch Lamoille River | 12.3 | 50 | 1050 | MHG | MW | Belvidere | VT07-14 |
| Elmore Br.-Lamoille | 1.7 | 39.4 | 783 | MHG | MW | Elmore | VT07-08 |
| Bailey Brook | .5 | 5.9 | 1078 | SHG | CW | Hardwick | VT07-21 |

1. Macroinvertebrate Stream Category refers to one of three wadeable streams types as defined by the characteristics of a minimally disturbed aquatic macroinvertebrate community (DEC, 2001d). The three categories are:

SHG - Small High Gradient streams;
MHG - Medium size High Gradient streams;
WWMG - Warm Water Moderate Gradient streams and rivers;

2. Fish IBI refers to the fish community index appropriate for the stream reach, based on the expected number of species.

# CHAPTER 7. SUMMARY AND IMPLEMENTATION OF THE BASIN PLAN

## Summary

The Lamoille River Basin Water Quality Management Plan identifies the top water quality issues in the basin and gives guidance through actions that can be taken to address these issues over the next five years. It is a pragmatic collaborative effort that has already resulted in building working relationships with various partners in on-the-ground watershed restoration and outreach projects. The success and value of the plan will be determined by its successful implementation.

## Implementation of the Watershed Plan

Water quality improvement at the basin level can be achieved through protection and restoration of waterways, modification of the adjacent land uses, and by providing outreach and education to those who live, work, and play in the watershed. Following through on as many of the action ideas listed in Chapters 4 and 5 of this plan as possible is the approach that DEC will take in implementation of this plan.

Many of the plan's implementation strategies are already being undertaken. DEC's Watershed Coordinator will lead or co-lead many actions to improve the water quality and the aquatic habitat of the watershed. Best management practices for agriculture, transportation infrastructure, logging, stormwater management and construction erosion will be undertaken to address discharges to the basin's waters. The Coordinator, working closely with watershed partners, will identify specific projects and relevant partners, secure funding sources, assist in project designs and permitting requirements, and oversee project implementation. The Coordinator and watershed partners will determine the success of practice implementation and evaluate whether additional practices may be necessary.

The Coordinator will work closely with municipalities and regional planning commissions to improve town plans and zoning ordinances to protect high quality waters and minimize future human conflicts with those of natural ecosystems and to provide necessary outreach to landowners. The Coordinator will work collaboratively with local land trusts, the USDA NRCS and FSA, watershed NRCDs, and Agency of Agriculture to proactively identify riparian and wetland areas for the purpose of obtaining easements to protect and restore these areas.

The Coordinator will partner with the Lamoille Watershed Association, watershed lake and pond associations, area schools and colleges, RPCs, NRCDs, and state and federal agencies to identify water monitoring and assessment needs for the basin's lakes, ponds, wetlands, and stream systems. These partners will also formulate more efficient ways to share this information with one another and watershed residents.

## Evaluating the Plan's Progress

DEC's Watershed Coordinator will meet with relevant watershed partners on an annual basis to specifically review the list of action items in the plan to determine if they are being implemented as scheduled and if not, to determine what is needed to make additional progress. The Coordinator will also meet with relevant DEC staff and members of the Lake Champlain Basin Program to determine the plan's success as it relates to the Lake Champlain Phosphorus TMDL and Opportunities for Action. The Coordinator will meet individually with specific watershed project partners to evaluate the success and determine needs for individual projects.

Other quantifiable measures of success can include:

- linear feet or acreage of riparian areas protected through easements,
- acreage or linear feet of riparian buffer planted,
- number of stream crossings upgraded,
- number of towns developing capital budgets for road systems,
- number of road best management projects implemented,
- number of agricultural best management practices installed,
- number of urban stormwater management practices applied,
- number of mass failures identified and remediated,
- number of wetland acres restored,
- number of flood plain acres restored,
- number of lake and pond VIP programs initiated,
- number of town plan and zoning improvements protecting waterways, and
- number of lake watershed surveys and BMPs implemented

## REFERENCES


Cantrell, P., 2002. *The New Entrepreneurial Agriculture.* Michigan Land Institute, Beulah, MI.

Central Vermont Public Service, 2003. Personal Communication with Mike Scarzello. CVPS, Rutland, VT.

The Champlain Initiative. 1999. *The Case Study for a Healthy Community: The History of Sprawl in Chittenden County.*

Chittenden County Regional Planning Commission and the University of Vermont, 2001. *Our Changing Landscape: Forest Fragmentation in Chittenden County.* Burlington, VT.

Hardwick Electric, 2003. Personal Communication with Joe Bongiovani and Eric Werner. Hardwick Electric, Hardwick, VT.

Hegman, W., D. Wang and C. Borer, 1999. *Estimation of Lake Champlain Basinwide Nonpoint Source Phosphorus Export.* Lake Champlain Basin Program, Technical Report No. 31. USEPA, Boston, MA.

Lake Champlain Management Conference. 1996. *Opportunities for Action, An Evolving Plan for the Future of the Lake Champlain Basin.*

Lamoille County Planning Commission, 1999. *Wild Branch Streambank Erosion Inventory.* LCPC, Morrisville, VT.

Lamoille County Natural Resources Conservation District, 2007. *Trees for Streams Final Report.* LCNRCD Morrisville, VT.

Lane, E.W., 1955. *The Importance of Fluvial Morphology in Hydraulic Engineering.* American Society of Civil Engineering, Proceedings, 81, paper 745: 1-17.

Milone and MacBroom, 2007. *The Vermont Culvert Geomorphic Compatibility Screening Tool.* South Burlington, VT

Rosgen, D. 1996. *Applied River Morphology.* Wildland Hydrology, Pagosa Springs, Colorado.

Ryan, J. 2000, *Stream Stability Assessment for Lamoille County*, Vermont. Prepared for Lamoille County Planning Commission and FEMA, Morrisville VT.

Sharpley, A. and D. Beegle. 2001. *Managing phosphorus for agriculture and the Environment.* Pennsylvania State University College of Agricultural Sciences. University Park, PA.

Smugglers Notch Resort, 2003. Personal Communication with Mark Delaney. Smugglers Notch Resort, Jeffersonville, VT.

The Transcript, *Cleaning Stormwater in Morristown*, April 4, 2005. Morristown, VT.

Vermont Agency of Agriculture, Foods, and Markets, 2002. *Executive Summary of Recommendations to the Vermont Agricultural Viability Council*. Vermont Agency of Agriculture, Food and Markets, Montpelier, VT.

Vermont Agency of Agriculture, Foods, and Markets, 2003. *Agriculture and Waterways*. Vermont Agency of Agriculture, Food and Markets, Montpelier, VT.

Vermont Agency of Agriculture, Foods, and Markets, 2005a. *Accepted Agricultural Practice Regulation-Draft*. Vermont Agency of Agriculture, Foods, and Markets, Montpelier, VT.

Vermont Agency of Agriculture, Foods, and Markets, 2005b *Medium and Small Farm Operation Rules for the Issuance of General and Individual Permits-Draft*. Montpelier, VT.

Vermont Agency of Agriculture, Foods, and Markets, 2003-2008, personal communication Pam Stefanek And John Hanning

Vermont Agency of Natural Resources, 2007. *Vermont Stream Geomorphic Assessment Phase 1 Watershed Assessment, Phase 2 Rapid Assessment, Phase 3 Survey Assessment, and Handbook Appendices*. Waterbury, VT.

Vermont Department of Environmental Conservation, January 1989. *Vermont's Whitewater Rivers: their Geology, Biology, and Recreational Use*. Jerry Jenkins and Peter Zika for the Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Environmental Conservation, 1990. *Planning for Lake Water Quality Protection, a Manual for Vermont Communities*. Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Environmental Conservation, 1991. *Hydropower in Vermont, An Assessment of Environmental Problems and Opportunities*. Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Environmental Conservation, 1992. *Vermont Swimming Hole Study*. Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Environmental Conservation, 1994. *A Threat to Vermont's Lakes: Eurasion Watermilfoil an Invasive Non-native Aquatic Plant*. Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Environmental Conservation, 1994. *Lake Protection Classification System*. Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Environmental Conservation, 1999. *Options for State Flood Control Policies and a Flood Control Program*, Prepared for the Vermont General Assembly Pursuant to Act 137 Section 2, Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Environmental Conservation, 2001a *Lamoille River Watershed Assessment Report.* Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Environmental Conservation, 2001b *Fluvial Morphology: a Foundation for Watershed Protection, Management, and Restoration.* Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Environmental Conservation, 2001c. *Wetlands in the Lamoille River Watershed.* Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Environmental Conservation, 2001d *Wadeable Stream Biocriteria Development for Fish and Macroinvertebrate Assemblages in Vermont Rivers and Streams*. Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Environmental Conservation, 2002a 2002 Vermont Lay Monitoring Report. Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Environmental Conservation, 2002b *Alternatives for River Corridor Restoration*. Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Environmental Conservation and New York State Department of Environmental Conservation, 2002. *Lake Champlain Phosphorus TMDL*. Waterbury, VT and Albany, NY.

Vermont Department of Environmental Conservation, 2003. *Vermont Fluvial Erosion Hazard Program*. Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Environmental Conservation, 2004. Letter to the Hardwick Select Board from the Water Quality Division, May 28, 2004.Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Environmental Conservation, 2006. *State of Vermont Year 2006 List of Waters*. Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Fish and Wildlife and K.K. Bates, 2007. *Guidelines for the Design of Stream/Road Crossings for Passage of Aquatic Organisms in Vermont*. Waterbury, VT

Vermont Department of Forests, Parks, and Recreation, 1987. *Acceptable Management Practices for Maintaining Water Quality on Logging Jobs in Vermont.* Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Department of Forests, Parks and Recreation and Chittenden County Regional Planning Commission, 2001. From *Backyards to Backcountry, the Value of Healthy Forests in Our Region.* Chittenden County Regional Planning Commission, South Burlington Vermont and the Vermont Agency of Natural Resources, Waterbury, VT.

Vermont Fish and Wildlife Department, 1998. *Inventory of Riverbank Lands Owned Along the Lamoille River by the Vermont Agency of Natural Resources*, *Report to the Vermont General Assembly*. Vermont Agency of Natural Resources, Waterbury, Vermont.

Vermont Fish and Wildlife Department, 2000. *Saving Our Open Landscape, Effects of Development and Sprawl on Vermont's Fish and Wildlife*. Vermont Agency of Natural Resources, Waterbury, Vermont.

Vermont Watershed Initiative Framework Committee, 2002. *Vermont Watershed Initiative, Guidelines for Watershed Planning*, 2002.

Vermont Local Roads Program, 5/1997. *Developing a Highway Access Policy*. Colchester, VT.

Vermont Local Roads Program, 5/1997. *Cost Effect Solutions to Protect Water Quality Near Vermont Town Roads*. Colchester, VT.

Vermont Local Roads Program, 5/1999. *Road Design and Maintenance Handbook*. Colchester, VT.

Vermont Water Resources Panel, 2008. *Vermont Water Quality Standards*. Montpelier, VT.

Vermont Water Resources Board, 2002. *Vermont Wetland Rules*. Montpelier, VT.

## GLOSSARY

**10 V.S.A., Chapter 47** - Title 10 of the Vermont Statutes Annotated, Chapter 47, Water Pollution Control, which is Vermont's basic water pollution control legislation.

**Accepted Agricultural Practices (AAP)** - land management practices adopted by the Secretary of Agriculture, Food and Markets in accordance with applicable State law.

**Acceptable Management Practices (AMP)** - methods of silvicultural activity generally approved by regulatory authorities and practitioners as acceptable and common to that type of operation. AMPs may not be the best methods, but are acceptable.

**Aquatic biota** - all organisms that, as part of their natural life cycle, live in or on waters.

**Basin** - one of seventeen planning units in Vermont. Some basins include only one major watershed after which it is named such as the Lamoille River Basin. Other Basins include two or major watersheds such as the Poultney/ Mettawee Basin.

**Best Management Practices (BMP)** - a practice or combination of practices that may be necessary, in addition to any applicable Accepted Agricultural or Silvicultural Practices, to prevent or reduce pollution from nonpoint source pollution to a level consistent with State regulations and statutes. Regulatory authorities and practitioners generally establish these methods as the best manner of operation. BMPs may not be established for all industries or in agency regulations, but are often listed by professional associations and regulatory agencies as the best manner of operation for a particular industry practice.

**Classification** - a method of designating the waters of the State into categories with more or less stringent standards above a minimum standard as described in the Vermont Water Quality Standards.

**Designated use** - any value or use, whether presently occurring or not, that is specified in the management objectives for each class of water as set forth in §§ 3-02 (A), 3-03(A), and 3-04(A) of the Vermont Water Quality Standards.

**Existing use** - a use that has actually occurred on or after November 28, 1975, in or on waters, whether or not the use is included in the standard for classification of the waters, and whether or not the use is presently occurring

**Fluvial geomorphology** - a science that seeks to explain the physical interrelationships of flowing water and sediment in varying land forms

**Impaired water** - a water that has documentation and data to show a violation of one or more criteria in the Vermont Water Quality Standards for the water's class or management type.

**Improved Barnyards** - a series of practices to manage and protect the area around the barn, which is frequently and intensively used by people, animals, or vehicles, by controlling runoff to prevent

erosion and maintain or improve water quality. Practices may include: heavy use area protection, access roads, animal trails and walkways, roof runoff management, and others.

**Mesotrophic –** An intermediate level of nutrient availability and biological productivity in an aquatic ecosystem.

**Natural condition** - the condition representing chemical, physical, and biological characteristics that occur naturally with only minimal effects from human influences.

**Nonpoint source pollution** - waste that reaches waters in a diffuse manner from any source other than a point source including, but not limited to, overland runoff from construction sites, or as a result of agricultural or silvicultural activities.

**pH** - a measure of the hydrogen ion concentration in water on an inverse logarithmic scale ranging from 0 to 14. A pH under 7 indicates more hydrogen ions and therefore more acidic solutions. A pH greater than 7 indicates a more alkaline solution. A pH of 7.0 is considered neutral, neither acidic nor alkaline.

**Point source** - any discernable, confined and discrete conveyance including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which either a pollutant or waste is or may be discharged.

**Reference condition** - the range of chemical, physical, and biological characteristics of waters minimally affected by human influences. In the context of an evaluation of biological indices, or where necessary to perform other evaluations of water quality, the reference condition establishes attainable chemical, physical, and biological conditions for specific water body types against which the condition of waters of similar water body type is evaluated.

**Riparian vegetation** - the native or natural vegetation growing adjacent to lakes, rivers, or streams.

**Sedimentation** - the sinking of soil, sand, silt, algae, and other particles and their deposition frequently on the bottom of rivers, streams, lakes, ponds, or wetlands.

**Thermal modification** - the change in water temperature

**Turbidity** - the capacity of materials suspended in water to scatter light usually measured in Jackson Turbidity Units (JTU). Highly turbid waters appear dark and "muddy."

**Waste Management System** -a planned system in which all necessary components are installed for managing liquid and solid waste, including runoff from concentrated waste areas and silage leachate, in a manner that does not degrade air, soil, or water resources. The purpose of the system is to manage waste in rural areas in a manner that prevents or minimizes degradation of air, soil, and water resources and protects public health and safety. Such systems are planned to preclude discharge of pollutants to surface or ground water and to recycle waste through soil and plants to the fullest extent practicable.

**Water Quality Standards** - the minimum or maximum limits specified for certain water quality parameters at specific locations for the purpose of managing waters to support their designated uses. In Vermont, Water Quality Standards include both Water Classification Orders and the Regulations Governing Water Classification and Control of Quality.

**Waters** - all rivers, streams, creeks, brooks, reservoirs, ponds, lakes, springs and all bodies of surface waters, artificial or natural, which are contained within, flow through or border upon the State or any portion of it.

**Watershed** - all the land within which water drains to a common waterbody (river, stream, lake pond or wetland).

## LIST OF ACRONYMS

| | |
|---|---|
| AAP | Accepted Agricultural Practice |
| ACOE | United States Army Corp of Engineers |
| AGC | Association of General Contractors |
| Agency | Vermont Agency of Natural Resources |
| AMP | Acceptable Management Practice |
| ANCF | Aquatic Nuisance Control Fund |
| ANR | Vermont Agency of Natural Resources |
| BASS | Biomonitoring and Aquatic Studies Section, Vermont Water Quality Division |
| BMP | Best Management Practice |
| CAV | Composting Association of Vermont |
| CVPS | Central Vermont Public Service |
| CWA | Federal Clean Water Act |
| DEC or Department | Vermont Department of Environmental Conservation |
| DFPR | Vermont Department of Forest, Parks and Recreation |
| EPA | United States Environmental Protection Agency |
| FERC | Federal Energy Regulatory Commission |
| GIS | Geographic Information System |
| LCBP | Lake Champlain Basin Program |
| LRAA | Lamoille River Anglers Association |
| LWA | Lamoille Watershed Association |
| NNHP | Vermont Nongame and Natural Heritage Program |
| NOAA | National Oceanic and Atmospheric Administration |
| NOFA | Northeast Organic Farming Association of Vermont |
| NPDES | National Pollution Discharge Elimination System |
| NPS | Non-point source pollution |
| NRCD | Natural Resource Conservation District |
| NRCS | Natural Resources Conservation Service |
| ORW | Outstanding Resource Water |
| PDM | Pre Disaster Mitigation |
| RC&D | Resource Conservation and Development Council |
| RPC | Regional Planning Commission |
| TMDL | Total Maximum Daily Load |
| TU | Trout Unlimited |
| USDA | United States Department of Agriculture |
| USFWS | United States Fish and Wildlife Service |
| UVM | University of Vermont |
| VAAFM | Vermont Agency of Agriculture, Food and Markets |
| VDHP | Vermont Department of Historic Preservation |
| VDOH | Vermont Department of Health |
| VFWD | Vermont Fish and Wildlife Department |
| VLCT | Vermont League of Cities and Towns |
| VNRC | Vermont Natural Resources Council |
| VTrans | Vermont Agency of Transportation |
| VYCC | Vermont Youth Conservation Corp |
| WWTF | Wastewater Treatment Facility |