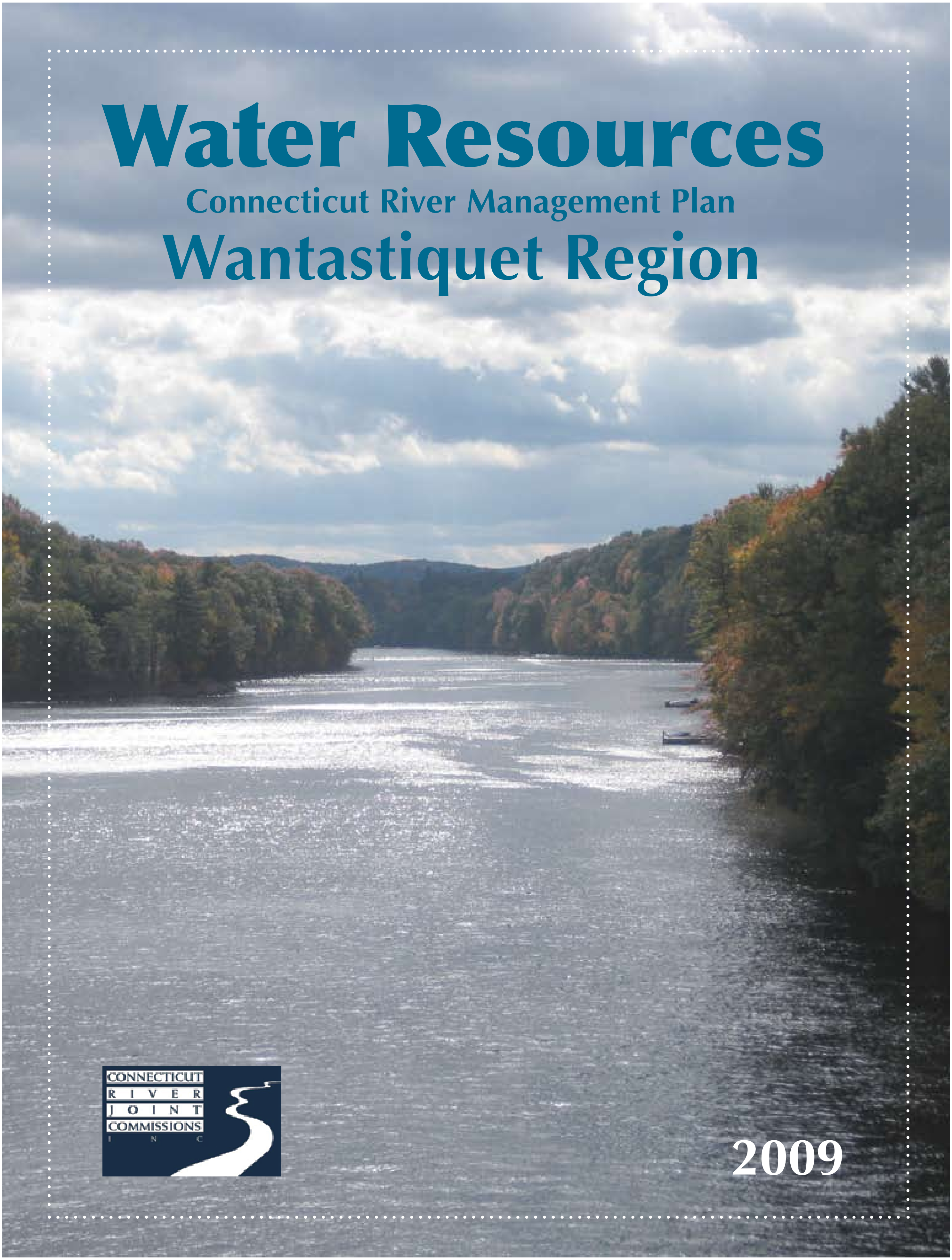
Water Resources

Connecticut River Management Plan

Wantastiquet Region



CONNECTICUT RIVER JOINT COMMISSIONS INC

2009

Water Resources

Wantastiquet Region River Subcommittee of the Connecticut River Joint Commissions

Adopted December 12, 2007. Updated August 2009

Produced with support from the New Hampshire Department of Environmental Services, the National Oceanic and Atmospheric Administration, US Gen New England, and the Davis Foundation. Printed with support from the American Recovery and Reinvestment Act through the New Hampshire Department of Environmental Services.

Drafted by the Wantastiquet Region River Subcommittee with the assistance of Adair D. Mulligan

This report is also available at www.crjc.org/waterresources.htm

Connecticut River Joint Commissions

PO Box 1182
Charlestown, New Hampshire 03603
603-826-4800 ~ www.crjc.org

Cover image: Kayaking near the mouth of Sackett's Brook on the Connecticut River at Putney, Vt. and Westmoreland, N.H.

Table of Contents

Key Recommendations

- **Expand water quality monitoring efforts in the region.** State water quality agencies should sponsor increased water quality monitoring activities in the region and make use of data collected by Vermont Yankee. Train and equip a team of roving volunteer monitors to track down sources of pollutants for which monitoring data suggest problems, such as elevated levels of phosphorus or copper.

- **Expand education for landowners and real estate agents about best management practices for waterfront land and applicable shoreland regulations.** Town conservation commissions should provide information to every new riverfront landowner to explain the special challenges of owning and managing riverfront land, including the benefits of riparian buffers and the requirements of state shoreland protection laws. The Connecticut River Joint Commissions (CRJC) could assist by preparing a publication for this purpose. State agencies should provide similar information to real estate agents.

- **Encourage wide understanding of the value of riparian buffers.** State water quality agencies should take an active role in encouraging waterfront homeowners to plant and maintain buffers of natural vegetation along the riverbank. Encourage the use of vegetative bank stabilization techniques, in combination with riprap only where necessary, to control erosion. County conservation districts should supply landowners with information about sources of assistance including nurseries offering buffer plant material.

- **Ensure that culverts are adequately sized and maintained so they will function well in times of high water.** Town road agents should ensure that culverts are regularly cleared of debris to prevent blocking during storms. Ensure that culverts are properly sized when replacing them during road work. New Hampshire should aggressively promote bridge and culvert surveys, by providing funds to the regional planning commissions to identify those that are undersized. Note if culverts or bridges block fish passage and seek grants for replacing them.

- **Ensure that wastewater discharges are as clean as possible.** The U.S. Environmental Protection Agency (EPA) should decide upon standards for phosphorus in wastewater treatment plant effluent so that Keene can plan effective phosphorus removal. EPA should update standards for disposing of unused and out-dated medicines, and assist area solid waste districts in educating consumers about disposal to reduce pharmaceuticals entering wastewater.

- **Improve stormwater management to reduce erosion and nonpoint source water pollution.** Towns should minimize addition of impervious cover because of its effects on storm water runoff and harm to aquatic systems. Look at ways to include low-impact development techniques to reduce runoff and promote stormwater infiltration for groundwater recharge. Towns should require additional treatment to remove oil for new discharges to surface waters and dry wells, and treatment to remove toxic metals for redevelopment projects.

- **Protect shorelands and floodplains.** Towns should evaluate their rules regarding shoreland protection and floodplain development, and consider if there are areas that need more protection. The New Hampshire Legislature should apply the Comprehensive Shoreland Protection Act to smaller streams. Vermont should adopt statewide shoreland protection.

- **Ensure a coordinated, inclusive, and efficient response to floods and other river-related disasters that is based in good river science.** The New Hampshire Department of Environmental Services (NH DES) and the Vermont Agency of Natural Resources (VT ANR) should each develop a coordinated approach to such disasters, and assign an agency staff person to ensure communication between the state environmental and transportation agencies, town officials, conservation commissions, and local river advisory committees or watershed groups. Town officials should meet regularly to discuss emergency planning and include local watershed groups for river-related issues.

- **Ensure that development does not contribute to erosion along the river.** Towns should require developers to follow best management practices for erosion and sedimentation control and ensure that riverside construction activities do not affect riverbanks and riparian buffers.

- **State and federal governments should pursue reduction in airborne pollutants that could affect the river.** Congress and the states should continue to reduce sources of mercury contamination and carbon dioxide emissions. States should consider regulations for outdoor furnaces. Citizens should obey the ban on barrel burning of trash. All should pursue increased energy efficiency to reduce airborne pollutants, including the carbon dioxide that contributes to climate change.

I. Preface

A. Citizen-based Plan for the Connecticut River

Members of the Wantastiquet Subcommittee tour the Connecticut River.

The Wantastiquet region's plan is a blueprint for stewardship of the Connecticut River...for communities, landowners, businesses, and agencies on both shores. Gathering together to create this plan for the Wantastiquet segment of the river were representatives from the towns of Walpole, Westmoreland, Chesterfield, and Hinsdale, in New Hampshire and Westminster, Putney, Dummerston, and Brattleboro in Vermont.

The strength of the Wantastiquet Region River Subcommittee's planning process lies in the diversity of its membership. These citizens, as directed by RSA 483, represent local business, local government, agriculture, recreation, conservation, and riverfront landowners. All of the recommendations of the Wantastiquet Region River Subcommittee's plan represent the consensus of this diverse group of citizens. Subcommittee members are listed in Appendix A.

B. Origin of the Connecticut River Management Plan

"A lot of the authenticity of the River Commissions comes from this participation at the grassroots level."

Cleve Kapala, CRJC President

The Connecticut River Joint Commissions mobilized hundreds of valley residents and local officials to join them in nominating the Connecticut River into the New Hampshire Rivers Management and Protection Program in 1991-2. The New Hampshire Legislature subsequently designated the river for state protection under RSA 483, which authorized CRJC to develop a river corridor management plan. CRJC sought support from the Vermont Legislature as well, so citizens from both states could engage in planning for their shared river. With backing from both legislatures, CRJC then contacted select boards or city councils from the 53 New Hampshire and Vermont riverfront communities and asked them to nominate representatives to serve on five bi-state local river subcommittees. This partnership between local town representatives and the state commissions for the Connecticut River enabled CRJC to publish the first edition of the *Connecticut River Corridor Management Plan* in 1997, after five years of work by the Commissions and the five bi-state local river subcommittees. Since this planning process began in 1993, nearly 200 citizens have thus participated in the subcommittees' work.

Following its publication, communities on both sides of the Connecticut River examined its findings and used them as a basis for enacting new or enhanced protection for the river. State and federal agencies also pursued its recommendations, embarking on studies of sediment and water quality and fish tissue toxins. The *Connecticut River Corridor Management Plan* was cited as a basis for designation of the Connecticut River as an American Heritage River by the White House in 1998. A summary of progress on the plan's recommendations appears in Appendix B.

C. A New Water Resources Plan

At the request of CRJC, a new assessment of water quality in the Connecticut River mainstem was conducted in 2004 by NH DES with the support of the EPA. Following announcement of the results in January, 2005, CRJC asked the local river subcommittees to begin work on updating, revising, and expanding the 1997 Water Quality chapter, exploring new topics such as flow, flooding, drought, groundwater, and other areas, in an attempt to portray and address the full range of water resources in the region. Because tributaries are responsible in large part for the river's condition, the subcommittees included an examination of tributary issues. Several members conducted windshield assessments of smaller tributaries within their towns, previously unstudied. The town of Vernon did not appoint a representative.

D. Plan Process

The Wantastiquet Subcommittee met from January, 2005 until November, 2007 to develop the new water resources chapter of the Connecticut River Management Plan for this section of the river. CRJC's conservation director transcribed the subcommittee's discussions to construct drafts of the plan, which the members revised and approved.

A first draft of the plan was circulated for public comment in May, 2007. After considering comments from the agencies, general public, and CRJC's Water Resources Committee, the Subcommittee adopted a final version in December, 2007.

E. Scope of the Plan

The Subcommittee has concentrated its planning upon the towns that border 40 miles of the Connecticut River in this segment. While the recommendations of this plan are directed toward this area, the Wantastiquet Subcommittee believes that their consideration beyond the riverfront towns could benefit the river, its tributaries, and the region as a whole. Recommendations are presented within each topic area, and are summarized in Appendix C, arranged by responsible party. Some are aimed beyond town boundaries, to guide state and federal agencies. The Subcommittee recognizes that proper care of the river is such a big job and important public duty that help from beyond the watershed is sometimes appropriate and needed from those agencies which share responsibility for the river.

F. Local Adoption of Recommendations

RSA 483 encourages communities on protected rivers such as the Connecticut to adopt a locally-conceived means of conserving the river and its shoreline. The legislature sought also that "the scenic beauty and recreational potential of [the Connecticut River] shall be restored and maintained, that riparian interests shall be respected" without preempting the land zoning authority already granted to the towns. The mechanism for adoption of this plan in both states is the conventional local planning process. Planning boards and commissions can review recommendations in the water resources chapter and integrate them into the local master plan, and select appropriate recommendations to bring to townspeople for adoption as specific additions to their zoning ordinances. The Subcommittee has also made many recommendations which are non-regulatory in nature, inviting landowners and others to put them into action.

G. The Connecticut River Joint Commissions

The New Hampshire Legislature created the Connecticut River Valley Resource Commission in 1987 to preserve and protect the resources of the valley, to guide growth and development, and to cooperate with Vermont for the benefit of the valley. The Vermont Legislature established the Connecticut River Watershed Advisory Commission in the following year. The two commissions banded together as the Connecticut River Joint Commissions in 1989, and are headquartered in Charlestown, N.H. The Commissions are advisory and have no regulatory powers, preferring instead to advocate and ensure public involvement in decisions that affect the river and its valley. CRJC's broad goal is to assure responsible economic development and economically sound environmental protection. The 30 volunteer river commissioners, fifteen appointed by each state, represent the interests of business, agriculture, forestry, conservation, hydro power, recreation, and regional planning agencies on both sides of the river.

H. Acknowledgments

The strength of this plan lies largely within its creation by a cross-section of local citizenry. From time to time, however, the local subcommittee called upon the expertise of state agencies, regional planning commissions, and local watershed group leaders to educate them about issues of particular concern. We would like to express our gratitude to those who lent their time to share information with the Wantastiquet Subcommittee:

- Marie Caduto, Water Quality Division, Vermont Agency of Natural Resources
- Steve Couture, Rivers Coordinator, New Hampshire Department of Environmental Services
- Ken Alton, TransCanada Hydro Northeast
- Deb Hinman and Mike Heidorn, Cold River Local Advisory Committee
- Doug Bechtel, The Nature Conservancy – New Hampshire Chapter
- Bill Roberts, Beverly Major, Bob Harcke, and George Watkins, Connecticut River Commissioners, participated enthusiastically in support of the Wantastiquet Subcommittee.

We are particularly grateful to the Towns of Westmoreland and Westminster for providing meeting space in their historic town halls.

Technical assistance - Mapping and other technical assistance was provided by the Upper Valley Lake Sunapee Regional Planning Commission through a grant from USGen New England.

Funding to support the work of the Wantastiquet Region River Subcommittee came from:

- NH Department of Environmental Services
- National Oceanic and Atmospheric Administration

- USGen New England
- Davis Foundation

A list of acronyms appears in Appendix J.

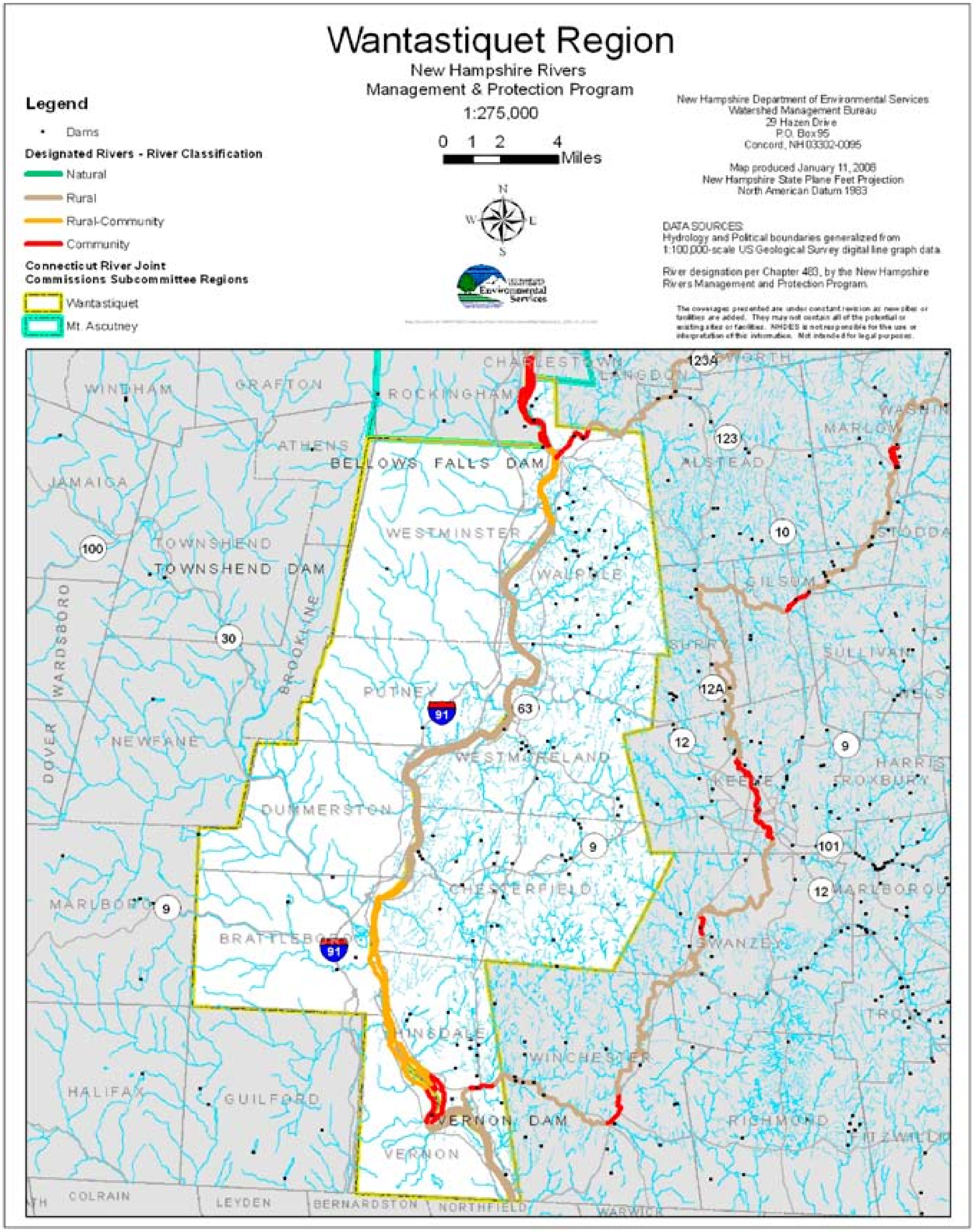
II. Introduction

Deep forests, wetlands filled with waterfowl, and the Connecticut River valley's richest, most productive agricultural lands remain on both sides of the river in a region that nonetheless has seen significant residential and other development. A long history of human occupation continues today as the quality of life offered by the river and its valley appeals to natives and newer residents alike. Towering over the river are Fall Mountain and Wantastiquet Mountain, the landmark chosen by the subcommittee for its name.

The Connecticut River at Westminster, Vt. and Walpole, N.H.

The Wantastiquet Region River Subcommittee's segment covers 40 miles of the Connecticut River as it runs from the northern boundaries of Walpole, N.H. and Westminster, Vt. south to the Massachusetts border in Hinsdale, N.H. and Vernon, Vt. Within the river corridor are the busy town of Brattleboro and nearby clusters of residential, commercial, and industrial development. In the upper 10 miles of this segment, water moves with a perceptible current and there is an opportunity for flushing of nutrients and sediment. A short set of rapids below Bellows Falls Dam and other such quickwater sections return oxygen to waters that have acquired pollutants from upstream sources. The Vernon Dam, just downstream from the Vermont Yankee Nuclear Power plant, creates a 26 mile long impoundment on the mainstem with 69 miles of shoreline. Major tributaries to the Wantastiquet region of the Connecticut are the Saxtons and West Rivers and Sackett's Brook in Vermont, and the Cold and Ashuelot Rivers and Partridge Brook in New Hampshire.

Habitat for fish and other aquatic life highly dependent upon excellent water quality is a notable feature of the Wantastiquet region, where several tributaries are home to the dwarf wedgemussel, a small mussel on the federal endangered species list. The presence of this and other species of greatest conservation need in this part of the watershed has stimulated a partnership between the US Army Corps of Engineers and The Nature Conservancy to improve water quality and other habitat values here.


Wantastiquet Region
New Hampshire Rivers
Management & Protection Program
1:275,000
0 1 2 4
Miles
N
S
W
E
Legend
Dams
Designated Rivers - River Classification
Natural
Rural
Rural-Community
Community
Connecticut River Joint
Commissions Subcommittee Regions
Wantastiquet
Mt. Ascutney
New Hampshire Department of Environmental Services
Watershed Management Bureau
29 Hazen Drive
P.O. Box 95
Concord, NH 03302-0095
Map produced January 11, 2008
New Hampshire State Plane Feet Projection
North American Datum 1983
DATA SOURCES:
Hydrology and Political boundaries generalized from
1:100,000-scale US Geological Survey digital line graph data.
River designation per Chapter 483, by the New Hampshire
Rivers Management and Protection Program.
CHARLESTOWN
LANGDON
ROCKINGHAM
WINDHAM
GRAFTON
ATHENS
BELLOWS FALLS DAM
JAMAICA
WESTMINSTER
WALPOLE
ALSTEAD
MARLOW
TOWNSHEND
TOWNSHEND DAM
GILSUM
SURRY
SULLIVAN
BROOKLINE
PUTNEY
WARDSBORO
DOVER
NEWFANE
WESTMORELAND
KEENE
ROXBURY
HARRIS
DUMMERSTON
CHESTERFIELD
MARLBORO
MARLBOROU
BRATTLEBORO
SWANZEY
HINSDALE
WINCHESTER
HALIFAX
GUILFORD
VERNON DAM
VERNON
RICHMOND
COLRAIN
LEYDEN
BERNARDSTON
NORTHFIELD
WARWICK
123A
123
10
100
30
12A
63
91
12
9
101

III. River Quality

A. Clean Water Has Clear Economic Value

Good water quality is an important economic as well as aesthetic and ecological resource for the Wantastiquet region. Today the river is once again safe for swimming, canoeing, kayaking, boating, wildlife habitat, and productive fisheries. Its water quality is also important aesthetically to residential use and tourism. The Connecticut River Byway, a heritage tourism and economic development initiative that has built strong momentum since 1998, is centered on the river's appeal as a recreation asset. River water is once again suitable and used for agricultural and industrial water supplies. A number of public and private wells are located near the river with the potential to draw upon associated groundwater.

While efforts are underway in New Hampshire to understand the economic value of clean water, little or no information is available in Vermont. To help state and local governments make better decisions regarding water quality protection, such information is needed.

The Connecticut River offers good, clean fun.

A 2007 study in New Hampshire found that about $379 million in total sales is generated by those who are fishing, boating or swimming in New Hampshire fresh waters, or about 26 percent of all summer spending in the state.[1] Fishing, boating and swimming have about the same economic impact as snowmobiling, downhill skiing, cross-country skiing, and ice fishing combined. Interviews with users of six public boat ramps in the Monadnock tourism region, including at the Prospect Street Boat Launch on the Connecticut River in Hinsdale, found that 68 percent of anglers, boaters and swimmers say they would decrease their intended visits to the Monadnock Region if water clarity and purity diminished. For the purpose of this study, "water clarity and purity" include milfoil or other invasives, mercury, and algae. Of those who would decrease their intended visits, 18 percent would leave the state and 13 percent would leave the region. Approximately 45 percent would go to some unspecified location in New Hampshire, and 24 percent would remain in the region. Those recreationists who would leave the state because of declining water clarity and purity would create a loss of about 21,000 visitor days.

The study found that overall, surface water recreation in the 36 towns in New Hampshire's Monadnock tourism region generates over 120 jobs. These jobs equate to over almost $3 million in personal income and almost $8 million in business sales. A perceived decline in water clarity

---

1. *The Economic Impact of Potential Decline in New Hampshire Water Quality: The Link Between Visitor Perceptions, Usage and Spending*. Prepared for the New Hampshire Lakes, Rivers, Streams and Ponds Partnership by Anne Nordstrom, May 2007.

and purity in the Monadnock region would lead to a loss of loss of about half a million dollars in business sales. While similar figures not available for Vermont, it is clear that Vermont residents and visitors are also enjoying these waters and contributing to the local economy.

Recommendation

- Vermont should investigate the economic value of clean waters to the state.

B. Connecticut River Water Quality

1. River Management Planning

The states approach river planning differently in the Connecticut River watershed. New Hampshire designated the Connecticut River into its Rivers Management and Protection Program in 1992 with the support of local citizens and CRJC. As part of this designation, the state required CRJC to act as the local advisory committee for the river, and to develop a Connecticut River Corridor Management Plan with the help of five local river subcommittees set up under state law. CRJC published the six-volume first edition of the plan in 1997. This document is a revised and updated version of the water quality chapter of that plan.

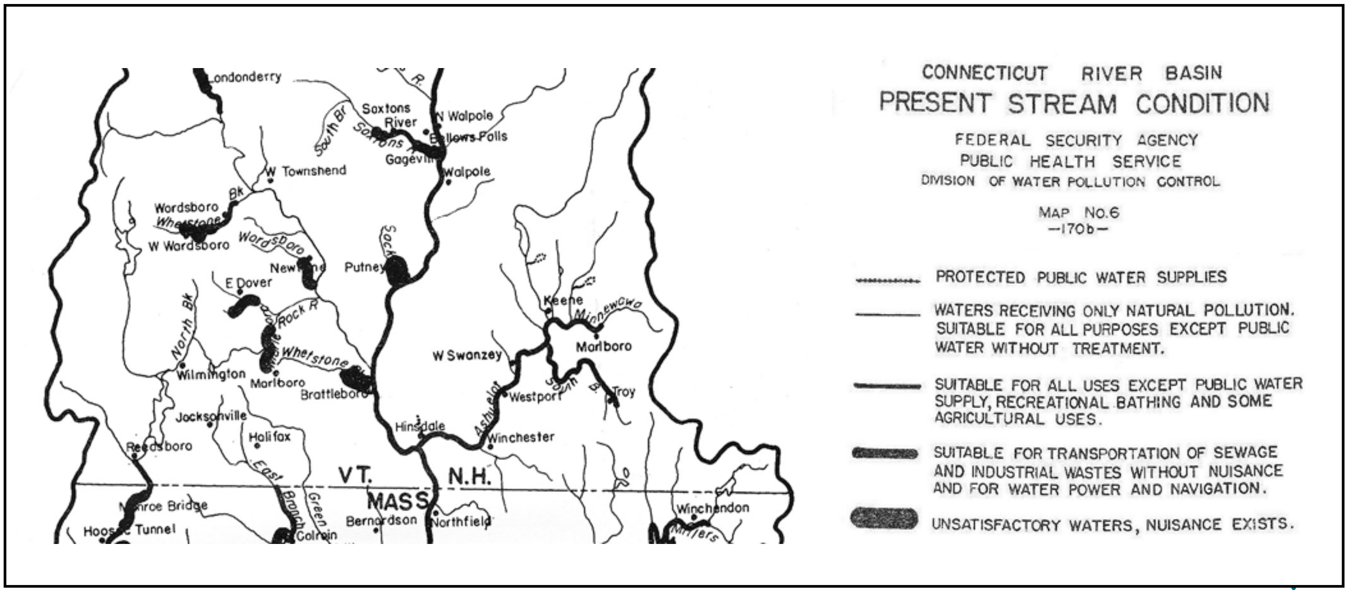
New Hampshire Rivers Management and Protection Act - RSA 483 provides general guidance for future land use in the New Hampshire corridor of the Connecticut River. While the majority of the Wantastiquet segment is designated as "rural," there are also "rural-community" and "community" sections that have included both commercial/industrial centers for almost 200 years.

Rural river segments - The law defines these waters as "adjacent to lands which are partially or predominantly used for agriculture, forest management and dispersed or clustered residential development. Management of rural river... segments shall maintain and enhance the natural, scenic, and recreational values of the river for agricultural, forest management, public water supply, and other purposes which are compatible with the instream public uses of the river and the management and protection of the resources for which the...segment is designated." In the Wantastiquet Region, two extensive segments of the Connecticut River are designated as rural:

- from the Westminster-Walpole bridge to the Brattleboro/Dummerston line (17 miles)
- from the point 0.3 miles below the Vernon Dam to the Massachusetts line (5 miles).

Local zoning in Walpole, Westmoreland, Chesterfield, and Hinsdale, N.H. should honor the stipulations of this designation. Westminster, Putney, Dummerston, and Vernon, Vt. should also consider these provisions.

Rural-community segments - According to RSA 483, these are river segments "which flow through developed or populated areas...and which possess existing or potential community resource values such as those defined in official municipal plans or land use controls. Such rivers have mixed land uses in the corridor reflecting some combination of open space, agricultural, residential, commercial and industrial land uses. Such rivers are readily accessible by road or railroad and may include impoundments or diversions.



Wantastiquet Region water quality in 1951.

“Management of rural-community...segments shall maintain and enhance the natural, scenic, recreational and community values of the river and shall consider, protect, and ensure the rights of riparian owners to use the river for such uses as agricultural, forest management, public water supply, residential, recreational, commercial, industrial, flood control, and other community uses which are compatible with the instream public uses of the river and the management and protection of the resources for which the...segment is designated.”

In the Wantastiquet Region, two segments of the Connecticut River are designated as rural-community:

- from the Saxtons River to the Westminster-Walpole bridge (3 ½ miles)
- from the Brattleboro/Dummerston line to Sprague Brook in Hinsdale (9 miles)

Local zoning in Walpole, Chesterfield, and Hinsdale, N.H. should honor the stipulations of this designation. Westminster, Dummerston, and Brattleboro, Vt. should also consider these provisions.

Community segments - RSA 483 defines community river segments are those “which flow through developed or populated areas...and which possess existing or potential community resource values, such as those identified in official municipal plans or land use controls. Such rivers have mixed land uses in the corridor reflecting some combination of open space, agricultural, residential, commercial and industrial land uses. Such rivers are readily accessible by road or railroad, and may include existing impoundments or diversions, or potential sites for new impoundments or diversions for hydro power, flood control or water supply purposes, and may include the urban centers of municipalities.

"Management of community...segments shall maintain and enhance the natural, scenic, recreational and community values of the river and shall consider, protect, and ensure the rights of riparian owners to use the river for such uses as agricultural, forest management, public water supply, residential, recreational, commercial, industrial, flood control and hydroelectric energy production purposes which are compatible with the instream public uses of the river and the management and protection of the resources for which the...segment is designated."

Two segments of the Connecticut River in the Wantastiquet Region, bracketing the Bellows Falls and Vernon Dams, are designated as community:

- from the southern side of the Williams River in Bellows Falls to the Saxtons River in Westminster, Vt. (3 miles)
- from Sprague Brook in Hinsdale to a point 0.3 miles below Vernon Dam (1 ½ miles).

Zoning regulations in Walpole and Hinsdale, N.H. should honor the stipulations of this designation. Vernon, Vt., should also consider these provisions.

Vermont - Vermont embarked upon watershed planning in 2002, under a mandate from the legislature that originally gave the Department of Environmental Conservation (VT DEC) until 2006 to complete basin plans for the state's 17 watersheds, although this will now not be complete until after 2011. Under the guidance of state basin planners, citizen committees are developing basin plans in a process modeled partly on the grassroots approach used by CRJC. At the same time, the state agency is moving ahead with watershed assessment and restoration projects, such as geomorphology studies. Watershed planning has recently been completed in Basin 11 (West, Williams, and Saxtons Rivers). Planning for other small direct tributaries (Basin 13) will begin when Basin 10 is completed.

2. Water quality has improved in the last 50 years

In 1951, the Federal Public Health Agency rated 219 miles of the Connecticut River between New Hampshire and Vermont as Class C ("Damaged. Unsuitable for recreational uses except boating, unsuitable for use in some industrial processes without treatment, and unsuitable for irrigation of crops consumed without cooking"), and six miles were rated Class D ("Damaged. Unsuitable for most legitimate water uses.[1] Suitable only for the transportation of sewage and industrial wastes without nuisance and for power development and limited industrial uses. Aesthetic quality poor."). These two classifications, and the rivers that portrayed them, are thankfully a thing of the past.

A mere half century ago, the river carried untreated domestic sewage from 17,300 people in the Wantastiquet region of New Hampshire and 8,400 in adjacent Vermont, plus untreated wastewater from 15 sawmills, nine textile mills, seven paper mills, five dairy plants, and a slaughterhouse, cleaning fluid manufacturing plant, and tannery on the Connecticut River and its local tributaries, all in addition to the burden brought by the river from upstream.

---

1. Federal Security Agency, Public Health Service, *Connecticut River Drainage Basin: A Cooperative State-Federal Report on Water Pollution*, 1951.

Whetstone Brook in Brattleboro and Sackett's Brook below the village of Putney, among the most badly polluted waters in the entire four-state watershed at the time, were simply labeled "unsatisfactory waters, nuisance exists."

Today, thanks to the Clean Water Act and investments by the public and private sectors, the Connecticut River has substantially recovered from its former reputation as "New England's best landscaped sewer." Still, the Wantastiquet region's reach of the river carries nutrients, sediments, debris, and other forms of pollution delivered from upstream, from within the region, and by the tributaries, and faces continuing challenges from increasing riverside development. As the river passes through this most densely populated portion of its upper watershed, it has an opportunity to acquire an even heavier load of pollutants.

3. Water Quality Management by the States

New Hampshire water quality standards apply to the Connecticut River. Water classifications, set by the states, give the management goals for a stretch of river. Water quality standards are used to protect the state's surface waters, and each state defines water quality in its own way, based on its statutes and administrative rules. An interesting difference appears between the two states' water quality standards, such as their concepts for bacterial contamination. Vermont has the strictest standard for *E. coli* in the nation, although the VT DEC does not have the resources to enforce these standards consistently. Class B waters must not exceed 77 *E. coli* organisms per 100 milliliters of water, while New Hampshire tolerates 126 per 100 ml. State water quality standards may be compared at www.neiwpcc.org/PDF_Docs/i_wqs_matrix04.pdf.

New Hampshire Water Quality Standards

Tracking water quality is the responsibility of the Watershed Management Bureau of the New Hampshire Department of Environmental Services (NH DES). Standards in New Hampshire consist of three parts: designated uses, including swimming, fishing, boating, and aquatic habitat; numerical or narrative criteria to protect the designated uses; and an anti-degradation policy, which maintains existing high quality water that exceeds the criteria. New Hampshire measures physical and chemical aspects of water, and also has a relatively new biological monitoring program for assessing aquatic life.

Class A waters - *Escherichia coli* are not to exceed a geometric mean of 47 *E. coli*/100 ml (based on at least 3 samples obtained over a 60-day period) or more than 153 *E. coli*/100 ml in any one sample. There shall be no discharge of any sewage or wastes into these waters.

Class B waters - *Escherichia coli* are not to exceed a geometric mean of 126 *E. coli*/100 ml (based on at least 3 samples obtained over a 60-day period) or more than 406 *E. coli*/100 ml in any one sample, shall have no objectionable physical characteristics, and shall contain a dissolved oxygen content of at least 75 percent of saturation.

New Hampshire - Today, the state of New Hampshire has two classifications: A and B, and has designated the entire Connecticut River as Class B, although back in 1951, only 44 miles of the river qualified as Class B.

Vermont - Vermont considers most of the Connecticut River to be Class B. In the Wantastiquet region, there is a 0.58 mile designated waste management zone that provides for mixing of the Saxtons River wastewater discharge. Waste Management Zones are a specific reach of Class B waters designated by a permit to accept the discharge of properly treated wastes that prior to treatment contained organisms pathogenic to human beings. Throughout the receiving waters, water quality criteria must be achieved, but increased health risks exist in a waste management zone due to the authorized discharge.

Vermont Water Quality Standards

The Water Quality Division of the Department of Environmental Conservation, in the Vermont Agency of Natural Resources, manages water quality information for this state. Standards in Vermont include designated uses, including swimming, fishing, boating, aquatic biota, wildlife and habitat, and aesthetics, numerical or narrative criteria to protect the designated uses including flow, and policies for flow, anti-degradation, and basin planning, among others. Vermont's water quality monitoring program emphasizes biomonitoring (an ambient monitoring program started in 1982) and also measures physical and chemical aspects of water bodies.

Class A waters - *Escherichia coli* are not to exceed a geometric mean based on at least 3 samples obtained over a 30 day period of 18 organisms/100 ml, no single sample above 33 organisms/100 ml. None attributable to the discharge of wastes.

Class B waters - *E. coli* are not to exceed 77 organisms/100ml. Vermont's water quality standards also include criteria for turbidity, dissolved oxygen and temperature based on whether the waters are designated for cold or warmwater fish habitat, and for aquatic biota, wildlife and aquatic habitat. Standards for phosphorus exist for the Lake Champlain basin, but not for the Connecticut River watershed. Nitrate standards exist for all waters, based on flow.

Vermont's Water Resources Board will eventually designate all Class B waters as either Water Management Type 1, 2, or 3, in order to more explicitly recognize their attainable uses and the existing level of water quality protection. Until waters are designated as a specific type, the criteria based on such designations do not apply. Vermont's Water Management Typing process has been before the Water Resources Panel for a long time and at this writing has not been resolved.

Vermont has also designated a 2.35 mile mixing zone around the Vermont Yankee cooling water discharge.

Total Maximum Daily Load (TMDL)

Each state must identify those water bodies that are not meeting their water quality standards, and calculate the maximum amount of a pollutant that each can receive and still meet the state's water quality standards. The state also develops a means to reduce these pollutants. TMDLs can be calculated for correcting water pollution from specific discharges or throughout a watershed and balance how much the pollutant needs to be reduced based on location. The draft 2008 state water quality assessments (Clean Water Act Section 303d List of Impaired Surface Waters) are the most recent available as this study was prepared.

New Hampshire TMDL list: In the Wantastiquet Region, 2.0 miles of the Connecticut River in Walpole, 11.05 miles of it in Westmoreland, and 5.99 miles of it in Hinsdale are on the TMDL list for low pH, possibly due to acidic waters delivered by the Cold and Ashuelot Rivers.

Some 60 miles of the Cold River and more miles of its tributaries are on the TMDL list due to low pH, and 20.93 miles of the Cold River are also impaired by *E. coli*. Bio-assessments carried out after major flooding in 2005 indicate that the benthic macro-invertebrate community is impaired in 6.91 miles of the Cold River, and impaired fish communities, aluminum, and *E. coli* appear in another 4.86 miles affected by the flood.

Partridge Brook in Westmoreland and Chesterfield is on the list for *E. coli,* where 16.26 miles are contaminated by bacteria from unknown sources.

Much of the Ashuelot River is on the list, 10.82 miles due to low pH, 37.46 miles due to both low pH and contamination by *E. coli,* and another 7.89 miles due to *E. coli* alone. Aluminum is a problem on 4.58 miles. A 2.57 mile stretch in Swanzey is contaminated by urban runoff that creates problems of low dissolved oxygen and pH. Spofford Lake is on New Hampshire's list of acid ponds. More information on tributaries appears in Appendix D. For more information see http://des.nh.gov/organization/divisions/water/wmb/swqa/index.htm.

Vermont TMDL list: In the Wantastiquet Region, 10 miles of the West River from Ball Mountain Dam to Townsend Dam have degraded aquatic habitat from sediment releases that occurred in 1993 and 1995 and also have elevated temperatures. A 1.5 mile section of the West River in Londonderry is contaminated by *E. coli,* possibly from a septic system discharge. Ball Mountain Brook, above the North Branch confluence, is critically acidified from atmospheric deposition, as are several other headwater streams in this watershed.


Discharge near Sackett's Brook in Putney.

Vermont also publishes a list of priority surface waters that are outside the scope of Clean Water Act Section 303(d), including impaired surface waters for which no TMDL determination is required, surface waters in need of further assessment, those with completed TMDLs approved by EPA, and waters altered by exotic species, flow regulation, and channel alteration. In the Wantastiquet Region, several impaired waters will likely need further assessment and a TMDL:

Sackett's Brook in Putney suffers from fish habitat degradation from undefined pollutants, including possible periodic spills at Putney Paper Company; Whetstone Brook in Brattleboro has a problem with *E. coli* from unknown sources, potentially a faulty sewer line or septic system; Crosby Brook in Dummerston and Newton Brook in Vernon are polluted by sediment. Other streams, including parts of the West River, lower Saxtons River, Wardsboro Brook, and the Winhall River, are affected by warming temperature from loss of riparian vegetation, road runoff, and other factors associated with development. For more information see www.vtwaterquality.org/planning.htm.

4. Water Quality Monitoring Activities

Surface waters are sampled to see whether they meet each state's water quality standards, but not always on a regular basis, although the Clean Water Act requires the states to report surface water quality conditions and problems to EPA every two years.

Biological monitoring - The particular species and the variety of aquatic life surviving in a stream give a good picture of the quality of the water and sediments in which they live. Biologists visit streams to collect fish and macro invertebrates (aquatic insects) as well as basic physical and chemical water quality data and assess habitat. Volunteers also participate in biomonitoring. Vermont has used this approach since 1982. New Hampshire started biomonitoring in 1997, and has looked at several locations in the Wantastiquet region.

Chemical/Physical monitoring - Monitoring and river clean-ups are suitable community service projects for area students that can help develop a lifelong sense of river stewardship. Both states are now welcoming the help of citizen volunteers in gathering data about their local waters. In 1998, NH DES started the Volunteer River Assessment Program (VRAP), providing training, water quality monitoring equipment, and technical support. VRAP followed in the footsteps of DES's very successful Volunteer Lakes Assessment Program. VRAP supports over a dozen volunteer groups throughout the state who conduct water quality monitoring, including the Cold and Ashuelot River Local Advisory Committees. VRAP data are available on-line at http://des.nh.gov/organization/divisions/water/wmb/vrap/index.htm. Vermont Yankee has conducted detailed water quality monitoring at its site for many years. Otherwise, there is currently no regular, on-going water quality monitoring program on the Connecticut River mainstem or lesser tributaries in the Wantastiquet region.

In Vermont, water quality monitoring rotates through the various basins on a seven year schedule. The Windham County Conservation District organized a volunteer citizen monitoring program on parts of the West and Saxtons Rivers, focused largely on swimming areas, as part of Vermont's basin planning.

A well-conceived water quality monitoring program has shown its value in the Cold River watershed, where monitoring began in 2002 at 28 sites and was in place before the 2005 flood. This work, and the photographs taken of sampling sites before the flood, established a firm baseline of information that can now be used to measure the river's recovery. Monitoring has continued since the flood.

Monitoring by Vermont Yankee - Vermont Yankee has a long record of water quality data, dating from 1967, that covers 26 miles of the river from the confluence of the West River to Northfield, Mass. Two continuous monitoring stations record temperature, dissolved oxygen, and pH, and until recently also monitored turbidity and conductivity.

5. Water Quality in the Connecticut River Today

NH DES, assisted by EPA, assessed the entire river mainstem in New Hampshire in 2004 at the request of CRJC in preparation for the update of this plan.[1] (See Appendix E.) The study looked at bacteria, to see if the water is safe for swimming, boating, and fishing, and also measured fish habitat quality by looking at dissolved oxygen, pH, specific conductance, and temperature.

The river was sampled in the following locations:

- the Vilas Bridge at the end of the Bellows Falls bypass;
- the Route 123 Bridge in Walpole;
- the Cheshire County Farm in Westmoreland;
- the Route 9 Bridge in Chesterfield;
- the Route 119 Bridge in Hinsdale;
- the Route 10 Bridge in Northfield, Mass.

"We want to thank the groups from up north for sending us clean water."

Gordon Schofield, Wantastiquet Subcommittee Chair, Hinsdale

Results - Results from this one season's testing indicated that the river's quality fully supports swimming and other forms of recreation, although it found that elevated aluminum and copper levels may affect aquatic habitat in the river below Vernon Dam. The copper levels may be related to contributions from the Ashuelot River. Bacteria can reach rivers through poorly functioning septic systems and through runoff, such as drainage from a pasture or stormwater carrying pet waste into the river from urban areas.

Vermont report - In 2002, Vermont considered swimming, aquatic habitat, and water supplies for crop irrigation to be threatened in the Connecticut River mainstem in this region. Threats are due to pathogens, turbidity, temperature, organic enrichment, metals and organics from flow fluctuations, streambank erosion, municipal and industrial discharges, motorboats, agricultural runoff and possible impact from the unlined Brattleboro landfill.

Recommendations for water quality monitoring

- NH DES should take additional samples on the Connecticut River above and below the mouth of the Ashuelot. This should verify whether the Ashuelot is causing elevated levels of phosphorus or copper in the Connecticut River.

- State water quality agencies should sponsor increased water quality monitoring activities in the region and make use of data collected by Vermont Yankee. NH DES and VT ANR should

---

1. *2004 Connecticut River Water Quality Assessment,* Preliminary Assessment Status, N.H. Department of Environmental Services.

train and equip a team of roving volunteer monitors to track down concentrated sources of pollutants for which monitoring data suggest problems, such as elevated levels of phosphorus or copper. Such teams could focus on high priority problems and hopefully track them to sources, and assist state agencies and local conservation commissions to develop solutions to identified water quality problems.

- EPA should fund state resource agencies to monitor for toxic substances such as mercury in the water, fish, and sediments, and release the results to the public in a timely manner.

- Towns, conservation commissions, schools, and local organizations should raise funds to support local volunteer water quality monitoring efforts that follow state protocols.

- Local citizen groups should pursue an aggressive volunteer water quality monitoring program for the Connecticut River, with the Wantastiquet region as a pilot program, and encourage participation by area schools, members of the academic and scientific community who live in the region, and the Bonnyvale Environmental Education Center in Brattleboro.

C. Connecticut River Sediment Quality

Road pollutants can drain into waterways, such as through this storm drain near the Ashuelot River in Hinsdale.

Studies of river sediments have shed light on what may be present in the silts and sands of the river bottom. In response to the 1997 *Connecticut River Corridor Management Plan,* EPA conducted two studies of sediments on the New Hampshire/Vermont portion of the river.[1] Three of the 10 sites sampled during the 1998 study are located in the Wantastiquet region: below Sackett's Brook in Putney, below the West River in Brattleboro, and below the Ashuelot River in Hinsdale.

In general, sediments looked relatively clean, although results indicate that road runoff probably has an effect upon aquatic life. Results are summarized in Appendix E.

"Low effects level" = level at which effects on aquatic life might be expected.

Copper and nickel exceeded the level at which ecological effects might occur, near Sackett's Brook and below the West River. Breakdown products of the pesticide DDT were detected in low concentrations downstream of the confluence of Sackett's Brook. This pesticide has not been used for years, but persists in the environment.

Heavy metals and polyaromatic hydrocarbons associated with automobiles appear in the sediments in relatively low levels. An exception is near Sackett's Brook where chrysene, a polyaromatic hydrocarbon, exceeded the level at which ecological effects might

---

1. *Upper Connecticut River Sediment/Water Quality Analysis*. U.S. Environmental Protection Agency, Region 1, October 1999.

occur. These chemicals can get into streams when roads closely follow waterways, from leaks and drips from automobiles, snowmobiles, or other vehicles, and from leaking underground storage tanks.

D. Connecticut River Fish Tissue

In 2000, EPA worked with the four Connecticut River states to conduct a comprehensive fish tissue toxin study. This landmark study, which may be the first river-wide study of fish tissue in the nation, represents significant cooperation among the four states, each of which contributed substantial funding and staff. The concept for the study comes directly from the public, raised in the 1997 *Connecticut River Corridor Management Plan*.

Fish Consumption Guidelines:
(do not apply to stocked fish): Pregnant and nursing women, and women who may get pregnant can safely eat one 8-ounce meal per month of freshwater fish. Children under age 7 can safely eat one 4-ounce meal per month of freshwater fish. All other adults and children age 7 and older can safely eat four 8- ounce meals per month of freshwater fish. When eating bass, pickerel, white perch or yellow perch, limit consumption to fish 12 inches or less in length while following the above guidelines. Stocked trout contains relatively low levels of mercury. For rainbow and brown trout, women of childbearing age and children can safely eat one meal per week, others can eat 6 meals per week. Brook trout could be either stocked or from a reproducing population, therefore they should be consumed at the rate of the general statewide advisory.

Biologists sampled white sucker, yellow perch, and smallmouth bass from eight sections of the Connecticut River, choosing fish species that represent different levels of the food chain and are widely found in the 410-mile long river. Smallmouth bass, yellow perch and white suckers were collected from the mainstem of the Connecticut River and composite samples were analyzed for total mercury, coplanar (dioxin-like) PCBs and organochlorine pesticides, including DDT and its breakdown products. Wantastiquet Region fish were sampled as part of Reach 5 (Wilder Dam to Vernon Dam).

Findings - In this reach, mercury in fish is a threat to fish-eating birds and mammals, but not to recreational or subsistence fishers. Dioxin-like PCBs pose a risk to recreational and subsistence fishers and to fish-eating mammals and fish-eating birds, but not to fish-eating fish. DDT and related breakdown products pose a risk to subsistence fishers and to fish-eating birds, but not to recreational fishers or fish-eating mammals. The study found that total mercury concentrations in all three species of fish were significantly higher upstream than downstream. Risk from PCBs was generally lower in upstream areas than in downstream areas, although this varied by fish species and was different for the humans, mammals, birds or fish that eat them. Dioxins and furans are a threat to subsistence fishermen, and a slight threat to fish-eating mammals, but not

---

Connecticut River Fish Tissue Contaminant Study: Ecological and Human Health Screening (2000). Prepared for the Connecticut River Fish Tissue Working Group by Greg Hellyer, Ecosystem Assessment Unity, USEPA - New England Regional Laboratory, N. Chelmsford, MA, May 2006.

to recreational fishermen. Ice fishermen from New Hampshire, Vermont, and Massachusetts fish in the area, and generally eat what they catch.

Repeating this study in the future could be done in a phased approach to control costs.

Recommendations for fish contamination

- NH DES and VT ANR should conduct a survey of local anglers to see how many are subsistence fishermen, in order to ensure that fish consumption advisories are well calibrated to local consumption.

- Fishermen should replace their lead sinkers with non-hazardous substitutes. Both states have banned use of lead sinkers weighing one half ounce or less.

E. Invasive Aquatic Species

The Wantastiquet region of the Connecticut River now has the most diverse group of invasive aquatic plants of any segment in New Hampshire and Vermont. The first recorded invasive in the New Hampshire/Vermont reach of the Connecticut River was reported in 1995 upriver in Springfield, Vt. The most recent unwanted arrival is the invasive alga Didymo, discovered in 2007 far upstream in the Connecticut River at Bloomfield, Vt. and in the White River.

Native plants have evolved together over thousands of years with animals such as beetles and other insects that have become specialized to feed on them. Exotic species, growing without such natural controls, can crowd out natives, disrupting the food chain and stunting fish growth. Exotic aquatic plants can interfere with boating and swimming and reduce the value of waterfront property. The zebra mussel could harm boating, swimming, fisheries, and even industry.

Once an invasive plant or animal is established in a water body, continuous management is the only way to control it. Therefore, it is important to prevent infestations in the first place and identify new ones early. State biologists conduct field searches each summer, but volunteer help is critical. Both states offer grants to local lake associations and towns for control and treatment of exotic aquatic weeds, and have programs and training for volunteer "weed watchers."

A list of invasive aquatic plants in the Wantastiquet region of the Connecticut River appears in Appendix F.

Sources of invasive aquatics - Exotic invasive plants and animals reach the river in many ways. Plants such as milfoil can come in on the propellers and trailers of boats that have been in infested waters, or spread through drainage from such waters. Zebra mussel larvae can survive several days in bait buckets, live wells, or engine cooling systems. Aquatic invasives could come from aquariums dumped into surface waters or from flooding of landscaped "water gardens" planted with exotic plants. Road crews can spread soil and fill contaminated with the seeds or root fragments of plants such as Japanese knotweed. Didymo apparently arrived in the watershed on the soles of fishing waders belonging to a fisherman who had recently traveled to New Zealand.

Didymo - *Didymosphenia geminata* (called Didymo for short, or "rock snot"), is an invasive freshwater diatom (microscopic algae). It can form extensive colonies on the bottoms of rocky river beds, smothering aquatic life such as macroinvertebrates (aquatic insects). Its appearance is very unattractive, making the water less appealing for recreation.

Biologists believe that Didymo could be spread by any recreational equipment, including bait buckets, diving gear (neoprene), water shoes, canoes, kayaks, and life jackets, in addition to fishing gear. There is currently no way to control or eliminate Didymo. The alga can remain viable for several weeks if kept moist. The agencies have concluded that the best approach is to attempt to prevent further spread by humans, especially to tributaries. Didymo is generally a northern circumpolar species of river systems with cobble or rock bottoms, although biologists are noticing a shift to streams in warmer climates and with more nutrients. While it may not pose a threat to sandy or silty portions of the Connecticut River in the Wantastiquet region, it could move from them into suitable habitat in the tributaries.

Milfoil - The first milfoil infestation on the entire upper Connecticut River was discovered at Hoyt's Landing in Springfield in 1995 by a member of the Mount Ascutney Subcommittee. Milfoil has since spread into the Wantastiquet Region, and there is now a thick growth in Retreat Meadows at the mouth of the West River. Establishment of a waterskiing course in Retreat Meadows in 2007 caused concern that water skiers and boat propellers would disturb this growth by chopping the milfoil into fragments that could then float freely downstream to infest other areas. Vermont does not currently have a means of controlling such activities. There is no boat/trailer check program in place anywhere in the region to ensure that boats are not delivering hitch-hiking weeds from other waters or bringing it elsewhere from the Connecticut River.

Purple Loosestrife - This invasive wetland plant has become noticeably more common in the last 10 years in the region. Releases of *Galerucella* beetles to control purple loosestrife have occurred in a number of areas. While some success has been reported with this bio-control, water level fluctuations in the Vernon impoundment may affect winter beetle survival in riverfront soils.

Japanese Knotweed - This highly aggressive invasive plant has formed nearly pure stands in the riparian buffer of the Saxtons River, and is perhaps the most noticeable invasive plant in the Wantastiquet region near waterways. A serious study of potential bio-control methods is needed for this plant. Incredibly, the plant was introduced to the U.S. as a means of controlling riverbank erosion, but its root systems and stems are poorly adapted for this purpose.

Other Invasive Aquatic Plants - The 2006 Connecticut River Aquatic Invasive Plants Outreach & Survey Project, funded by CRJC's Partnership Program, surveyed for invasive plants at 21 mainstem sites in New Hampshire and Vermont. A number of invasive plants were found in the four areas surveyed in the Wantastiquet portion of the Connecticut River, including the only reported population of European Naiad on the upper river. A subsequent study has added to this information.

Invasive aquatic animals - The zebra mussel has not yet invaded the Connecticut River, which is considered one of the few New Hampshire water bodies possibly susceptible to this invader because of the chemistry of the water. The zebra mussel is becoming a scourge in Lake Champlain, and there is concern that tournament fishermen may inadvertently deliver zebra mussel larvae to the Connecticut River. Upstream in the White River watershed, studies indicate that the exotic rusty crayfish is increasing after fishermen using them as bait released them into the water. Carp, gizzard shad, and white perch are also present in this part of the river. The status of other invasive aquatic animals in the Wantastiquet Region is currently unknown.

Site	Town	Invasive Species Found
Confluence of un-named brook and Connecticut River & portion of Connecticut River on NH side; public boat launch at Pine St., Walpole	Walpole, NH	Eurasian Milfoil Purple Loosestrife Yellow Flag Iris True Forget-Me-Not
Connecticut River, vicinity of islands between Brattleboro and Hinsdale including marina area on NH side	Brattleboro, VT & Hinsdale, NH	Eurasian Milfoil Curly Leaf Pondweed Purple Loosestrife
West River/Connecticut River confluence (including Retreat Meadows) & small portion of Connecticut River, VT side; Public access, Rte 30	Brattleboro, VT	Eurasian Milfoil Curly Leaf Pondweed Purple Loosestrife Phragmites True Forget-Me-Not
Broad Brook/CT River confluence& portion of Connecticut River, VT side; public access, Rte 142	Vernon & Brattleboro, VT	Eurasian Milfoil Curly Leaf Pondweed Purple Loosestrife Phragmites Yellow Flag Iris
Connecticut River backwater cove; Prospect St., public access	Hinsdale, NH	Eurasian Milfoil Curly Leaf Pondweed European Naiad Purple Loosestrife Phragmites

Recommendations for invasive aquatic species

- State environmental and fisheries agencies should continue to cooperate to better understand and address the Didymo infestation.

- Fishermen and other recreational users must carefully clean their gear after visiting the Connecticut River and report sightings of invasive aquatic species to state agencies. Do not release unused bait into the water.

- Local outfitters and guides should educate their customers about Didymo and other invasives, and to clean their gear.

- Boaters or divers traveling from waters infested with zebra mussel must wash and dry all equipment before reuse, hose off the boat, diving gear or trailer, and drain and flush the engine cooling system and live wells of the boat, bait buckets and the buoyancy control device from diving equipment.

- Aquarium owners should not dump aquarium plants or animals into any water body, but dispose of them by freezing or drying before putting them in the trash.

- Town conservation commissions should conduct a campaign against Japanese knotweed in their towns.

- USDA should sponsor studies of potential bio-controls for Japanese knotweed similar to those for purple loosestrife, and inform the public about the results.

IV. River Flow

In additon to receiving runoff of rainfall and snowmelt, rivers draw their waters from underground springs of groundwater, slow seepage from wetlands, and tributaries large and small. The amount of water in a river changes naturally during the year as the ground freezes and thaws, as trees leaf out and draw moisture from the soil, and as warm winds evaporate surface water.

Humans can affect the river's flow volume by withdrawing water for irrigation or industrial use, building dams, clearing forests, filling wetlands, covering soil with hard surfaces like pavement and roofs, and by drilling wells to pump out groundwater that otherwise might reach the stream. Some of these actions, like withdrawals, simply reduce the amount of water flowing in the river. Others, such as clearing and development, send runoff to the river more quickly and erosively, rather than slowly and steadily. Dams can influence river flow by holding back water and allowing only a portion to flow, and by creating an impoundment where water can evaporate before it has a chance to flow downstream.

All rivers rise and fall through the year, and respond to changes in weather and condition of the watershed. A healthy river has enough water flow to keep fish and aquatic life alive year-round, and today must also dilute and flush pollutants. A healthy river floods, but humans can also affect the severity of floods by where they build and how they alter water's natural path to the river.

Local regulations regarding protection of wetlands and shorelands are summarized in Appendix G.

A. Streamflow Gaging Stations

Gaging stations measure water level and flow rates, and are useful in helping to forecast flooding, set floodplain levels and regulations, and indicate historical flow rates and flooding trends in river systems. Gages tell river managers, state and local officials, and landowners about flow conditions on the river and its gaged tributaries, essential during times of low and high water. Gages are also cited in water use permits and help define operations of hydro generating plants that affect flow. Good river management requires good knowledge of current river conditions. Satellite communication technology now provides such knowledge.

There is one gaging station on the Connecticut River in the Wantastiquet region and 11 on tributaries that enter the river in this area. Gage data are available at www.crjc.org/riverflow.htm.

Table 1a. Active Gages in the Wantastiquet Region

Watershed	Location	River	Gage number	Drainage area (sq.mi.)	Measurements available (real time)	Years of Record
Connecticut River mainstem	North Walpole NH	Connecticut River	01154500	5,493	discharge, gage height, precipitation, air temperature	since 1942
Cold River	Alstead NH	Cold River	01154950	74.6	real time data	Since Sept. 2009
Saxtons River	Saxtons River VT	Saxtons River	01154000	72	discharge, gage height	since 1940
West River	Jamaica, VT	West River	01155500	179	discharge, gage height	since 1946
	Below Townsend Dam, Townsend, VT	West River	01155910	282	discharge, gage height	since 1994
Ashuelot River	Near Gilsum, NH	Ashuelot River	01157000	71	real time data; discharge, gage height	1923-2005 Since July, 2009
	Below Surry Mt. Dam near Keene NH	Ashuelot River	01158000	101	discharge, gage height	since 1945
	S. Branch at Webb	Ashuelot River	01160000	36	discharge, gage height	1920-1978 Since May, 2009
	Above the Branch at Keene NH	Ashuelot River	01158110	214	gage height (operated for flood-control purposes)	not given
	Below Otter Brook Dam, Keene NH	Otter Brook	01158600	47	discharge, gage height	since 1958
	W. Swanzey NH	Ashuelot River	01160350	316	discharge, gage height	since 1994
	Hinsdale, NH	Ashuelot River	01161000	420	discharge, gage height	since 1907 *

***first and longest operating gage in the Connecticut River watershed of New Hampshire and Vermont.** Table prepared by CRJC based on US Geological Survey information.

Loss of gages - Funding for gage upkeep is shared by the U.S. Geological Survey (USGS) with other agencies, and averages $12,500/year/gage for gage calibration, equipment maintenance, data analysis, and data management, although the actual on-site costs must be extremely low since the units are solar-powered and unmanned. There have been threats to gage funding over the years, primarily as a result of efforts to cut state budgets. While Vermont generally adds one to two gages a year, and has added ten gages between 2000 and 2005, New Hampshire has been losing stream gages since 1969, including the Drewsville gage on the Cold River, and in 2007 its stream gage network was at its lowest numbers since 1939. Fourteen stream gages were lost in 2004-2005 alone.

Since more extreme weather patterns seem to be emerging, and water is an increasingly valued commodity, it is important to be sure gages remain funded so that the data will continue to be available. New Hampshire's Rivers Management Advisory Committee has recommended addition of some gages, particularly in the watersheds of designated rivers such as the Connecticut, Cold, and Ashuelot Rivers. The Drewsville gage on the Cold River was not active at the time of the October, 2005 flood, but was among those recommended for reinstatement. Gages suggested for the Wantastiquet region include:

- Cold River. Rationale: undammed watershed, N.H. Designated River, former USGS gage 1155000, high-priority salmon nursery, flash flood prone; site of 500+ year flood in October 2005.

- Middle Ashuelot River. Rationale: reactivate 01160000 South Branch Ashuelot at Webb, near Marlborough, or install new gage higher in watershed; needed for NPDES permitting and compliance issues with the Troy wastewater treatment plant; undammed watershed.

- Upper Ashuelot River. Rationale: former USGS gage 1157000, undammed watershed, headwaters of Designated River; 28 miles of river that are poorly gaged; may represent a small, relatively unimpacted watershed for a reference gage (existing USGS gage 01158000 Ashuelot below Surry Mtn. Dam near Keene).

- The Branch (Ashuelot).Rationale: temporary gage at Beaver Brook, flows through center of Keene, tributary to Ashuelot River.

Of these, three have been added as of September, 2009:

- Cold River at High Street, Alstead N.H.

- Ashuelot River near Gilsum N.H. (former gage reinstated)

- South Branch Ashuelot River at Webb near Marlborough(former gage reinstated)

Table 1b. Discontinued Gages in the Wantastiquet Region

Watershed	Location	River	Gage number	Drainage area (sq. mi.)	Years of Record
Connecticut	Vernon	Connecticut	01156500	6,266	1936 - 1973
Cold River	Drewsville	Cold River	01155000	83	1940-1978
Ashuelot River	near Gilsum	Ashuelot	01157000	71	1922-1980 (reinstated 2009)
	near Keene	Otter Brook	01158500	42	1923-1958 (Replaced nearby the next year)
	Chesham	Pratt Brook	01159000	11	1919-1921
	Marlborough	Minnewawa Brook	01159500	32	1919-1922
	near Keene	Beaver Brook	01159600	6	1972-1973
	Webb, Marlborough	S Br Ashuelot River	01160000	36	1920-1978 (reinstated 2009)
West River	near Londonderry	Flood Brook	01155300	9	1963-1974
	Newfane	West River	01156000	308	1919-1980

Table prepared by CRJC based on US Geological Survey information.

Temperature gages: Vermont Yankee maintains two continuously operating and recording temperature monitoring stations on the Connecticut River to monitor mixing of its warm water discharge. They are located three miles above the discharge site and a half mile below Vernon Dam, well below the discharge site. Monthly monitoring reports are submitted to the Vermont Agency of Natural Resources.

Recommendations for gages

- States and USGS should work together to maintain existing gages for public safety.

B. Flow & Flooding

The Connecticut River in the Wantastiquet region typically experiences heavy flows with spring ice-out and snowmelt, receiving the drainage from thousands of square miles of New Hampshire and Vermont. Flooding at this and other times of the year is now controlled to some extent by four flood control dams on the West and Ashuelot Rivers and on the Ottauquechee, Black, and Ompompanoosuc Rivers upstream of this region. Together, these dams control less than 15 percent of the 6,266 square miles of the Connecticut River's watershed that drains through Vernon Dam. Operations at hydro dams profoundly affect water flow throughout the Wantastiquet reach of the river.

At drier times of the year, the Connecticut River in the Wantastiquet region may not carry enough flow to dilute pollutants to ensure the river meets water quality standards, because of water withdrawals from both the tributaries and the mainstem and because of current dam licenses which permit the dams to retain water and allow only a minimum flow. Vermont water withdrawals from the mainstem are not registered but the information could be useful in flow calculations.

1. Instream flow

Instream flow refers to how much water is flowing in a river or stream...how often, how long, when, and how fast it changes. Instream flow is affected by rainfall, snowmelt, drought, and also by damming, diversion, withdrawals, and development. This can in turn affect water quality, erosion, temperature, recreation, nearby water supplies, and especially habitat. Except in very high water conditions, instream flow of the Connecticut River in most of the Wantastiquet region is controlled almost completely by operations at Bellows Falls and Vernon Dams, and is also affected by operations at Northeast Utilities' dam at Turners Falls, Mass., and pump storage at Northfield Mountain.

Effect of instream flow upon temperature and dissolved oxygen - In the Wantastiquet region, the effect of flow upon temperature is especially important for fish habitat and migration and also for waste assimilation. Both require ample oxygen dissolved in the water. Warmer water holds less oxygen. The longer water is captured, unshaded, behind the two major dams at the head and foot of this segment, the more opportunity it has to heat up water entering from the cooler, shaded uplands. The river must also accept and disperse heated water piped into the river by the Vermont Yankee nuclear power plant. In the same area, the river receives runoff from warm pavement. Greater instream flow better mixes this thermal discharge. The discharge permit for Vermont Yankee therefore ties the temperature of the released heated water to the ambient temperature of the river upstream of the plant.

Migratory smolt of Atlantic salmon pass through this stretch of the Connecticut River on their journey to the Atlantic Ocean, and adults pass through this area on their way to spawn in the West River and elsewhere. Likewise, young American shad are at risk from high water temperatures as they journey up and downriver.

Instream flow regulation by the states - As a river designated into New Hampshire's Rivers Management and Protection Program, the Connecticut River is to be governed by instream flow rules to ensure that there is adequate flow for "public uses including but not limited to navigation, recreation, fishing, storage, conservation, maintenance and enhancement of aquatic and fish life, fish and wildlife habitat, wildlife, the protection of water quality and public health, pollution abatement, aesthetic beauty, and hydroelectric energy production."

Instream flow rules for two New Hampshire rivers, the Souhegan and the Lamprey, have been created through a pilot process that will eventually be used on other rivers. A Protected Instream Flow has been adopted and used to develop a water management plan for each river. At this time, there are no plans to attempt to create flow rules for the Connecticut River.

Vermont considers instream flow when issuing dam permits and water quality certificates, snow-making withdrawals, stream alteration permits, and state land use permits. The purpose is to "assure the passage of adequate water to maintain fisheries interests, aesthetic qualities, recreational and potable water supply uses appropriate to the water body in question." The state focuses on minimum flows adequate for fisheries-related interests, and uses the "7Q10" level, which means a drought flow equal to the lowest mean flow for seven consecutive days, adjusted to nullify any effects of artificial flow regulation, that has a 10 percent chance of occurring in any given year.

The U.S.Army Corps of Engineers captures tributary flow at four flood control dams in the Wantastiquet Region, including on the Ashuelot River at Surry Mountain.

2. Flood Control Dams

The U.S. Army Corps of Engineers manages four flood control dams on tributaries that enter the Connecticut River in the Wantastiquet segment: on the West River in Jamaica and Townshend, Vt., and on the tributaries of the Ashuelot River in Roxbury and Surry, N.H. The Surry Mountain Dam, built in 1941, is the oldest of the 16 flood control dams in the Connecticut River basin. The others in the Wantastiquet region were constructed by the federal government in response to flooding during hurricanes that affected the region in the 1950s. In recent years, partly as a result of the 1997 *Connecticut River Corridor Management Plan*, the Army Corps has communicated information about its water releases and dam operations much more effectively to managers of mainstem dams.

The Army Corps has begun to look at structural changes to these dams to determine the best way to provide fish passage and to better regulate flow and temperature to lessen their effects on downstream waters. The Corps announced an agreement with The Nature Conservancy in 2005 to look at the Ashuelot and West Rivers. By combining the Corps' flow modeling expertise with the results of the Conservancy's study of the ecological effects of dam-controlled flow regimes, they plan to define flow "prescriptions" for the West River which will balance ecological, flood control and recreational needs. At the Otter Brook Dam, the Corps is planning to install a system to accommodate a slow breach.

Sudden releases from the Ball Mountain and Townsend Dams for whitewater recreation in May and September contribute to sedimentation downstream in the West River, greatly affecting the natural communities downstream. These releases occur on two weekends, and greatly increase recreational activity in the area. As of 2006, VT ANR and the Army Corps have agreed to a more natural increase in flow, to ramp up over 24 hour period to a full release level to allow aquatic life to adjust, rather than a sudden opening of gates. The Nature Conservancy is doing a major study of impacts of whitewater releases on the natural aquatic communities of the West River.

Ball Mountain Dam: Hundreds of thousands of cubic yards of sediment have accumulated behind the Ball Mountain Dam on the West River, and pose a threat to the river below. An automatic gate was installed in 1993 to assist downstream passage for Atlantic salmon smolts. In the first year of this gate's operation, equipment failures during unmanned periods on the weekend caused two accidental releases of sediment downstream of the dam, causing extensive sedimentation of high quality coldwater fish spawning habitat. The Corps investigated to determine ways to prevent future sediment releases and recommended better sensors, improved communications, and increased manpower during the migration period, but no structural changes were found necessary at the time. There is potential for further such sediment releases.

Table 2a. New Hampshire Flood Control Dams in the Wantastiquet Region

	Otter Brook Dam	Surry Mountain Dam
Owner	U.S. Army Corps of Engineers	U.S. Army Corps of Engineers
River	Otter Brook, Ashuelot River watershed	Ashuelot River
Date constructed	1958, at a cost of $4.4 million	1941, at a cost of $1.75 million
Location	Keene, NH	Surry, NH
Dam size	1,288 feet long, 133 feet high	1,800 feet long, 86 feet high
Dam type	earthen, concrete	earthen, concrete
Spillway	145 feet long	338 feet long
Impoundment	90 acre lake; capacity 5.7 billion gallons; 17,000 acre-feet	265 acre lake; capacity 10.6 billion gallons
Drainage area	47.2 square miles	100 square miles
Fish passage	downstream passage in spring	downstream passage in spring
Flow control	3 hydraulically operated gates, 2.5' x 4.5'	2 cable operated 4.5 x 10 foot, Broome Type gates
Minimum flow	10 cfs	10 cfs
Property size	582 acres, managed for flood control and recreation	1698 acres, managed for flood control, wildlife, forestry, recreation (also owns flowage rights on an additional 108 acres)

Table 2b. Vermont Flood Control, Dams in the Wantastiquet Region		
	Ball Mountain Dam	**Townshend Dam**
Owner	U.S. Army Corps of Engineers	U.S. Army Corps of Engineers
River	West River	West River
Date built	1961, at cost of $10.3 million	1961, at a cost of $7.8 million
Location	Jamaica, VT	Townsend, VT
Dam size	915 feet long, 265 feet high	1,700 feet long, 133 feet high
Spillway	235 feet	
Dam type	earthen, concrete	earthen, concrete
Impoundment	capacity 54,600 acre-foot reservoir, 17.8 billion gallons	capacity 33,200 acre-foot reservoir, 10.8 billion gallons
Drainage area	172 square miles	278 square miles
Fish passage	downstream passage in spring	downstream passage in spring
Flow control	3 hydraulically operated gates, 5'8" x 10'	3 electrically controlled gates, 7'6" x 17'
Minimum flow	100 cfs	100 cfs
Property size	1227 acres, managed for flood control and recreation, including white water releases for kayaking, rafting, and canoeing	1010 acres, managed for flood control and recreation, including white water releases for kayaking, rafting, and canoeing

Table created by CRJC based on information provided by the US Army Corps of Engineers.

Recommendations for flood control dams

- U.S. Army Corps of Engineers should work with The Nature Conservancy to study the West and Ashuelot River watersheds' diversity for the benefit of water quality and aquatic habitat. At periods of low flow, the discharge should be maintained at run of river levels to protect aquatic life downstream. Continue to coordinate flood control dam operations with mainstem dams to avoid local flooding, where possible, when flood waters need to be released from the four Army Corps dams. Put preventive measures in place to prevent sediment releases from Ball Mountain Dam that could harm aquatic habitat.

- VT ANR should determine whether sudden releases from the Ball Mountain and Townsend Dams for whitewater recreation are affecting water quality and aquatic habitat in the West River, such as trout holdouts in warm water periods.

3. Extreme Storms and Floods

The Wantastiquet region has suffered from a number of sudden, severe rainstorms in recent years. Two isolated heavy rainstorms in the Westmoreland, N.H. area in 2003 caused severe erosion and flooding in Mill Brook and nearby small streams, sending enough debris into the Connecticut River mainstem to alter the river's flow and erode the Great Meadows on the opposite Vermont bank. A year later, this material had begun washing downstream and erosion on this agricultural land had slowed. On the Vermont side, Brattleboro's Whetstone Brook has a tendency toward flash flooding, since it has a steep, high watershed and receives a significant input of stormwater from concentrated development in its lower watershed.

The Cold River Flood of 2005 severely affected the region.

The Cold River Flood - In October, 2005, the Cold River watershed experienced a 500+ year storm and received 11 inches of rain in 24 hours, reaching a total of 17 inches during the ensuing week. Flooding caused over $4 million in damage in New Hampshire and seven deaths, four of them in the Cold River watershed. The USGS calculated flows at the old Drewsville gage at the Route 123 bridge at 21,800 cubic feet per second (cfs). Historical normal flows at this site averaged about 100 cfs. During this same month, flows in the nearby Ashuelot River watershed exceeded the 100-year return level, creating the largest flood since construction of the Surry Mountain and Otter Brook Flood Control Dams.

"The rain that fell on October 8 and 9 completely rewrote our river."

Deb Hinman, Cold River Local Advisory Committee

A confluence of conditions on the ground including an undersized culvert that caused a road washout, resulted in a devastating loss of lives and homes and declaration of a federal disaster area. During high water, some boats and docks from the West River Marina went over Vernon Dam. The flood also took out several bridges, many homes, and a number of septic systems. Several landowners later claimed that the only things that saved what was left of their properties were clumps of strongly-rooted trees in the buffer zone. Better buffers might have helped other owners to reduce their losses.

Following the flood, heavy machinery was employed in the bed of the river itself to remove debris, including the remains of much of the riparian buffer. After this initial work, NH DES arranged for a fluvial geomorphic assessment of the river to guide the river restoration plan and to ensure that the river channel was restored to a condition that could soon achieve a stable equilibrium given the particular shape of its valley. The source of federal funds available to restore the river is, however, oriented to protecting private property rather than accommodating the science-based principles of river dynamics. Thus agencies and the community of Alstead repaired horrendous damage, but lost an opportunity to create a river system with long term stability.

"It is a great river and has big problems when it has them."

Vermont stream scientist

Flood preparedness - The amount of rainfall experienced in these storms was unprecedented, but such events must be anticipated. Building of homes and septic systems in floodplains is a dangerous practice. A number of septic systems were washed away during the Cold River flood, probably contaminating the Cold and Connecticut Rivers for many miles.

Good communication is essential before, during, and after a flood. Town officials, including road agents and members of all elected and appointed town boards, should meet annually to be sure all understand their roles with respect to stormwater and river management issues, and what emergency or other planning needs to take place. Towns should include local river advisory committees when plans are made for remediation of a river-related disaster. State law (RSA 483, Rivers Management and Protection Act) requires that a designated river's local advisory committee provide advice on issues relating to their river, such as agency response to a flood or other disaster.

While towns may not be technically liable for private property losses, the Cold River flood has demonstrated that towns do have strong ethical obligations to assist their residents after a large disaster. For this reason, towns should be planning for worst-case scenarios in their Hazard Mitigation Plans and Master Plans. Planning should account for the possibility of total loss of homes, lives and/or key businesses and seek to avoid such losses by preventing new floodplain construction and encouraging current floodplain occupants to reduce their risks or relocate.

Flood response - Among the effects of flooding are road and bridge washouts, prompting immediate activity on the part of transportation agencies. However, experience shows that the expertise of state environmental agencies is also essential to ensure that the road and streambank repair work that takes place is consistent with good river science. Much of the response to the Cold River flood might have been handled differently had NH DES been involved from the beginning, along with the Department of Transportation. The goal of flood response should be a healthy system river as well as providing the right information to towns and landowners.

Land owners and town officials will likely have questions about best management practices (BMPs) and permitting requirements for stabilization and landscaping work following a major flood, and a clear response or public communication from permitting agencies such as DES is needed. Key decisions about working in the streams, such as extent of debris removal, need for clear-cutting banks, placement of extensive rip-rap, backfilling of flood channels, earth-moving to protect homes, and the use of streams as highways for equipment, requires clear oversight by the state permitting agency and can benefit from the involvement of the local river advisory committee and conservation commission.

"Maybe the Alstead incident is the pot of gold at the end of the rainbow, to wake everybody up on the need to look at culverts and flood hazards."

Co-chair, Mt. Ascutney Region River Subcommittee

Culverts and bridges - Stream crossing information is important for disaster planning. Culverts and bridges must be sized properly in order to carry the water that might come their way, and consider geomorphic characteristics of the stream in addition to hydraulic capacity. River groups, such as the Cold River Local Advisory Committee, and regional planning commissions are helpful advisors in this area. A study by Michael Simpson at Antioch New England Graduate School in

Keene concluded that current engineering design specifications for culvert sizing is inadequate to handle the higher frequency of storms of greater intensity that can be expected with climate change.[1]

In other parts of the river valley, regional planning commissions are helping towns with surveys of their bridges and culverts, to identify those that may be too small and could be a public safety hazard in times of high water. Vermont has supported such work in this area, and nearly all towns on the Vermont side of the watershed, except for Vernon, now have bridge and culvert surveys that identify sites that are potentially hazardous. New Hampshire has not set this as a priority, and it is possible that such a survey would have identified the culvert on Warren Brook before the flood occurred. Other than a volunteer effort in the Ashuelot River watershed led by The Nature Conservancy and the Ashuelot Valley Environmental Organization, no bridge and culvert surveys have been done on the New Hampshire side of the watershed.

Many culverts are sized for a 50 year storm. Going back with today's knowledge and looking at culverts such as the one that failed on Warren Brook in the Cold River watershed could avoid future trouble. Funding is available for culvert replacement from several sources, especially for hanging culverts that create obstacles for fish passage. The USDA Natural Resources Conservation Service's Wildlife Habitat Improvement Program and Environmental Quality Incentives Program are among these sources. New Hampshire's Aquatic Resource Mitigation Fund will soon be another.

Role of mainstem dams in flood control - The dams on the mainstem of the Connecticut River were built for hydro power generation, not for flood control, although when possible, they are operated to help ease flooding in the Connecticut River. However, it is a mistake to assume that even the largest hydro dams are able to control flooding at all times. Following heavy rains in October, 2005, flood water exceeded storage capacity at both Moore and Comerford Dams many miles upriver at Fifteen Mile Falls, and flooding occurred below them. Wilder and Bellows Falls Dams are much lower dams whose impoundments have little room to store water to keep the Wantastiquet region from flooding. TransCanada operates the Bellows Falls Dam in coordination with Wilder Dam upstream and Vernon Dam downstream.

The role of ice in flooding - Ice jams can block the water's flow, sending it in a new path or causing sudden release and flooding as the jam breaks. Ice flow can damage the gate cylinders and seals at Bellows Falls, so river ice is monitored during spring runoff. TransCanada attempts to manage water levels at Bellows Falls to help prevent ice jams.

There have been three major ice-out events in the last century in this region. Ice jams created an extreme hazard during a fast ice-out in 1996, when ice backing up behind the Bellows Falls Dam was forced under the surface and caught on the submerged log boom structures that remained on the river bottom from the days of the log drives. Eddies and ice eroded a high sandy bank in North Walpole, threatening homes, Route 12, and the rail line that runs along the river.

---

1. Stack., L.J., M.H. Simpson, T.W. Crosslin, W.S. Spearing, and E.P.M. Hague, 2007. A point process model of drainage system capacity under climate change.

River dredging for flood control - Years ago, some rivers were dredged in the belief that this would create more storage room for flood water, and was actually encouraged by USDA and other resource management professionals at a time when sediment transport in streams and other stream mechanics were poorly understood. Contrary to expert advice and public opinion, extensive gravel mining contributed directly to the destabilization of river channels, increased bank erosion, and flood-related property damage as the streams began to readjust to their natural shape. The states no longer permit gravel dredging in rivers except under very limited circumstances. A better way to prevent flood damage is to restore a stable stream form and protect the stream corridor from incompatible development.

4. Climate Change and water resources

The extreme storms detailed above, which can have very damaging effects on smaller streams in particular, have been described as symptoms of climate change. According to the most recent research published by the Union of Concerned Scientists, climate change is already underway, and the Northeast can expect higher temperatures and shifting seasons, reduced snow cover, and more extreme weather.[1] How large these changes will be depends on emissions choices we make now and in the near future, both here in the Wantastiquet region, in the Northeast, and globally. The build-up of heat-trapping gases — primarily carbon dioxide, methane, and nitrous oxide – is already affecting the earth's climate, as human activities alter the chemical composition of the atmosphere.[2] During the 20th century, the average temperature in Hanover, N.H., increased 2 degrees F,[3] while in Vermont, the average temperature in Burlington increased 0.4 degrees F.[4]

Climate change may have important implications for water resources, including changes in stream flow, drought, snow cover, and flooding. Keene, N.H. has begun a program devoted to emissions reduction, setting an example for other towns in the region.

Precipitation - Climate change could do more than add a few degrees to today's average temperatures. Some places could be drier, others wetter. More important, more precipitation may come in short, intense bursts (more than 2 inches of rain in a day), which could lead to more flooding. Michael Simpson's findings in the Ashuelot River watershed indicate that high intensity storms, as a result of climate change, should be expected with greater frequency in this part of New England. Measurable increases in the number of heavy rain storms have already occurred across the Northeast in recent decades.[1] More flooding could lead to greater erosion and increases in sediment, fertilizers, and other pollutants in runoff. Ensuring that wetlands remain to act as sponges and encourage infiltration will be important.

Droughts - On a higher-emissions pathway, a short seasonal drought can be expected every year in most of New England by the end of this century, while the frequency of longer droughts could

---

1. *Climate Change in the U.S. Northeast. A report of the Northeast Climate Impacts Assessment,* Union of Concerned Scientists, Cambridge, MA, 2006.
2. *Climate Change 2007: the Physical Science Basis; Summary for Policy Makers. Intergovernmental Panel on Climate Change,* Paris, February 2007(3) Climate Change and New Hampshire. US Environmental Protection Agency, Office of Policy (EPA fact sheet 230-F-97-008cc), September 1997.
4. *Climate Change and Vermont.* US Environmental Protection Agency Office of Policy (EPA fact sheet 236-F-98-007aa), September 1998.

triple. On a lower-emissions pathway, the risk of drought is projected to be only slightly greater than today.[1] Such droughts could lower groundwater levels and affect the drinking water supply of some smaller towns and rural residents who depend on shallow aquifers and wells. Farmers finding reduced soil moisture in their fields due to drought and increased evaporation may turn more toward irrigation to satisfy their crops' water needs, at a time when river flow is already down, setting up a possible conflict between flows needed to support fisheries.

Snow pack - The number of days of snow cover is predicted to fall. With higher emissions, the Wantastiquet region will no longer retain snow cover for at least 30 days by the end of this century.[1] By contrast, lower emissions would result in a 25 percent reduction in snow-covered days. Therefore, while some winter warming and reduced snowfall appears inevitable, the most extreme change is not. Winter snow accumulation and spring melt strongly affect river flow. Precipitation that falls in early winter as rain rather than snow can run off frozen ground, rather than staying to melt in the spring. A warmer climate could also lead to earlier spring snowmelt, and result in higher streamflows in winter and spring and lower streamflows in summer and fall.

Stream flow - During the summer, the flow of many rivers and streams is typically down, creating low water levels and putting stress on fish and other aquatic life. Fall rains usually bring the streams back up, and conditions improve. With higher emissions, however, projections show that stressful low water levels could occur nearly a month earlier in the summer and persist almost a month longer into the fall. With lower emissions, the low-flow period is expected to expand by roughly two additional weeks in fall.[1]

Because evaporation is likely to increase with warmer temperatures, and over a longer growing season, it could result in lower river flow and lake levels, especially in summer. Warmer water temperatures also reduce dissolved oxygen, adversely affecting fish habitat, and lower summer streamflows could reduce the ability of rivers to assimilate waste. Less flow in summer streams could mean less dilution of pollutants and poorer water quality. Minimizing thermal discharges to the river is important in the face of rising ambient water temperatures.

State action - Both New Hampshire and Vermont have adopted state climate change action plans:

New Hampshire Climate Change Action Plan - http://des.nh.gov/organization/divisions/air/tsb/tps/climate/index.htm

Vermont Comprehensive Energy Plan and Vermont Greenhouse Gas Action Plan, 1998 - http://publicservice.vermont.gov/pub/state-plans-compenergy.html

Recommendations for flow and flood control

- The U.S. Army Corps of Engineers should continue to communicate effectively with TransCanada about releases from flood control dams for effective flow management in the

1. *Climate Change in the U.S. Northeast*. A report of the Northeast Climate Impacts Assessment, Union of Concerned Scientists, Cambridge, MA, 2006.

Connecticut River.

- New Hampshire should aggressively promote bridge and culvert surveys, by providing funds to the regional planning commissions to work with town road agents to do this work. RPCs should include culvert issues in their transportation planning. Vermont should provide funds to assist Vernon with a bridge and culvert survey.

- State and town road managers should ensure that culverts are large enough to handle a heavy flow; bigger box culverts are advised. Ensure that there is an adequate abutment around bridges for protection during heavy flow.

- Town officials should meet regularly to discuss emergency planning, and include local watershed groups in river-related discussions. States should encourage a mechanism for towns to alert and include local advisory committees, conservation commissions, and other water related organizations when plans are made for remediation of a river-related disaster. NH DES and VT ANR should each develop a coordinated approach to river-related disasters such as floods and contaminant spills, and assign an agency staff person to ensure that there is good communication between the state environmental and transportation agencies, town officials, conservation commissions, and local river advisory committees or watershed groups. Response to floods should be based on good river science.

- Landowners, towns and state/federal agencies should more aggressively protect and plant vegetated buffers.

- The Federal Emergency Management Agency should advise towns on potential technical and financial assistance to help them identify potential flood and erosion hazards.

- Road crews and landowners should watch for fallen trees upstream of smaller culverts and bridges, and cut large woody debris into smaller pieces or remove it in these locations. Road crews need to keep brook culverts clean, especially if there is beaver activity that contributes to woody debris in a stream's watershed.

- State water quality agencies should minimize thermal discharges to the river in anticipation of increasing ambient river temperatures resulting from climate change.

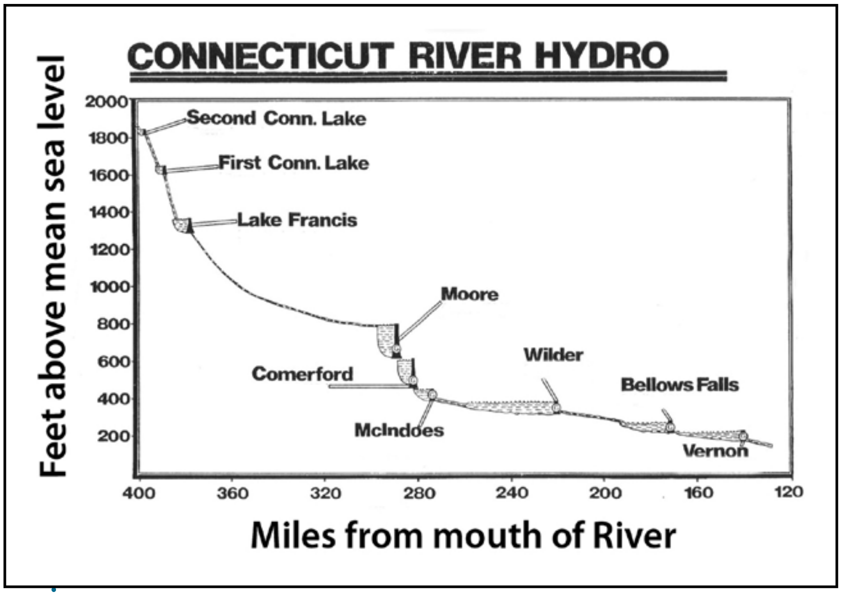
- State water quality agencies should take an active role in educating people to promote riverbank stability; encourage riverfront homeowners to plant and maintain buffers of natural vegetation along the riverbank to help protect it during times of heavy flow.

- Area towns should encourage reduction of carbon dioxide emissions, following the example of Keene.

- Towns should adopt ordinances prohibiting building in the 100-year floodplain to protect their citizens and businesses from damage, avoid contributing to flooding of their downstream neighbors, and reduce the public cost of disaster relief.

V. Working River - Dams

Two major hydropower dams influence the Wantastiquet segment of the Connecticut River mainstem: Bellows Falls and Vernon Stations. TransCanada Hydro Northeast purchased both from USGen New England in 2005. Their federal operating licenses expire in 2018 with that of Wilder Dam. Both are daily peaking generation plants, storing and releasing water during periods of the day, and are controlled remotely by an operator upstream at Wilder Dam. The timing and amount of this release depend upon flow conditions in the river and upon market price for electricity. It takes about four hours for a pulse of water to travel from Bellows Falls to Vernon. The Wantastiquet reach of the Connecticut River is also influenced by operations at the Northfield Mountain Pump Storage Station in Northfield, Mass.



Location of Bellows Falls and Vernon Dams on the upper river. From New England Power Company.

Dams have both positive and negative effects on the local economy and the environment. They provide renewable electric energy and contribute to a town's tax base. The Vernon and Bellows Falls impoundments provide deeper water for power boating, which was not possible on much of the river until the dams were built, although the presence of the dams also interferes with recreation, forcing paddlers to portage their craft. At Bellows Falls, the portage is 1.5 miles long.

While dams create new habitat for some species of fish and wildlife, they block passage for other species of fish. TransCanada's predecessors invested in both upstream and downstream fish passage at Vernon and Bellows Falls to remove this obstacle for both migratory and resident fish, and the Bellows Falls station includes an underwater window for viewing fish in the ladder. Walleye, perch, and bass now inhabit the warmer water of the impoundments, using the shallows of tributary setbacks for spawning.

Dams create impoundments that slow the movement of water, allowing it to warm up, evaporate, and lose oxygen, thus reducing the river's ability to clean its waters and affecting conditions for fish and other aquatic life. Dams also break up ice, reducing the potential for scour, ice jams and related erosion downstream. The impoundments can trap nutrient-rich sediments, reducing or preventing enrichment of the river's floodplain soils.

Because Bellows Falls and Vernon dams are operated in a peaking mode, where water is alternately stored and released, they can affect the stability of riverbanks and impoundment shorelines, sometimes creating erosion. Rapidly changing water levels can cause pressure imbalances at the water-saturated bank face, causing water to seep out of the bank and carry small particles of soil with it. This is called soil piping, and it can contribute to bank collapse. Sending large amounts of impounded water into the tailrace can also abruptly change water temperatures, which can affect spawning and other fish movements.

There are currently no required “ramping rates,” or controls on the suddenness with which water is stored and released, for either dam. The VT DEC noted in 2002 that peaking hydro generation at this dam results in flows fluctuating severely in the bypass reach (1,000 to 10,000 cfs with no ramping).

Federal license for Bellows Falls and Vernon Dams - The renewal of the dams’ federal operating license in 2018 is an opportunity to consider changes in the dams’ operating procedures and other aspects of managing the dams and associated property. If TransCanada decides to select an Integrated Licensing Process to prepare for re-licensing, as it did with the series of hydro dams upstream at Fifteen Mile Falls, the company will invite federal and state agencies and other interested organizations to participate in shaping the terms of the new license. These terms would be negotiated over a period of five years, beginning in 2013, with a diverse group of stakeholders.

A. Bellows Falls Dam

The Bellows Falls Dam is located between the villages of Bellows Falls, Vt. and North Walpole, N.H. It sits at the head of the 60-foot thundering cascade where the river narrows at the base of Fall Mountain. Once known as the Great Falls, this gorge has been the upstream limit for migrating American shad and a focal point for fishing for perhaps nearly as long as the river has run. The original bed of the river at this rocky chasm is now largely dry for 1,700 feet, except in spring, as the river is diverted through turbines at the dam.

There has been a dam on this site since the late 1700s. The current powerhouse, located on the Vermont side, occupies the site of the first canal built in the U.S., in 1802, to bypass the falls. Through the next two centuries, the river powered the growth of major paper factories, including International Paper Company.

Bellows Falls generates hydroelectric power by operating as a daily peaking facility. It is equipped with two 115-foot long roller gates and three stanchion board bays, a 1,700 foot long canal 100 feet wide, skimmer gate, a powerhouse, and associated switch yards. The roller gates are used to pass high water flows up to approximately 68,000 cfs. Flows greater than this require dropping the stanchion bay boards. The Bellows Falls Dam has limited water storage, of about 7,476 acre-feet of water in three feet of drawdown.

For the first 75 years of its operation, Bellows Falls was fully staffed 24 hours/day, 7 days/week. In 2005, the station was automated and is now controlled by river managers at Wilder Dam. The town of Rockingham pursued a possible purchase of the Bellows Falls Dam for several years, although voters eventually rejected the idea in 2005.

Table 3. Mainstem Dams in the Wantastiquet Region		
	Bellows Falls Dam	**Vernon Dam**
Owner	TransCanada Hydro Northeast	TransCanada Hydro Northeast
Date constructed	1928	1909
Location	Bellows Falls VT and North Walpole, NH, river mile 174	Vernon VT and Hinsdale, NH, river mile 142
Dam type	concrete	concrete
Operating limits	288.6 feet to 291.6 feet above mean sea level	212.1 feet to 220.1 feet above mean sea level
Normal operating range	289.6 and 291.6 feet above msl	218.8 feet to 220.1 feet above mean sea level
Required minimum flow	1,083 cfs or inflow, year round	1,250 cfs or inflow, year round
Spill capacity	58,800 cfs	61,349 cfs
Fish passage	upstream (since 1984) and downstream	upstream and downstream
Impoundment	approximately 30 miles, 26,900 acre feet at full reservoir; surface area of 2,804 acres	approximately 26 miles, surface area of 6,266 acres
Generating capacity	49 megawatts (3 turbines)	32 megawatts (8 turbines including 4 new)
Watershed drainage area	5,414 square miles	6,266 sq mi
Bypass length	1700 feet	none
Rated hazard potential	high hazard potential	high hazard potential

B. Vernon Dam

Vernon Station's "deep gate" design includes eight 7 x 9-foot gates at a depth of 52 feet which help flush sediment through the dam and minimize siltation in the reservoir behind it. Ice movement and inflows are monitored closely at both Bellows Falls and Vernon Dams. Ice was a major problem at Vernon until its 140 feet of pinned flash boards were replaced with stanchion bay boards in 1991. Ice has not damaged them since that time, although some people are concerned about possible further inundation of the shoreline. Since the hydraulic flash boards were installed, four culverts built in the 1800s by the railroad near Liscomb Brook in Hinsdale are inundated, and now have to be regularly cleared of silt. Impoundment fluctuations are of concern because they influence water levels of nearby wetlands like Retreat Meadows.

In 2006, a project began to install four new units at Vernon Dam, replacing four that were so unreliable and difficult to run that they were not being used. The dam is authorized for 44 megawatts (MW) but with the new units will be about 32 MW and more efficient to operate.

Vernon Dam has regulated the flow of much of the Wantastiquet reach of the Connecticut River for a full century.

C. Northfield Mountain Pump Storage

Northfield Mountain Station is a pumped storage, hydroelectric generating station owned by FirstLight Power Resources Company. It was the largest facility of its kind in the world when it went into service in 1972. The plant is located in Northfield, Mass., about 5.5 miles up the Connecticut River from Turners Falls Dam. A 20-mile stretch of the Connecticut River from Turners Falls to Vernon Dam serves as the station's lower reservoir.

During periods of lower electrical power demand, usually at night, the plant pumps water from the river to a man-made upper reservoir. This has the effect of lowering the Connecticut River by approximately two feet and causing piping of water from the face of the riverbank. The 300-acre upper reservoir, 800 feet above the river, is capable of storing 5.6 billion gallons of water. To produce electricity, water is released to flow downhill through a turbine generator. Its underground powerhouse, 700 feet below the surface, includes four large reversible turbines, each of which can pump about 20,000 gallons of water per second and generate 270,000 kilowatts of electricity. Water levels generally come up more slowly than they go down in response to operations at the station. The 1,080 megawatt plant is entirely underground and its operation does not depend upon the natural flow of the river.

Although Northfield Mountain is located downstream in Massachusetts, the operations of the pump storage station affect the river in New Hampshire and Vermont by creating erosion and sedimentation. Riverbank data from 2004 for this reach indicates that approximately 9.25 miles (48,845 linear feet) of bank are actively eroding. This study identified a total of 10,170 linear feet that are contributing approximately 836,000 cubic feet of sediment to the river per year, causing significant turbidity[1].

New Dams - No new dams may be built on the Connecticut River mainstem in the Wantastiquet region under the New Hampshire Rivers Management and Protection Act. In river segments designated "natural," "rural," or "rural-community," the Act allows repair of a dam which was in place when the river was designated in 1992, at the same place and with the same impoundment level, but only within six years of the failure. The two designated "community" segments, which run from the southern side of the Williams River to the Saxtons River and from Sprague Brook to just below the Vernon Dam, embrace the Bellows Falls and Vernon Dams. In these selected areas, the Rivers Act permits hydroelectric production, dam repair and replacement, and flood control.

Tributary dams - There are a number of dams on Connecticut River tributaries in this region, ranging from farm pond berms to major flood control dams, dams powering industrial use, and others, some of which are being refurbished to supply hydro power. Such dams may be valuable as an energy source in the future, and should be carefully designed for fish passage. Many farm pond dams funded by the USDA Natural Resources Conservation Service were installed in the

---

1. *Erosion Control Plan for the Turners Falls Pool of the Connecticut,* 2004 Full River Reconnaissance Report. January 28, 2005. Prepared for Northeast Generation Services, FERC No. 2485 and 1889.

1930s and 40s and some may not have been maintained. In 2005, a small private dam near Townsend State Park failed, sending a load of bacteria into a nearby stream. Other dams may be physical or public safety hazards. Surveying the condition of these dams should be considered.

Recommendations for Dams

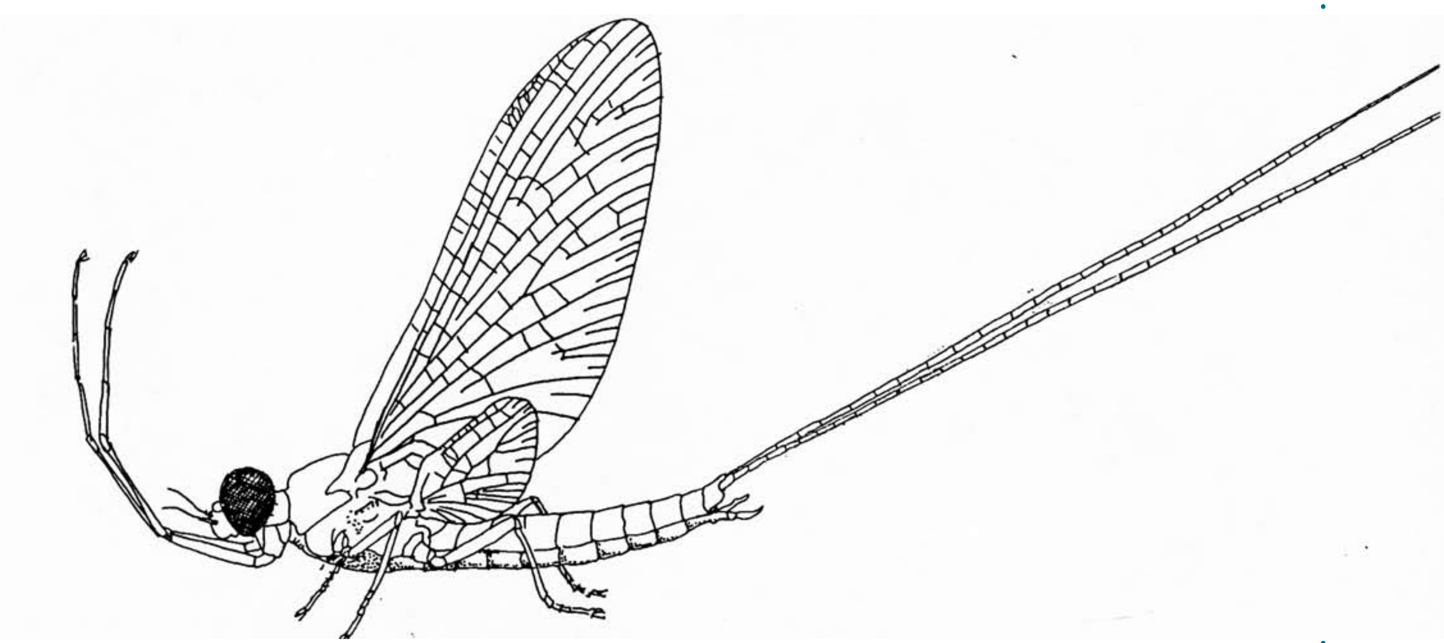
- The Federal Energy Regulatory Commission (FERC) should encourage citizen participation in dam relicensing, and fund state and federal resource agencies to review the water quality effects of dams on the Connecticut River and its tributaries to balance the hydro power generation use with water quality uses and values. FERC should require site specific studies of impact, usage, resource studies of fish and erosion by the licensees at both the Vernon impoundment and downstream from the dam.

- State water quality agencies should study further the impact of dams on water quality, look closely during dam relicensing at whether the historic low flow is an adequate minimum flow requirement, and conduct regular safety inspections of dams in the region. Seek funding for the removal of hazardous dams or those that obstruct fish passage, with landowner permission.

- Local citizen groups should participate in the relicensing process for Vernon and Bellows Falls Dams.

- The Federal Energy Regulatory Commission should include best management practices such as a slower, more natural raising and lowering for the ramping rate in the 2018 license for Bellows Falls and Vernon Dams. Include a provision for emergency gate operation, such as in the context of a "black start" when the dam is needed to provide immediate power in case of a blackout.

- Dam owners should strongly consider removing dams whose costs outweigh the benefits they offer or are a threat to areas downstream, and investigate sources of funding assistance for dam removal.



VI. Using the Water

A. Water Withdrawals

Water withdrawals from the river could influence the instream flow of the river, even here in the Wantastiquet region where it has gained substantial size. Its status as a designated river in New Hampshire's Rivers Management and Protection Program shields the Connecticut River from actions that would divert its water outside of New Hampshire's portion of the watershed.

1. New Hampshire water withdrawals

New Hampshire requires registration of water withdrawals over a certain size, but does not require a permit unless there is a physical disturbance to the river. There is no charge for using the public's water, and at this writing, no flow level below which withdrawals could not be allowed. This registration program helps identify potential future problems of well interference, declining water tables and/or diminished streamflows but does not actually limit withdrawals or provide a means of avoiding these problems (see box).

The water quality of the mainstem is acceptable for irrigation and industrial water supply, and there are six registered water withdrawals on the New Hampshire side of the mainstem in this segment: three for water suppliers, one for mining, one for irrigation, and one for the Cheshire County Complex. A list of registered water withdrawals appears in Appendix H.

NH policy on surface water withdrawals

New Hampshire requires registration of water withdrawals with the N.H. Geological Survey of DES that exceed 20,000 gallons per day averaged over any 7-day period from a single location or exceed a total of 600,000 gallons during any 30-day period. Once registered, monthly water use must be reported on a regular basis as long as the source is being used. No permit is required unless the withdrawal involves a physical disturbance to the bed or banks of the river. Examples of those affected uses include: water supply for domestic, commercial, industrial or institutional use, dilution of treated or untreated municipal or industrial discharges, including industrial process water, contact and non-contact cooling water, water for agricultural irrigation and snow making, and water used for power generation.

VT policy on surface water withdrawals

The proper management of water resources now and for the future requires careful consideration of the interruption of the natural flow regime and the fluctuation of water levels resulting from the construction of new, and the operation of existing, dams, diversions, and other control structures. These rules provide a means for determining conditions which preserve, to the extent practicable, the natural flow regime of waters. Act 250 and Stream Alteration permits may be needed, as well as a permit from the U.S. Army Corps of Engineers and a Section 401 Water Quality Certification. For most types of water withdrawals, the Agency has adopted a procedure for determining the minimum streamflow necessary to meet Vermont Water Quality Standards.

2. Vermont water withdrawals

Vermont requires permits for water withdrawals from in-state waters, limiting them to the "7Q10" level, which means a drought flow equal to the lowest mean flow for seven consecutive days, adjusted to nullify any effects of artificial flow regulation, that has a 10 percent chance of occurring in any given year. However, the state has no formal system for tracking withdrawals from the Vermont side of the Connecticut River. The amount of water that would otherwise have flowed in the Connecticut River from Vermont is unknown.

Recommendations for water withdrawals

- State water quality agencies should consider tiered user fees for consumptive water withdrawals over a threshold which will not impact small users but which will encourage water conservation by larger users.

- Vermont should explore a water withdrawal registration program.

- States and towns should determine whether local approval of water withdrawals over a certain amount is needed.

B. Groundwater and Drinking Water Supplies

Clean drinking water may be our region's most valuable but under-appreciated commodity. In the Connecticut River watershed, stratified drift aquifers, where large stores of groundwater are available, are closely associated with the river and its tributaries. Surface water and groundwater are closely linked. Groundwater feeds the river's flow, and the water beneath the river feeds groundwater. Pollution in groundwater can therefore pollute a nearby stream and vice versa. No individual actually owns groundwater.

1. Identifying groundwater supplies

Stratified drift aquifers have now been mapped for the state of New Hampshire. New Hampshire's state geologist is pursing even more detailed mapping in the Connecticut River valley to give a more precise idea of where water supplies are located, and the Wantastiquet Region has the most detailed information in the Connecticut River valley. Surficial geology maps have been completed for Walpole, Westmoreland, Chesterfield, and Hinsdale, also covering adjacent parts of Putney, Dummerston, Brattleboro, and Vernon. However, these maps were produced in an older computer program and need to be converted to Arc-GIS to make them more useful to land use planners.

Vermont's aquifers have not been mapped as comprehensively as New Hampshire's, although the state is now moving in this direction. An older set of maps covering most of Vermont called "Groundwater Favorability maps" show rough aquifer delineations based on surficial geology. Source Protection Area maps are available for Vermont community water systems.

Groundwater regulation by the states - In New Hampshire, DES has regulated new groundwater withdrawals for public community water systems since 1991, to ensure that these wells have a sustainable yield and are sited in appropriate places, Since 1998, the state has regulated all groundwater withdrawals larger than 57,600 gallons/day. The legislature's intent is to prevent harm to existing water users and nearby ponds, streams, and rivers from large withdrawals at a new well, such as for a bottling plant. Such withdrawals can pull water that had been supplying nearby wells and providing the base flow of streams. Large withdrawals that affect groundwater levels can cause nearby surface water levels to retreat; wetlands, ponds, and streams can shrink or dry up, and wells can be similarly affected.

Vermont requires that new public community water systems have delineated the areas from which the groundwater is drawn, with potential sources of contamination identified. However, without a statewide policy on groundwater withdrawal, and without adequate aquifer mapping, Vermont until recently remained a target for commercial water bottling companies looking for private profit from a resource that belongs to the public.

2. Threats to groundwater

Groundwater, which many residents pump into their homes for drinking, can be contaminated by a long list of pollutants which are difficult if not impossible to remove. Septic systems located within the floodplain and inadequate or failed septic systems are a problem because they can send disease-carrying pathogens, and whatever else homeowners put down the drain, to groundwater which may also reach the river. Leaking underground fuel storage tanks remain a problem in many of the villages in the Wantastiquet region. Other possible sources of groundwater contamination are chemical spills, pesticide application areas, leaking sewer lines, junkyards, auto service centers, dry cleaners, industrial sites, sludge piles and lagoons, landfills, metal-working shops, improperly built manure storage, and even cemeteries. Both states have set up permitting programs to eliminate groundwater contamination by the improper disposal of waste.

Salt contamination is a growing concern. Salt above a certain level in groundwater makes the water unhealthy for drinking, since it can lead to high blood pressure and other diseases. Salt dissolves easily in water and can reach groundwater through road salting, road salt storage areas, and places where snow is dumped, since there is often road salt mixed with the snow. For more on this issue, see Roads and Railroads on page 58.

Groundwater contamination by MtBE - The gasoline additive MtBE (methyl tertiary butyl ether), which was introduced after lead was removed from gas in the 1980s and was intended to increase the octane rating and reduce air pollution from burning gasoline, proved to be a worrisome problem for groundwater. MtBE is considered a possible carcinogen. It degrades very slowly, is colorless, and is highly soluble in water. Leaking underground fuel storage tanks allowed this contaminant to pollute groundwater in southeastern New Hampshire. In Vermont, MtBE contamination has been discovered near the Main Street Service Center in Putney and also in Westminster village wells. It may also be present elsewhere in the region, but has not yet been picked up. The State of New Hampshire offered free testing of private wells for MtBE in 2005.

3. Protecting drinking water supplies

Recent studies demonstrate that conserving land to protect drinking water quality makes good economic sense. A study of 27 surface water supplies in watersheds with 10 to 60 percent forest cover found that the more forest cover in a watershed, the lower the water treatment costs. For every 10 percent increase in forest cover, treatment and chemical costs decreased approximately 20 percent.[1]

While clean drinking water is essential, few communities have taken steps to protect its source. A New Hampshire study in 2000 showed that only 11 percent of lands through which water flows to sources of public drinking water are protected by ownership or conservation easement, and 39 percent of community water systems do not even own the sanitary protective radius around their wells (75-400 feet).[2] Local regulations regarding groundwater protection are summarized in Appendix G. In the Wantastiquet region, Walpole has identified a public well supply area and Hinsdale has a wellhead protection program, but no New Hampshire towns have groundwater protection regulations or regulate the use of land on top of underground water supplies. On the Vermont side, Putney and Brattleboro have most or all of these protections in place.

New Hampshire's Source Water Protection Program offers grants to help communities conserve land around their public water supplies to protect the quality of the water that reaches the wells. Vermont currently offers low interest loans from the Drinking Water State Revolving Fund for public water supply protection, but not a specific grant program. However, each state's conservation license plate program offers grants that can be used to protect water supplies.

Recharging groundwater - The quantity of groundwater is as important as the quality. If groundwater supplies drop, there is less water to feed both wells and streams. Prolonged drought is one of the few causes of reduced groundwater levels that people cannot control. Changing the surface of the soil, such as through paving, development, or diversion through storm drains, prevents rain and melting snow from soaking into the soil to restore (or "recharge") groundwater. By building many small vegetated areas such as "rain gardens" to capture water that might otherwise have run off, and keeping impervious surfaces and development on steep slopes to a minimum, careful developers can invite water to soak in and recharge groundwater as it might have naturally before development. Development designs should include plans for encouraging stormwater retention on site.

Sometimes the groundwater is withdrawn and not replaced in the same watershed, such as by bottling companies who sell the water out of state. Imagine water pumped from an aquifer in Westminster to be sold as bottled water in Burlington. The water will not return.

---

1. *Protecting the Source: Land Conservation and the Future of America's Drinking Water,* Trust for Public Land and the American Water Works Assn., 2004.
2. Research funded by NH DES and performed by the Society for Protection of New Hampshire Forests.

Recommendations for groundwater

- Towns should protect groundwater recharge areas and consider a wellhead protection program such as Hinsdale's to save money in sampling costs; provide information on wellhead protection to new property owners.

- State water quality agencies should distribute accurate maps of aquifers and aquifer recharge areas to the towns as soon as they are available.

- Towns and state agencies should not permit landfills, salvage yards, and junkyards to be located on aquifers.

- Towns should work with regional planning commissions or with larger neighboring towns to offer more frequent hazardous waste collections.

- Vermont should map its aquifers.

- States should be vigilant about possible MtBE contamination and encourage the use of alternative fuels.

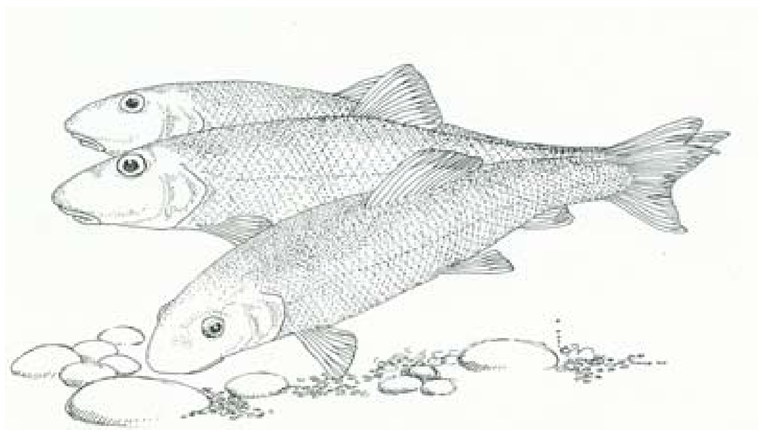
- Towns and regional planning commissions should educate people to keep their septic systems in good shape, to handle automotive fluids, pesticides, and other chemicals properly so they don't contaminate their own wells, and to select less hazardous alternatives.

- Developers should keep natural drainage patterns and use pervious paving, swales and depressions ("rain gardens") in their projects to reduce runoff, and plan for stormwater retention and infiltration on site.

- Communities and state highway crews should ensure that road salt supplies are properly stored so they do not contaminate surface or groundwater.

- Towns should enforce shoreline setback requirements for buildings such as garden sheds and garages that could be used to store hazardous materials.

- Town fire and highway departments should have up to date training in the proper handling of spills.



VII. Land Use & Water Resources

A. Point Source Pollution - Wastewater Discharges

The Connecticut River has long served to take away wastewater from Wantastiquet area residents and businesses. Thanks to the Clean Water Act and major local investments, the wastewater the river carries today is much cleaner than it was in years past. Many of the area's wastewater treatment plants were built 30 to 40 years ago, when substantial federal assistance was available. At that time, the federal government bore 80 percent of the cost of construction and the state contributed 10 percent. The government's participation has evaporated in the years since, leaving towns responsible for the expensive burden of upgrading their plants to meet new needs. This financial help to protect public waters is drying up, although towns must maintain and in some cases improve their aging facilities, which can be a costly proposition.

1. Direct discharges

Careful management of wastewater discharges is important for public safety and for the health of the streams that receive these discharges. Any facility that discharges directly to surface water is required to obtain a federal permit, called a National Pollutant Discharge Elimination System (NPDES) permit. EPA regulates this program, and in New Hampshire EPA issues these permits. The Department of Environmental Services must certify that the limitations and conditions of the NPDES permit will ensure that the proposed discharge will not violate any state law or regulation. EPA has delegated this responsibility in Vermont, where permits are issued by the VT DEC.

In 1957, in an effort to clean up Brattleboro's smaller streams, sewage from all downtown businesses was collected and piped directly into the Connecticut River, untreated. Then, in 1960, the town built a facility to treat this discharge. Phosphorus readings in the Ashuelot River increase downstream of Keene. Keene has funds to improve its phosphorus removal but is awaiting an updated discharge permit from EPA which will dictate the level of phosphorus to be discharged, and the WWTF is prepared to upgrade to meet the limit.

Subcommittee members have occasionally observed what appears to be raw sewage floating in the river between Westmoreland/Westminster and Putney/Chesterfield. The source of this discharge is unknown.

2. Combined sewer overflows

Combined sewer overflows (CSOs) can allow runoff from a heavy storm to mix with untreated sewage, sending it into the river. River contamination is therefore more likely during and immediately after heavy rainfall. Eliminating CSOs is an expensive burden on upstream towns such as Lebanon, Hartford, St. Johnsbury, and Springfield. The Wantastiquet region is fortunate that the long-urbanized communities in the area, Brattleboro and Keene, have always had separate stormwater drainage and sewerage systems. Brattleboro's records in this regard date back to the 1800s.

Table 4. Public Wastewater Treatment Plants in the Wantastiquet Region

Wastewater Treatment Plant	condition of discharge	comments
Bellows Falls WWTF	meets state standards	annual average flow = 504,000 gal/day; permitted to discharge 1,500,000 gal/day
Saxtons River WWTF	meets state standards	annual average flow = 33,567 gal/day, permitted to discharge 105,000 gal/day
Cheshire County Home WWTF	improved after upgrade	lagoons built close to the river; received protection from erosion in 2007
Keene WWTF (Ashuelot River)	releasing significant amounts of phosphorus	repairs to the facility await a decision by EPA on phosphorus standards
Putney WWTF (to Sackett's Brook)	meets state standards	annual average flow= 57,100 gal/day; permitted to discharge 80,000 gal/day
Brattleboro WWTF	meets state standards	annual average flow = 1,479,583 gal/day; permitted to discharge 3,000,000 gal/day, done 20 year evaluation, have preliminary design for upgrade
Hinsdale WWTF (to Ashuelot R.)	generally good	adequate capacity if inflow/ issues are addressed and growth does not accelerate.

Pharmaceutical and personal care product pollutants - Many substances, some harmful and some not, can pass through wastewater treatment systems and are not removed before the water is discharged into rivers and streams or when septic system leachate passes into groundwater. Scientists have only been able to detect these chemicals in streams since about 2000, and little is known about their effect upon groundwater. In 2002, 80 percent of streams sampled (139 rivers in 30 states) by the U.S. Geological Survey showed evidence of drugs, hormones, steroids, and personal care products such as soaps and perfumes.[1] While no studies have been done in the Connecticut River watershed to see whether this is a problem, disturbing evidence of the effects of these chemicals has been found in deformed fish in other rivers, including the Potomac and Shenandoah.

Painkillers, antibiotics, contraceptives and other hormones, chemotherapy drugs, and other medicines can pass through the body and through a wastewater treatment plant. Antibiotics flushed down the toilet can harm the beneficial bacteria that break down waste in septic systems and wastewater treatment plants. Hormones, fragrances, other substances have been detected in all urbanized and farm-intensive watersheds in the United States. Cosmetics, cleaners, insect repellant, and even nicotine and caffeine have been detected in some studies of waterways. Wastewater treatment plants are not required to change their procedures to remove these chemicals. Most tend to be largely removed or broken down but remain in sludge, where they usually do not mix with water but could become a problem if biosolids erode into streams or if

1. Kolpin, D. W.; et al. *Pharmaceuticals, Hormones, and Other Organic Wastewater Contaminants in U.S. Streams, 1999–2000: A National Reconnaissance. Environ. Sci. Technol.* 2002, 36, 1202–1211.

pH changes. Biosolids aged more than 15 days are safer than fresher sludge.
Recent studies indicate that half of antibiotics produced are given to farm animals, which metabolize only 10-30 percent. The antibiotic level in manure slurry is thousands of times higher than municipal wastewater, landfill leachate, or sludge. Research suggests that soils rich in clay and iron oxides will be good at holding antibiotics in land-applied manure, although adding lime or phosphorus to cropland could prompt release into waters.

For years, patients have been told to discard unused or expired medications by flushing them down the toilet, where they go directly into the wastewater stream. Federal rules for disposal of controlled medications have not changed since the 1970s and require the presence of a law enforcement officer. The conventional method of disposal in many hospitals, hospices, and nursing homes is to flush unused narcotics and other medications after the death of a patient, even when they are enclosed in sterile packaging and could be reclaimed for use by other patients.

A better way to dispose of these materials is urgently needed. In February, 2007, EPA advised that individuals wishing to dispose of medicines could add a small amount of water to solid drugs and flour, kitty litter, or sawdust to liquid medicines before capping, double sealing, and placing in the trash. To protect its surface waters and drinking water supplies, Maine began to experiment with collections of unused drugs in 2005 and in 2006, began allowing residents to mail unused drugs to the state. However, more direction is needed.

Industrial discharges - A number of industries discharge wastewater to the river and its tributaries, with NPDES permits.

Table 5. Industrial discharges to the Connecticut River in the Wantastiquet Region

Industry	Receiving water	comments
Putney Paper Company	Sackett's Brook	treated paper mill wastes
Fiber Mark	Connecticut River	treated paper mill wastes
Barrows Coal	Connecticut River	treated storm water
Vermont Yankee	Connecticut River	house heating boiler blowdown, circulating water, cooling water, sand filter backwash, storm water, screen backwash, and rarely, tritiated water.
Bradley Laboratories	Connecticut River	treated contaminated groundwater

Source: NH DES

3. Vermont Yankee Nuclear Power Station

This nuclear power plant, which has been producing electricity since 1972, is situated on the banks of the Connecticut River in Vernon, Vermont approximately 3/4 mile upstream of Vernon Dam. There is an extensive record of river conditions and biological sampling conducted by the facility with oversight from the states of Vermont, New Hampshire, and Massachusetts.

The plant was constructed with cooling towers. Shortly after it went on line, plant managers requested and in 1978 received a permit to discharge heated water to the Connecticut River in the cooler months of the year, to help avoid some of the costs of using the cooling towers for this purpose. Warmer water is discharged when there is enough flow to mix it. There is an upstream ambient river temperature monitoring station and another located one half mile below Vernon Dam.

The plant was purchased by Entergy, Inc., and in 2003 applied for permission to increase the plant's production by 20 percent beyond that for which it was originally designed. Cooling tower motors have been increased in size to handle the upgrade. An agreement reached with the state of Vermont includes a $20 million payment to Vermont that the state intends to apply not to the Connecticut River, where the discharge takes place, but to benefit the Lake Champlain watershed on the opposite side of the state. For lack of a better solution, radioactive waste is stored in "dry casks" on the station's riverfront property.

Vermont Yankee Nuclear Power Plant in Vernon withdraws water for cooling from the Connecticut River, returning it at a higher temperature.

Entergy has also applied to increase the temperature of its discharge by 2 degrees F to the Connecticut River. There have been minor discharge temperature violations over the years, partly due to the fact that the ability of the river to assimilate a warm water discharge (20 degrees over ambient river temperature) depends on how much water is flowing in it. Legal challenges to the Vermont decision to issue a permit for this thermal discharge have not yet been resolved.

Temperatures sometimes reach high levels even without discharge from Vermont Yankee. The impoundment of Vernon Dam also serves to increase the temperature of the river, as the dam slows river flow and allows it to heat up in the sun, and tributaries such as Whetstone Brook draining urbanized areas deliver warmed water of their own. Fisheries agencies have asked that the temperature increase in discharge from the plant not occur in mid-May to mid-June to avoid effects on migrating salmon and shad. These coldwater anadromous fish return from the ocean during this time period to spawn, including in Vermont's West River.

Approximately 3,800 cfs of flow is needed to absorb the increased temperature discharge, yet there are times, such as August 2001, when the river was flowing at less than half that (1,655 cfs at the North Walpole gage). There is not always sufficient flow in the river to adequately dilute the warm water discharge before it arrives below Vernon Dam. Even when there is, flow may be irregular due to normal operations of the dams at Bellows Falls and Vernon. Operators at Vermont Yankee formerly depended upon power company staff at Vernon Dam to communicate with them if there would be an anticipated a change in flow so they could adjust the temperature and flow of their discharge, but now that the hydro dams are automated and controlled from a more distant location (Wilder Dam), this communication is less effective.

The Subcommittee is concerned about the biological effects on fish and other aquatic life if thermal criteria are relaxed, and about storage of radioactive waste on the banks of the river. The 1997 *Connecticut River Corridor Management Plan* cautioned about the limited ability of the Vernon pool to accept more wastewater. Warmer water holds less oxygen which can further reduce its ability to assimilate waste.

Recommendations for wastewater discharges

- EPA should decide upon standards for phosphorus in wastewater treatment plant effluent so that Keene can move ahead with effective phosphorus removal. Provide funding to help towns add phosphorus removal to their wastewater treatment facilities.

- State water quality agencies should study proposed additional discharges for the river, examining the specific area to see if it can assimilate the additional waste load and still meet the water quality standards of both Vermont and New Hampshire.

- In the tradeoff between the cost of running the cooling towers at Vermont Yankee and the cost to the river, state and federal regulatory agencies should assign more value toward the river.

- State water quality agencies should continue to monitor and enforce procedures at wastewater treatment facilities.

- The US Fish & Wildlife Service and EPA should update standards for disposing of unused and out-dated medicines, and assist area solid waste districts in educating consumers about proper disposal. Rather than flush these medicines, consumers should wrap them and dispose of them in household trash. Pharmacies should help educate consumers about proper disposal of unused and out-dated medicines by applying a label to the packaging.

- VT ANR and NH DES should identify and eliminate the source of the raw sewage observed in the part of the river between Westminster/Westmoreland and Putney/Chesterfield.

- Citizens discovering a suspicious pipe or pollutant should contact the NH DES or VT DEC.

B. Non Point Source Pollution

Significant amounts of organic matter and nutrients are believed to be entering the Wantastiquet reach from streambank soils, agricultural runoff, tributaries, and upstream sources. These sources of pollution are sometimes difficult to identify because they do not come from an easily observed point, but can include home landscapes, road runoff, storm drains, farms, logging sites, failed or inadequate septic systems, and eroding riverbanks. Tributaries can also deliver such pollution to the mainstem. The slowing of water in the Vernon impoundment may be enhancing the biological uptake of nutrients and be partially responsible for the algal blooms in summer below the dam and in backwater areas, such as the mouth of the West River. Swimming in the Wantastiquet region is threatened by nonpoint sources of pollution and is sometimes unappealing due to algal blooms and turbidity. It may not be safe to swim in the mainstem during or shortly after heavy rain storms, and since the water is not monitored in these situations, it is best to avoid it.

1. Storm Water runoff

What happens to rain falling on a forest is considerably different than what happens on a recently cleared hillside, the family yard, or a paved parking lot. Each surface sheds water differently – faster or slower, with more or less chance to gather speed, cause erosion, and pick up pollutants from automotive fluids and beer cans to thermal pollution. Stormwater runoff may be the simplest but least understood means of water pollution. As a result, EPA and the states are phasing in stronger stormwater controls.

Impervious surfaces - Cleared, compacted, or paved land sends water downhill faster than when the water is captured by thick vegetation and transpired by trees. Studies in Vermont show that when more than 10 percent of a stream's watershed is impervious (pavement, rooftops, compacted soil), the stream and its fish suffer from water quality problems.[1] Roads and parking lots can account for as much as 70 percent of the total impervious surface in urban areas. Towns should view commercial parking lots and down towns as hot spots for petroleum hydrocarbons, metals, nutrients, or solids, and especially for salt and warming of water. Elevated salt and temperature typical of parking lot runoff can be lethal to aquatic life. Sediment studies tend to show more pollutants in the river where the roads are close.

Stormwater regulation by the states

The State of New Hampshire does not issue its own stormwater permits, but reviews and certifies EPA's permits. The state does limit impervious surfaces within 250 feet of lakes, ponds, and fourth order and larger streams, and considers stormwater in its Alteration of Terrain program. Otherwise, the state is involved only to provide technical assistance and public education. If NH receives a water quality related stormwater complaint, the state will go out to be sure there is a federal stormwater permit and a stormwater pollution prevention plan. Controls on stormwater are otherwise through any local regulation that might exist.

In Vermont, the Department of Environmental Conservation Stormwater Program issues separate permits for runoff from impervious (i.e. hard) surfaces, construction sites and industrial facilities. These last two permits are requirements of the federal Clean Water Act, and in Vermont, the Agency of Natural Resources is delegated by EPA to issue these permits.

A prominent example of the effects of impervious surfaces on stormwater is Crosby Brook in Brattleboro, which enters the Connecticut River near the Route 9 bridge. The watershed of this small brook includes the rotary and Exit 3 off Interstate 91. Stormwater runoff from these and other impervious surfaces has created a significant head cut.

Effects of land clearing - Heavy clearing, whether for forestry or for development, can change stormwater runoff, how a tributary flows, and ultimately the Connecticut River itself and even property in another state. Towns may become concerned how such clearing can affect the

"Terrain drains!"
Springfield Act 250 administrator

1. Pease, James, *Urban Nonpoint Pollution Source Assessment of the Greater Burlington Urban Stormwater Characterization Project,* Vermont Department of Environmental Conservation, 1997, in *Champlain Initiative, The Case for a Healthy Community: The History of Sprawl in Chittenden County,* March 1999.

Here, parking lot runoff is captured and treated at the Hinsdale School.

roads and culverts they are responsible for maintaining. Experience in Hinsdale shows that there is more runoff after heavy clearing.

Animal waste - The typically urban problem of what to do with pet waste has arrived in the upper Connecticut River valley. Stormwater may be washing pet waste into the river and contributing to the higher bacteria levels found here. Some towns in other regions have installed pet waste stations with bags. Waste from wild geese is also a growing problem, and can be discouraged from using a waterfront area if their sight line to the water is cut off by a riparian buffer, but more direct control may be needed to prevent water quality problems.

Controlling stormwater - There are a number of common sense ways to keep runoff from causing trouble downhill. The main idea is to mimic the natural pattern of runoff when a property is developed, with low-impact design techniques that slow it down and soak it up. Rather than channeling runoff into larger drainage ditches, the design calls for spreading runoff around and detaining it in many small vegetated catch areas and swales where it can soak into the ground and recharge groundwater rather than run off the land. Low impact design also recommends narrower or shared driveways, porous paving materials, smaller parking lots, smaller road setbacks, directing runoff to places with porous soils, building on soils that are less porous, flattening slopes on cleared areas, keeping as many trees as possible or planting more, and avoiding construction close to streams. The water that eventually arrives at the stream tends to be cleaner and more moves through the ground, keeping water levels up in wells and in waterways.

"If you control your runoff at every single dwelling then you don't have a problem with all that water running into your stream."
Public Works Director, Colebrook

Additional treatment to remove oil should be required for new discharges to surface waters and dry wells, and treatment to remove metals should be required for redevelopment projects with discharges to surface waters.

Recommendations for stormwater management

- Towns should minimize addition of impervious cover because of its effects on storm water runoff and harm to aquatic systems. Consider discouraging roads and development on steep slopes to control stormwater runoff and consider sizing culverts in anticipation of runoff from future cleared slopes. Look at ways to include low-impact design ideas as they review projects and at how to change existing development to reduce runoff and promote stormwater infiltration. Developers should include infiltration methods in their designs, such as many small swales and runoff basins to capture runoff for groundwater recharge. Require additional treatment to remove oil for new discharges to surface waters and dry wells, and treatment to remove toxic metals should be required for redevelopment projects with discharges to surface waters. Ensure that developers installing stormwater management devices such as vortex units will maintain them into the future.

- Regional planning commissions should offer training and model ordinances on low impact development to town planning boards/commissions.

- Trail managers should check for trails that need water bars to keep stormwater from eroding compacted soils.

2. Landfills, Junkyards, & Transfer Stations

In years gone by, people simply dumped their refuse in a stream gully, off a bridge, or over a riverbank, thinking that it would be gone by spring. The Connecticut River and its tributaries are still home to these old informal dumps.

Modern landfills are built with liners and internal collection systems that gather the liquid leachate so it can be treated and sent to the nearest wastewater treatment plant. The leachate, however, still reflects the materials in the landfill, which can include heavy metals, poisons, and all kinds of hazardous materials that were dumped there rather than collected for safer disposal, including products containing mercury.

On the New Hampshire side, new solid waste facilities (including transfer stations) are not permitted within the 500-year floodplain of the Connecticut River. They must be set back at least 100 feet beyond this level and screened from the river with a vegetative or other natural barrier to minimize visual impact. An existing solid waste facility located within 250 feet of the normal high water mark may continue to operate under an existing permit, provided it does not cause degradation to an area in excess of that area under permit. A resource recovery operation can occur at such a landfill. Vermont's regulations require a 300-foot setback from surface waters.

Area landfills - The Wantastiquet Subcommittee is concerned about soil and water contamination from both old junkyards and also from capped but unlined landfills located within the floodplain, including the Putney Paper Company discharge from unlined lagoons. All major unlined landfills along the Connecticut River in this region have now been capped: Saxtons River in the 1960s, Brattleboro's in 1996, Walpole's in 2000, and Hinsdale's in 2001. The Bellows Falls dump in Westminster, an unlined landfill capped in the 1970s, is now a recycling center. While there have been no complaints of contamination from most of these unlined landfills, leachate from the Brattleboro landfill is entering groundwater, with potential water quality degradation from metals, organics and inorganics. Groundwater near the Brattleboro landfill was reclassified so it would not require remediation. Groundwater sampling in 2000 showed no volatile organic compounds, although zinc levels were above the maximum allowable. The Hinsdale landfill at the end of River Road, located on a steep bank next to the water, could be a continuing source of pollution although it was capped in the 1970s. Since the Brattleboro and Hinsdale landfills have been covered, the large population of gulls has disappeared.

Riverside dumping, such as here on the banks of the Ashuelot River, is a hard habit to break.

Construction and demolition debris - Another source of concern is disposal of debris from construction and demolition sites. This material may include woodwork painted with lead paint, wiring and other construction materials that contain heavy metals, asbestos, and other materials that, if incinerated, could deliver these dangerous pollutants to the air. A 2004 proposal for a major construction and demolition incinerator in Hinsdale did not move forward after considerable concerns about emissions, truck traffic, and cooling water were voiced by local citizens and legislators on both sides of the river. In 2007 New Hampshire banned the incineration of construction and demolition debris.

Area residents and businesses have a new opportunity to recycle building materials, through the private non-profit organization, "ReNew Salvage" in Brattleboro. This organization's fast growth reflects the demand for its service of de-constructing buildings and reselling the materials.

Radioactive waste - Vermont Yankee will store radioactive waste from its operations in dry casks on its Connecticut River front site. The large, heavy storage casks appear to be the only alternative for storage, since the federal government, which is responsible for solving the problem of nuclear waste, has not provided a better solution. Reprocessing of nuclear waste was practiced until the 1970s and is known to be feasible, but is no longer done.

Recycling and hazardous waste - Communities are working to reduce the tonnage of solid waste they bring to landfills, by recycling, although rates vary greatly. Westmoreland and Chesterfield have adopted mandatory recycling, and Walpole has a state of the art recycling center. Most towns in the region could do a better job of recycling. Vermont has a bottle bill that encourages return of bottles that would otherwise end up in the waste stream or as litter if not recycled, while New Hampshire does not. The Wantastiquet Subcommittee believes that the benefits of the Vermont system are clear.

There is a need for more household hazardous waste collection opportunities in Vermont. Brattleboro sponsors hazardous waste collections for Vermont towns in the region, as does Keene twice a year for New Hampshire area towns, through the regional planning commissions.

Table 6. Municipal Solid Waste and Recycling - reported by NH towns in 2007 (source: NHDES)						
Town	Combined municipal solid waste (tons)	Commercial/ Industrial Waste (tons)	Construction/ Demolition Waste (tons)	Compost (tons)	Recycling (tons)	Recycling rate
Walpole	641	0	30	18	571	48%
Westmoreland	316	0	42	0	88	22%
Chesterfield	751	0	196	23	442	38%
Hinsdale	725	15	141	7	48	7%

Littering - From time to time, people still illegally dump tires and other unwanted materials in the Connecticut River. Roadside dumping is also still a problem. The amount of litter in the river has declined due to the Connecticut River Watershed Council's annual source to sea cleanup, in which area people have participated for several years. Vermont towns and some of their New Hampshire neighbors hold an annual "Green Up" Day in spring, encouraging residents to help pick up the winter's accumulation of roadside trash.

Recommendations for landfills, junkyards, and transfer stations

- Towns should encourage more recycling and strongly encourage their citizens to use regular household hazardous waste collections at Keene and Brattleboro.

- VT ANR should provide funding for more household hazardous waste collections.

- NH DES should investigate whether the Hinsdale Landfill at the end of River Road was adequately capped and whether it is leaching into the river.

- The federal Nuclear Regulatory Commission should address the storage problem of spent fuel and nuclear waste, to prevent the necessity of storing Vermont Yankee's radioactive waste near the Connecticut River.

- Towns should require construction and demolition debris to be separated and recycled where practical.

- States should develop best management practices for separation and treatment of construction and demolition debris.

- State agencies and regional planning commissions should encourage emulation of the ReNew Salvage organization.

- Towns and regional planning commissions should encourage mercury product recycling; encourage paint swaps and educate homeowners on how to dispose of various kinds of paint, since paint is expensive to treat.

- States should continue to educate fishermen on the need to replace lead fishing tackle with non-hazardous substitutes.

- New Hampshire should consider enacting a bottle bill.

- Towns should hold an annual spring “Green Up” Day if they are not already doing so.
- State agencies and towns should not permit landfills to be located on top of aquifers.

3. Shoreline & Floodplain Development

Riverfront land, which is all the more attractive now that the river is no longer a “nuisance” or a health hazard, is now attracting people seeking waterfront home sites. The value of shorefront property has risen sharply, and riverfront homes are appearing at an increasing rate, although new shorefront owners are not always entirely aware of the hazards associated with being neighbors to the largest river in New England. Inadequate or failed septic systems may allow wastes to pass into groundwater or surface waters, and conversion of seasonal residences into year-round homes may strain inadequate septic systems.


Mill Brook in Westmoreland has become an uncomfortably close neighbor to this home.

New Hampshire Comprehensive Shoreland Protection Act - The New Hampshire side of the Connecticut River is covered by the Comprehensive Shoreland Protection Act (RSA 483-B) within 250 feet of the ordinary high water mark. Provisions of this law and the rivers to which it applies are described in more detail in Appendix I. As of 2006, this state law applies to the New Hampshire shore of the Connecticut River and also to the Ashuelot and Cold Rivers, Mill and Partridge Brooks and a few other streams, as well as to lakes and ponds over 10 acres in size. The goal of this state law is to protect the river for the public, and avoid “uncoordinated, unplanned and piecemeal development along the state’s shorelines, which could result in significant negative impacts on the public waters.” The law also protects property owners by preventing financial investments in structures dangerously close to the river.

This law calls for buildings to be set back at least 50 feet from the river. All new riverfront lots need subdivision approval by NH DES. Minimum lot size is determined by soil type in places dependent on septic systems, and must have at least 150 feet of shoreland frontage. No fertilizer, except limestone, shall be used within 25 feet of the reference line. Twenty-five feet beyond the reference line, low phosphate, slow release nitrogen fertilizer may be used on lawns or areas with grass. No other chemicals, pesticides or fertilizers of any kind shall be applied within 50 feet.

In 2007, New Hampshire enacted new, easier to understand riparian buffer protection. In the “waterfront buffer” (within 50 feet of the reference line no natural ground cover shall be removed except as necessary for a six-foot wide path to the water. Limited pruning may be done to improve a view, and a minimum amount of tree cover must be maintained. Stumps and root systems within 50 feet of the river cannot be removed because they keep riverbank soil in place. Owners of lots legally developed before July 1, 2008 may maintain but not enlarge cleared areas, including existing lawns and beaches, within the waterfront buffer.

Between 50 and 150 feet from the reference line, in the "natural woodland buffer," at least 50 percent of the area outside of impervious surfaces shall remain undisturbed. Owners of lots legally developed before July 1, 2008 that do not comply are encouraged to, but shall not be required to, increase the percentage of area maintained in an undisturbed state. The updated law also limits impervious surfaces within 250 feet of the river to 20 percent of the lot, with some exceptions based on buffer and stormwater management. Property owners and developers are encouraged to seek creative solutions that utilize low impact development techniques. If impervious surface limitations are increased to 30 percent within the protected shoreland, a DES-approved stormwater management plan is required.

Until recently, the state has been largely unable to monitor or enforce this law and violations have occurred, even under the eye of local zoning administrators. The Subcommittee is concerned about this lack of enforcement and about confusion among local administrators about responsibility for jurisdiction. The Subcommittee also believes that realtors should be well aware of the provisions of the law so that they can inform potential buyers of shorefront property.

Vermont Shoreland Protection - Vermont is the only state in the Northeast that does not have a statewide shoreland protection law. Vermont's Agency of Natural Resources has issued riparian buffer guidance for Act 250-regulated projects. The guidance recommends 100 feet from lakes and ponds, and depending on the situation, either 50 or 100 feet from rivers and streams. This is only guidance, however, and does not protect rivers or streams in the case of smaller projects. However, all Vermont towns in the Wantastiquet region, except for Vernon, have their own shoreland protection for the Connecticut River and other streams which is comparable to or more protective than the New Hampshire law.

"Floodplains are called floodplains for a reason. If we keep building in floodplains, we use up the sponge."
Riverfront farmer

Building in floodplains - All of the towns along the Connecticut River in the Wantastiquet region currently permit building in the 100-year floodplain, although Westmoreland prohibits "all buildings intended for human occupancy" "within or within 50 feet of the outer limits of the flood prone areas." Flood-prone area means any land area susceptible to being inundated by water from any source. The boundaries of these areas are based upon past history records of flooding.

Filling in floodplains, and elimination of this "green infrastructure" invites flooding elsewhere. Mobile homes in floodplains are particularly threatened during high water, and the region has experience evacuating flooded mobile home parks. Septic systems within the floodplain have also proved to be a source of contamination, as during the Cold River flood of October, 2005.

Because building in floodplains takes over valuable farmland, transfers flooding problems downstream, and costs taxpayers money when flooding occurs, some Connecticut River towns have passed ordinances banning construction within the 100-year floodplain. Local regulations regarding shoreland and floodplain protection are summarized in Appendix G.

The National Flood Insurance Program, administered by the Federal Emergency Management Agency, requires special construction standards for buildings that are built in floodplains, but they still permit buildings to be built on this dangerous land and a building is allowed to take up space that flood waters would otherwise have occupied. While this might reduce the amount of flood damage to the property, it does nothing to prevent pollution or stop increased flooding downstream. One building may not make much difference, but the effects of allowing many buildings to take up space in a floodplain can be a different story. Agricultural buildings are exempt from permit requirements in Vermont, even though they take up floodplain space as any other building would.

"You can spend a little now and preserve your floodplains or pay through the nose later."

Littleton Conservation Commission member

Floodplain maps - It is essential for landowners, town officials, and banks issuing mortgages and loans to have correct information on floodplain locations. Prior maps were often inaccurate. The 1997 edition of this plan recommended that FEMA provide more accurate floodplain maps (Flood Insurance Rate Maps) to the towns. This request was answered by FEMA for the southernmost 16 towns in New Hampshire and Vermont in 2001, including all the Wantastiquet region towns, based on a new study of the river from its headwaters down to the Massachusetts border. These new maps only provide updated information for the Connecticut River mainstem, not for tributaries. While the new draft maps were provided to towns in 2004 and final maps in 2006, not all towns have adopted them. The new flood way line runs right through the sewage lagoon at the Cheshire County Farm.

The few floodplain forests that remain in the Wantastiquet region, such as at Monkey Island in Hinsdale, offer excellent wildlife habitat and protect nearby development from high water.

Varves - Thousands of years ago, some of the river valley was a lake bed, with soil deposits that could pose problems for anything built upon them. Glacial Lake Hitchcock left behind layers of ancient lake-bottom sediments that in some places sort themselves into varves, layers that have differing physical properties that can create unstable drainage. Knowledge of varves is important for land use planning, because they behave differently from other kinds of soils. If a town planning board knows where the varves are and can ask applicants to deal with the challenges posed by varves, then the board can then decide on whether a proposed project is safe. Siting landfills, bridges, large buildings, and other important structures on varved deposits is risky. Reconstruction of the Route 9 bridge, for example, was a special challenge because of the presence of varves.

Marinas - The Wantastiquet segment of the upper Connecticut River has the most concentrated marina development anywhere north of Massachusetts. There are presently two marinas here: the West River Marina at the mouth of this major tributary in Brattleboro, and Norm's Marina in Hinsdale. Concerned about the potential for fuel spills at these facilities, the Subcommittee suggests that sufficient marina service now exists, and discourages development of further marinas elsewhere in the segment which could threaten pollution and create more boat traffic congestion leading to boating conflicts and bank erosion.

Recommendations for shoreland and floodplain development

- Towns should adopt ordinances prohibiting building in the 100-year floodplain to protect their citizens and businesses from damage and to avoid contributing to flooding of their downstream neighbors and to reduce the public cost of disaster relief. Ensure that buildings are set a safe distance back from the river even when outside of the floodplain, to reduce the risk of property loss in erosion-prone areas.

- Towns and state agencies should discourage construction of new marinas on the river.

Marinas bring the potential for pollution closer to the shore.

- Towns should ensure that new town emergency management plans include water quality considerations.

- The New Hampshire Legislature should apply the Comprehensive Shoreland Protection Act to smaller streams.

- Cheshire County government should allow no additional buildings to be built on the floodplain at the Cheshire County Farm, except for agricultural buildings, and should protect the County Farm with a conservation easement.

- Towns should provide information to every new riverfront landowner to explain the special challenges of owning and managing riverfront land, including the benefits of riparian buffers and the requirements of the N.H. Comprehensive Shoreland Protection Act. State agencies should provide information to real estate brokers to explain the special challenges of owning and managing riverfront land, including the benefits of riparian buffers and the requirements of the Act. Town planning boards should be mindful of state shoreland protection laws.

- Landowners should preserve agricultural uses and forest lands along the river and minimize negative impacts from forestry and agricultural practices on the river.

- Towns should encourage developers and landowners to establish and/or maintain buffers of native vegetation along rivers and streams for privacy and pollution control.

- Towns should ensure that septic systems meet minimum state standards.

- Towns should adopt new Flood Insurance Rate Maps.

- Towns should enforce sedimentation and erosion controls during and after construction.

- Towns should encourage the use of low-impact design and infiltration of all stormwater on-site. Limit the percentage of impervious cover allowed on all sites. Preserve agricultural uses and forest lands along the river.

- Towns should consider working with state geologists to map varves in their towns, to be sure major construction does not take place on unsafe soils (50/50 match with USGS).

- Vermont should adopt statewide shoreland protection.

"Towns should enforce their own regulations."
Gordon Schofield, Wantastiquet subcommittee chair

4. Roads and railroads

In the Wantastiquet region, parts of Route 12 in New Hampshire, Route 5 in Vermont, and many local roads follow the Connecticut River on ancient routes that are little changed in the last two centuries, except that the river, especially where it has widened due to impoundment by dams, has attempted to claim parts of them. People have responded by widening, straightening, and armoring riverfront roads, rarely by moving them a safer distance from the river. A sudden heavy storm can cause problems with blocked culverts and send sediment from such a road into a stream. Better riparian buffers might help hold streambanks in place and help capture road-related pollutants escaping into the stream.

Railroad - An active rail line follows the Connecticut River on the Vermont side. In many places, the railroad company has removed the riparian buffer vegetation growing between the tracks and the river, removing a source of protection for the bank and for water quality. The railroad has also installed considerable large stone to stabilize the riverbank where it runs along the shore.

The integrity of the rail bed is vulnerable to uneven drainage patterns, such as those created by varved soils. The resulting instability has led to at least one disaster. The derailment of the New England Central freight train in April, 2001 spilled six cars and a locomotive into a thaw-swollen Connecticut River. The cars were carrying thousands of gallons of diesel fuel, as well as road salt and limestone slurry, all toxic to river life. An unknown quantity of road salt also seeped into surrounding wetlands. Seventeen fire departments from both states were involved in helping with the accident. The riverbank above the site of the wreck was wet from water piping out of the bank below a flooded 40-acre field. This water broke out of the bank where a drainage pipe had been installed for a recently built house. Such washouts can be caused by something as simple as woodchuck or beaver activity, or by rerouting drainage. It appears to be a problem endemic to soft soils on steep old river terraces, possibly related to varves.

Rail has left a strong historical legacy in the Wantastiquet region on both sides of the river, exemplified by several stone arch trestles such as at Gilboa Mountain Road in Westmoreland. While the tracks have been taken up and the line no longer carries rail traffic, it is now an important recreational corridor. The stone arch at this site has become blocked, allowing water to flow through East Westmoreland and leading to collapse of a third of the trestle. Should it collapse further, the result could be a substantial flood with downstream damage.

Culverts and bridges - In 1997, the *Connecticut River Corridor Management Plan* reported problems with inadequately sized or located road culverts and inadequate drainage ditch construction. These problems proved to be very real after five inches of rain fell in 24 hours in Westmoreland's Mill Brook watershed in 2003. Culverts need regular maintenance and clearing to be effective. One man was killed while attempting to clear a blocked culvert during this storm. If culverts are properly sized to bankfull width and properly maintained, they are less likely to clog.

An under-sized culvert or bridge can block with debris in a sudden storm and cause a stream to cut through a road. Such a problem in Alstead, N.H., contributed to a major disaster on the Cold River in October, 2005. While logs and other woody debris create healthy fish habitat, culverts need to be kept clear to allow water to move through. Sedimentation and erosion control is not always practiced when culverts are repaired.


A poorly set culvert creates a barrier for fish.

Good information about the adequacy and safety of culverts and bridge crossings is missing in the New Hampshire towns of the region, except for the Ashuelot River watershed. Vermont towns, except for Vernon, have already conducted bridge and culvert surveys with the help of the Windham Regional Commission and the state of Vermont.

An innovative project in the Ashuelot River watershed, sponsored by The Nature Conservancy with support from NH DES and CRJC, enlisted volunteers to look at the 1400 road and stream crossings and bridges in the watershed and to measure them to see if they are interrupting habitat for fish. Perched culverts, for example, create a small waterfall and so prevent fish from moving upstream. Those that fragment the most valuable and extensive habitat could be prioritized for restoration. Culverts should be set at a level that allows fish passage throughout the year. Three sided culverts provide natural habitat and other designs simulate a natural bottom. Larger box culverts and an adequate apron around bridges will help avoid scour. The N.H. Fish and Game Department has developed Stream Crossing Guidelines to determine how to properly size culverts for fish passage.

Snow dumping - The sand and salt used to keep roads clear in winter can easily end up in a stream or river come spring. Plowed snow, which can also end up in the water, contains salt, sand, broken glass, oil, trash, and cigarette butts. Towns have not always followed state regulations on snow dumping and storage. Long-time snow dumping sites may also show signs of lead accumulation in the soil from the days of leaded gasoline. Upstream in Windsor, Vt., high concentrations of lead were found in a small area where the town has piled snow for years, and the contaminated soil required clean-up. Other towns may be unwittingly suffering a similar problem. Brattleboro dumps snow on the edge of river setbacks at Norm's Marina.

Road salt - Salt and salted sand used for road de-icing can pollute ground and surface waters. Salt in drinking water can threaten public health. Salt in surface waters is toxic to fish and other aquatic life. Improper salt storage and loading procedures can easily lead to trouble, since salt dissolves so easily in water.

A recent study (of three rivers, including at Hubbard Brook in rural northern New Hampshire just east of the Connecticut River watershed), found that salt concentrations have been increasing for the past 30 years.[1] Research shows that sodium and chlorine, the elements that make up salt, are increasing and staying at elevated levels even when salt is not in use on the roads. In spring, summer and fall the levels of chloride concentrations at study sites were 10 to 100 times higher in the waters near salt use areas than in more isolated waters, and in the winter, concentrations were up to 1,000 times higher in the exposed waters. The study suggested that salt from a half century of use on winter roads is accumulating in soils, groundwater and rivers themselves.

Salt storage - New Hampshire does not permit establishment or expansion of salt storage yards within 250 feet of the Connecticut or any other river covered by its Shoreland Protection Act. Vermont has no similar protection for its waters, beyond requiring that the Agency of Transportation (VTrans) store salt under cover and on an impervious material, so it does not leach into the ground. Vermont has guidelines that recommend that towns avoid storing salt on floodplains, over aquifer recharge areas, or where salt could run off into streams or wetlands, but these are only guidelines. The Vermont Local Roads Program assists town highway departments on the full range of road issues, including storage building designs. VTrans must report weekly to the Agency of Natural Resources about the amount of de-icing material applied during the winter. VTrans is now offering grants to Vermont towns which require only a 20 percent match, for projects like moving sand and salt storage.

Utilities - Vegetation under utility crossings is sometimes maintained with herbicides, although landowners have a right to object to their use (except where the vegetation is maintained by the railroad). A better option may be low-growing perennial vegetation, such as blueberry bushes.

---

1. Kaushal, Sujay S., et al. "Increased salinization of fresh water in the northeastern United States," *Proceedings of the National Academy of Sciences of the United States of America,* September, 2005.

Recommendations for roads and railroads

- State water quality agencies should educate town road agents about BMPs for road, ditch, and culvert maintenance to save the town money and to prevent siltation. Towns should ensure that they are followed.

- Town road agents should follow best managment practices (BMPs) for applying salt to roads, and consider using environmentally friendly de-icing products and establishing limited salt areas near waterways. Vermont should consider establishing regulations for salt storage.

- Town road agents should ensure that culverts are regularly cleared of debris, especially if there is beaver activity in the area, to prevent blocking during storms. Landowners should do this on their property. Watch for fallen trees upstream of smaller culverts and bridges, and cut up or remove large woody debris in these locations. Otherwise, woody material is extremely beneficial for fish habitat, and should only be removed if the property is threatened.

"A well-set culvert equals fish portage."
Regional planner

- Towns should not construct new roads near rivers and streams.

- Towns should ask for help from regional planning commissions to survey culverts and bridges to identify those that are undersized; also note if they block fish passage and seek grants for replacing them where necessary.

- State transportation agencies should offer support to towns to cover engineering costs for sizing culverts and bridges. State and local highway crews should ensure that culverts are properly sized when replacing them during road work. Consult the N.H. Fish and Game Department's Stream Crossing Guidelines.

One of these riverfront homes in the Wantastiquet region retains a protective riparian buffer, and one does not, leaving the shorefront vulnerable to erosion.

- Towns should follow snow disposal BMPs. Snow should be stored on flat, pervious surfaces, such as grass, and at least 100 feet from the edge of a stream or river, with a silt fence between the snow and the stream. There are larger setbacks for snow disposal near public wells. By June 1 or once snow melts, debris should be quickly cleared from the site and brought to the landfill. Towns should test the areas where they have piled snow for many years to see if lead has accumulated in the soil.

- State transportation agencies and towns should include riparian buffer restoration in road projects near streams and rivers.

- NH DOT should repair the stone arch railroad trestle at Gilboa Mountain Road in Westmoreland to avoid potential flooding.

5. Home landscapes

Residential development pressure is significant in the Wantastiquet Region and much of the riverfront, especially in Chesterfield, Brattleboro, Dummerston, and Westmoreland, features homes that display views of the river. Development has taken place over many years, and sometimes, on the New Hampshire side, in violation of state shoreland protection laws. Some of this change has occurred on prime agricultural soils after farm landowners decided not to keep the land in production, and sold it for subdivision and development. Little if any of this development is served by municipal wastewater collection systems, and the homes rely upon on-site septic systems.

> **"It's a very good concept not to utilize riverfront land all the way to the edge."**
> ***Riverfront farmer, Upper Valley River Subcommittee***

This shift from farmland to homeland often means a change for the river. Where farmers are well trained and licensed to apply fertilizers and pesticides, homeowners are not, and uncontrolled and often uninformed use of fertilizers, pesticides, and other toxic materials by homeowners can lead to unintended addition of these pollutants to streams. Home septic systems must be regularly maintained to prevent contaminating surface waters. Homeowners seeking a clear view of the river may be tempted to cut trees and other vegetation growing naturally in the riparian buffer that protects their shoreland. Many homeowners in this area mow their lawns right down to the water's edge.

Cost of Community Services studies can help a town understand the relative costs for public service (police, fire protection, education, and other costs) for various kinds of land use, and better evaluate the cost to the town when farmland or other undeveloped land is converted to house lots. Studies conducted in more than 25 states found that tax and other revenues collected from farm, ranch and forest landowners more than covered the public service costs these lands incur.[1] These studies show that on average, residential development generates significant tax revenue but requires costly public services that typically are subsidized by taxes on commercial and industrial land uses. Farm and forest lands are important commercial land uses that help balance community budgets. Conservation of these lands can allow them to continue in production without the cost to the community of added public services.

Recommendations for home landscapes

- Riverfront landowners should learn about the proper use and disposal of fertilizers, pesticides, and toxic materials; refrain from using fertilizer within 250 feet of rivers. Landowners should maintain and enhance the native riparian buffer vegetation on their property, and avoid mowing to the water's edge. Landowners should know the location of and regularly maintain their on-site septic systems.

- Towns should consider a cost of community services study to investigate how conservation easements can help keep town service and school costs down if the land is not developed into house lots or into second homes which could later become year-round residences.

---

1. American Farmland Trust web site, March 2007.

6. Cultivated lands and rivers

Prime agricultural soils distinguish much of the floodplain in the Wantastiquet region. Although much of the finest farmland is now submerged under the impoundment behind the Vernon Dam, land use along both sides of the river still speaks of a long-time lively agricultural economy and way of life in the river valley. Farms, golf courses, and home landscapes can all be sources of unwanted nutrients that can reach streams and rivers in the region. Many farms in this region are well-prepared to help maintain water quality.

Vermont's rules on Accepted Agricultural Practices require management of barnyards and manure storage to prevent the discharge of manure or other wastes; buffers to neighbors' wells and prohibitions on manure stacking on land subject to overflow from adjacent waters; a prohibition on manure application between December 15th and April 1st; and buffers of perennial vegetation 10 feet from the top of the streambank on cropland and 25 feet from the top of the bank at points of runoff. New Hampshire's Best Management Practices call for similar measures, but function more as guidance rather than rules.

Fertilizer use - Farmers working near the river and its tributaries are aware of the need to manage manure and other fertilizers well so that they serve the farm and are not lost to the river, where they could cause algal growth downstream. Most farms in the region now have nutrient management plans to help calibrate fertilizer use to the specific soils and crops grown on the farm. New satellite-based technology for evaluating soil fertility holds great promise for helping farmers fine-tune fertilizer application.

At the same time, the public remains largely unaware of how farm operations are managed and regulated, especially with respect to the training and certification required for farm fertilizer and pesticide application.

On the New Hampshire side, only low phosphate, slow release nitrogen fertilizer can be used within 250 feet of the Connecticut, Ashuelot, and Cold Rivers and other waterways covered by the Comprehensive Shoreland Protection Act, and no closer than 25 feet to the water. Only lime may be used within 25 feet. Choosing good sites for winter field stockpiling of manure has been a struggle with the weather changes in the last several years. Fertilization at the Brentwood golf course in Keene on the Ashuelot River is closely monitored because there is a public well just downstream.

Farm cost-share programs - Vermont has voted in extra dollars to make the Conservation Reserve Program more helpful to farmers for water quality improvements, and funds for this Conservation Reserve Enhancement Program are available in the Connecticut River valley. Unfortunately, similar assistance is not available in New Hampshire. The U.S. Department of Agriculture offers several cost-sharing programs to assist with riparian buffers, fencing, and other farm projects that improve water quality. Some farmers find these programs unattractive because they consider the requirements too complicated and the cost-share extreme for farm structures they consider over-built. Many farmers choose to build water quality management structures such as manure pits on their own to avoid the heavy price of the cost-shared designs. In the past, some of these designs have created structures that have brought their own water quality problems, such as runoff from earth storage manure pits and pits that collect so much water that the wetted manure takes more time to spread.

Biosolids - Sludge spreading on local agricultural lands carries the potential for contamination of riverside soils from heavy metals and other pollutants in biosolids. While normally bound to the soil under most pH conditions, a number of materials can be present in biosolids that derive from toxics, pharmaceuticals, heavy metals, and hazardous materials delivered to wastewater treatment plants by homeowners. This is why the states regulate such application. Biosolids are not being used in the New Hampshire part of the Wantastiquet Region.

Recommendations for cultivated landscapes

- USDA Cooperative Extension Service should educate homeowners about the wise use and disposal of fertilizers, pesticides, and toxic materials, and work with farmers to encourage use of best management practices and develop nutrient management plans if they don't already have one.

Farming has a long and fine tradition in the Wantastiquet region, such as here at the conserved Windyhurst Farm in Westmoreland and Vermont Shepherd Farm in Westminster.

- USDA Natural Resources Conservation Service (NRCS) should ensure that all farms in region have adequate manure storage and are making the optimum use of nutrients. Farmers should work with conservation districts and Cooperative Extension Service to reduce potential for water contamination from on-farm pollutants. Encourage the technology of satellite-based evaluation of soil fertility.

- NRCS should work with Vermont farmers to help them to make best use of the Conservation Reserve Enhancement Program.

- States should fund or continue funding a state Conservation Reserve Enhancement Program.

- Farmland owners should retain their riparian buffers to help prevent erosion of valuable soils and to trap nutrients that may wash off the land.

7. Forests and rivers

A forest is well known as the best guardian of the quality of water for drinking and for trout. Those who manage forests also, indirectly, manage the water quality of the Connecticut River and its tributaries. Forest landowners can use forested riparian buffers to control flooding and erosion, trap pollutants, protect fisheries, and provide an attractive streambank and recreational opportunities.

In New Hampshire, those planning to make a timber cut can cut up to 10,000 board feet, or 20 cords for personal use, without the need to file an "Intent to Cut" form with the town. This translates to two fully loaded logging trucks. Should such cutting take place within a riparian buffer or on a steep slope, it could affect nearby waters. In Vermont, a landowner must submit an Intent to Cut Notification to the VT Department of Forests, Parks and Recreation only if he or she plans to conduct a heavy cut of forty acres or more.

Flash flooding and siltation can result from increased surface runoff when large areas of forest cover are removed. Siltation can result in impacts to fisheries, water quality, and aesthetics, and pose problems at downstream industrial water intake pipes. Forestry rules restrict cutting along streams.

Recommendations for forest management

- Towns should insist that best management practices be used when logging on steep slopes near the river and in the riparian buffer.

- Forest landowners should seek the advice of professional foresters to ensure responsible forest management.

8. Airborne pollutants

The Connecticut River and its tributaries are not secure from contaminants that arrive on the wind, both from within and outside the region. Both New Hampshire and Vermont have issued fish consumption advisories for the Connecticut and other rivers, based on mercury levels. A study of Connecticut River fish tissue indicates that mercury and dioxins have bio-accumulated, sometimes to high levels, in the aquatic food chain.[1] Much of this mercury originates from Midwest power plant and urbanized eastern seaboard emissions, and also from local sources. The states are doing a good job at addressing this problem, although Congress has yet to act. In 2007, the New England Interstate Water Pollution Control Commission worked with New Hampshire, Vermont, and the other New England states and New York to form a draft mercury reduction plan using the federal Clean Water Act to establish the maximum levels of mercury that local lakes and rivers can absorb ("total maximum daily load"=TMDL). The federal government has not set national standards.

Dioxins are produced in nature and also inadvertently by humans, often through combustion processes such as at waste incinerators or through illegally burning trash in backyard barrels. Outdoor furnaces are also becoming increasingly popular, and could contribute to airborne pollution, especially if household trash is burned in them. Vermont has passed legislation and rules controlling the location, particle emissions and burnable material for outdoor wood burning furnaces. New Hampshire is following suit.

---

1. *Connecticut River Fish Tissue Contaminant Study: Ecological and Human Health Screening* (2000). Prepared for the Connecticut River Fish Tissue Working Group by Greg Hellyer, Ecosystem Assessment Unity, USEPA - New England Regional Laboratory, N. Chelmsford, MA, May 2006.

Recommendations for airborne pollutants

- Congress and the states should continue to reduce sources of mercury contamination.

- Citizens should obey the ban on barrel burning of trash.

- All should pursue increased energy efficiency to reduce airborne pollutants, including the carbon dioxide that contributes to climate change.

9. Brownfields

"Brownfields" is a term coined by EPA for land that cannot be easily redeveloped or reused due to the potential or perceived presence of hazardous substances or other pollutants. Many of these sites are located along rivers. Historical industrial areas and downtowns in the Connecticut River watershed, such as Keene and Brattleboro, are likely to have such properties where contamination may linger in the soil and prevent the property from contributing once again to the tax rolls and economic vitality of the community. Cleanup and redevelopment, in turn, helps prevent sprawl and protects groundwater that could, in turn, help protect surface waters. EPA's program includes legal protections for non-polluter owners of brownfields sites.

The Windham Regional Commission in Vermont and Southwest Region Planning Commission in New Hampshire have assessed a number of brownfields in the region and have funding to do more. They can assist property owners and prospective purchasers of brownfields with environmental site assessments of these properties, and with grants and loans for cleanup of those sites found to be contaminated. Bellows Falls tells a brownfields success story, where a long-unused brownfields site on the island close to downtown was identified, cleaned up, and redeveloped as part of the Connecticut River Byway waypoint center and farmer's market area.

The one known brownfields site in a New Hampshire Connecticut riverfront town in the region, Chesterfield, has now been cleaned up. On the Vermont side, current brownfields areas include a former mill site in Putney, the Estey Organ site in Brattleboro, and two other Brattleboro sites. The Putney Paper sludge lagoons and sludge landfill have undergone environmental site assessments.

Recommendations for brownfields

- State agencies should update information posted on their web sites for brownfields and other contaminated properties.

- Federal and state funding, with local governments, is needed to pay the often high cost of cleaning up brownfields sites.

- Landowners with concerns about possible contaminants on their property should contact their regional planning commission and the state, to take advantage of available assistance, including loans and expertise.

VIII. Riverbank Erosion

Riverbank erosion is a significant cause of concern for landowners on this segment of the Connecticut River. While it is a natural process, and is caused primarily by shear stress of water forced against the bank, abrasion by ice, and also wind-driven waves, erosion is made worse by human actions, including water level fluctuations at the dams, boat wakes, and removal of the riverside vegetation that naturally holds the bank together. Streambank erosion and removal of riparian vegetation are difficult problems in the Wantastiquet region, particularly on the West and Saxtons Rivers in Vermont and on the tributaries that have been most affected by sudden heavy storms in recent years. Erosion has long threatened the sewage lagoon at the Cheshire County Farm in Westmoreland. Morse Brook in Westminster has changed course and is currently threatening several properties near the interstate access road.

Erosion is a natural process that can be aggravated by human activity.

Land development is the primary source of eroded sediments in the basin of the West River, which delivers them to the Connecticut River. Towns sometimes riprap along streambanks without consulting state or local conservation commissions. There are a number of places where recreation-related foot traffic has led to erosion, such as at Dummerston Bridge. At this site, an extensive and very successful collaborative effort addressed the problem, involving community volunteers and officials, the Windham Regional Commission and the state, with funding from CRJC, restoring the riparian buffer and creating river access that is healthier for the river.

"People think the Connecticut River doesn't need any help because it flows all by itself."

Hank Swan, Connecticut River Commissioner

Rock riprap has long been the conventional method of bank stabilization, but it is now understood that this method has a number of disadvantages. Riprap may actually speed up the flow of water, contributing to flooding downstream, and can start new erosion by deflecting the current against the opposite shore or by creating eddies that erode adjacent banks. Therefore, attempting to repair an eroded bank on one property may cause erosion on someone else's property. Riprap also destroys habitat along the bank and cannot filter pollutants entering the river from runoff as a vegetated riverbank can.

Vermont's River Management Program provides technical assistance to conduct geomorphic assessments of streams and their watersheds. Understanding the natural tendencies of a stream, its current condition, and what changes may be anticipated in the future is invaluable to making sound protection, management, and restoration decisions.

A. U.S. Army Corps of Engineers Study

The causes of erosion are many and complex on the Connecticut River, as on most large alluvial rivers. Erosive forces can act alone or together, making it difficult to pinpoint exact causes. The New England Division of the U.S. Army Corps of Engineers conducted a study of riverbank erosion on the Connecticut River in 1979 between Wilder and Turners Falls Dams (Massachusetts). It concluded that the primary cause of erosion is shear stress of high-velocity flows, especially on banks composed of non-cohesive material.[1] The sandy to silty soils of the river in this part of the river valley are non-cohesive and so are very susceptible to erosion.

The Corps also identified pool fluctuations behind dams, boat wakes, gravity, seepage, natural flow variations, wind-driven waves, ice, flood variations, and freeze-thaw effects on the banks as causes of erosion, in that order of importance.

B. Erosion Inventory

Erosion on both sides of the Wantastiquet segment of the Connecticut River was inventoried by the Sullivan and Cheshire County Conservation Districts in 1997.[2] However, an erosion inventory is a snapshot in time, and can become out of date as bank conditions change due to natural or manmade flow conditions. Data were collected on riparian land use, bank height and slope, vegetation and soil type, river dynamics, and existing erosion controls. Results show that bank erosion is a significant problem in some places, with the more severe erosion along banks with steep, high, sandy slopes on inside bends.

The report concluded that areas with severe and moderate erosion are largely attributable to natural forces such as higher velocity flows against concave banks and factors such as steep, high banks composed of sandy soils. Most of the reaches with moderate or severe erosion had moderate to high banks and slopes greater than 60 percent. Low banks with gentle slopes were generally stable.

In the four Cheshire County riverfront towns, 33 sections, or reaches, of the Connecticut River were studied; 12 were stable, 13 showed slight erosion, six showed moderate erosion, and two showed severe erosion. The slope of the riverbank in these four towns primarily varied from moderate to steep (25-60 percent slopes), although a few reaches had lower bank heights that were more gently sloped. A majority of the reaches had high banks (30-150 feet) with at least moderately steep slopes. These reaches generally showed the most significant erosion problems. Farming was the dominant riverfront land use (18 of 33 reaches) in these towns, especially in Walpole and Westmoreland, and forest was the second most common (8 reaches), concentrated in Chesterfield and Hinsdale. The remaining seven reaches were nearly evenly divided among residential use and roads. Erosion problems are generally more moderate in Chesterfield and Hinsdale, where the river is wider, and where the riverbank is composed of rock outcrops, such

---

1. U.S. Army Corps of Engineers, New England Division, *Report on Connecticut River Streambank Erosion Study: Massachusetts, New Hampshire, and Vermont*. Waltham, Mass.,1979.
2. Sullivan and Cheshire Counties Conservation Districts, *Connecticut River Erosion Inventory for Sullivan and Cheshire Counties, New Hampshire and Windham and Windsor Counties, Vermont*, 1997.

as below Wantastiquet Mountain and downstream of Vernon Dam. An exception is a residential area in Chesterfield where several homes are located very close to the river and some have set up rock or wooden erosion control measures.

In Windham County towns, 38 sections of river were examined from Rockingham south to Vernon. The land use was more evenly divided between agricultural and forest land use, with 14 reaches in each use. Roads and railroads dominated five reaches, and four reaches were classified as residential, and one as a meadow reach. A significant number of the reaches in Windham County had steep, high bank slopes greater than 60 percent. Of the 38 reaches, 13 were stable, 17 showed slight erosion, six showed moderate erosion, and two showed severe erosion. Erosion control, primarily rock riprap, exists in nine of the reaches on the Vermont side, most commonly along the rail line, which in places runs only a few feet from the river.

Erosion in North Walpole - An unusual erosion situation arose in North Walpole in 1997, when high water combined with ice above the Bellows Falls Dam created a jam that developed to such depth that it caught against the underwater remains of log boom islands, forcing the current into an eddy on the New Hampshire shore and creating a deep hole. The severe erosion that followed threatened a home, Route 12, and a rail line. The power company attempted to slow the collapse of the bank by applying mats of imitation eelgrass against the river bottom to capture sediment. The company has monitored the success of this approach and believes that it is moderately effective, although the Conservation Districts still consider the homes, road, and rail line to be in danger. However, the town of Walpole has continued to permit development up to 50 feet from the edge of this vulnerable riverbank.

Erosion site for sale on the Connecticut River in the Wantastiquet region. Buyer beware!

C. Riparian Buffers

Vegetation along streams and rivers is probably the simplest, least expensive, and most effective way to slow erosion and protect these waters from pollution and overheating. Buffers along smaller tributaries are especially important in controlling temperature by shading. These strips of grass, shrubs, and/or trees along the banks of rivers and streams filter polluted runoff, capture sediment and nutrients, and provide a transition zone between water and human land use. Vegetated buffers are relatively inexpensive and have the added advantage of providing habitat for both land based and aquatic animal species and privacy for landowners. Shading streams with vegetation helps to optimize light and temperature conditions critical to the survival of certain species, such as trout.

The Conservation Districts concluded that human activity appears to be affecting erosion rates in some reaches where riparian vegetation has been removed from the bank, and that landowners needed to be more aware of the potential erosion problems that removing riparian buffers could cause. Local regulations regarding riparian buffer protection are summarized in Appendix G. The erosion inventory noted that several farm parcels on both sides of the river lacked riparian buffers and crops were planted less than 10 feet from the top of the bank. The erosion inventory report states that this is a significant problem in the lower third of the reaches in Walpole and in reaches throughout Westmoreland. In many of these reaches, undercutting is occurring at a slow but persistent rate, such as the farmland at Canoe Meadows, where farmers are losing valuable land to the river.

Riparian buffers in the Wantastiquet region are strongly threatened by invasive plants. Japanese knotweed has formed nearly pure stands in the riparian buffer of the Saxtons River, and is perhaps the most noticeable invasive plant in the Wantastiquet region near waterways.

D. Geomorphic Assessments

Geomorphic assessments identify the major natural and human factors controlling stream channel shapes and causing bank erosion. Vermont has invested much money in stream geomorphic assessments, and has completed Phase 1 (river location history) for the entire West and Saxtons Rivers. Phase 2 assessment (detailed measurements of stream channel) is underway on the Rock River in the West's watershed, which will give an opportunity to apply for funding for bank restoration.

Recommendations for erosion and riparian buffers

- State water quality agencies should encourage stream and riverfront homeowners to plant and maintain buffers of natural vegetation along the riverbank, and recommend vegetative bank stabilization techniques, in combination with riprap only where necessary, to control erosion and sedimentation.

- Towns should require developers to follow BMPs) for erosion and sedimentation control, and ensure that riverside construction activities do not impact riverbanks and riparian buffers.

- The N.H. Department of Safety should increase boating law enforcement to help reduce boat wake-induced riverbank erosion.

- Landowners should plant and maintain buffers of natural vegetation along the riverbank for privacy, to keep pollutants from entering the river, to provide wildlife habitat, and to help stabilize the bank. Landowners should select vegetative stabilization methods or where appropriate, vegetative methods in combination with a rock toe to slow serious erosion problems that threaten structures.

- Citizens and local citizen groups should work with governmental agencies, landowners, and watershed associations to survey streambank erosion and siltation on Connecticut River tributaries in the Wantastiquet region.

- County conservation districts should supply waterfront landowners with information about sources of assistance and where they can find nurseries for buffer plant material.

IX. Current Protection for the River

A. New Hampshire

New Hampshire's Comprehensive Shoreland Protection Act (RSA 483-B) sets minimum shoreland protection standards for shore lands near great ponds, fourth-order rivers, artificial impoundments and coastal waters. These standards are designed to minimize shoreland disturbance in order to protect the public waters, while still accommodating reasonable levels of development in the protected shoreland. Although the act sets minimum standards, section 483-B:8 gives municipalities the authority to adopt land use control ordinances which are more stringent. The Legislature updated the Act in 2007 and 2009.

B. Vermont

Vermont is the only state in the Northeastern U.S. that still has no statewide protection for shorelands. Section 1422 of Title 10 of the Vermont Statutes gives towns the authority to regulate shorelands to prevent and control water pollution; preserve and protect wetlands and other terrestrial and aquatic wildlife habitat; conserve the scenic beauty of shorelands; minimize shoreland erosion; reserve public access to public waters; and achieve other municipal, regional or state shoreland conservation and development objectives. Other state regulations set standards for management of agricultural land, silvicultural practices, and sediment and erosion control. In-stream water quality continues to be directly regulated at the state level, including withdrawals and discharges from and into surface waters.

C. Local Tools

Besides the state statutes, many tools are available to communities and individuals to protect water quality; some are of a regulatory nature, some are non-regulatory. Local tools can include adopting a master plan (town plan) and/or water resources management plan with strong recommendations for protecting water quality, scenic views, agricultural soils, riparian buffers, prime wetlands, floodplains, open space, and wildlife habitat. These recommendations can then be carried through to regulatory documents such as zoning, subdivision and site plan review.

1. Local Regulatory Measures

Floodplain Ordinances - Floodplain ordinances can prohibit construction in the floodplain. Floodplains provide flood storage, wildlife habitat and essentially act as buffers to protect water quality. Construction, development, or filling in of floodplains removes flood storage and displaces floodwater to locations further downstream. There is the added benefit of protecting buildings from flood damage which costs taxpayers millions of dollars each year. Vermont towns should update their floodplain ordinances, incorporating them into town zoning bylaws where possible.

Shoreland Overlays - A community can adopt a shoreland protection ordinance or a buffer overlay to the zoning ordinance in which protection measures for surface waters can be more closely defined than for the rest of the town. In both states the requirements of the shoreland ordinance supersede that of the underlying zoning ordinance.

Others - Towns may also adopt measures to limit the amount of impervious surface created by new development to reduce the transportation of sediments and nutrients, require sediment and erosion control measures during and after construction, and minimize development on valuable agricultural soils. Communities can help account for river erosion hazards and help to maintain the stability of a stream system by establishing an overlay district based on fluvial erosion hazard mapping. There are several ways that towns can implement fluvial erosion hazard overlay zones. Education of property owners is a less intensive way to implement these zones, and incorporating the zones into town zoning bylaws is ideal.

Under current zoning, it can be too easy for highly productive land to go under pavement.

2. Local Non-regulatory Methods

Vegetated Buffers - The use of riparian buffers can be either regulatory or voluntary, and is one of the best and most commonly used methods of protecting surface water. This strip of natural or planted vegetation along the riverbank can intercept harmful nutrients, toxic chemicals and sediments before they enter the surface waters, and control bank erosion.


The Cheshire County Farm: valuable agricultural soils, a remnant floodplain forest, public recreational trails, and an important conservation opportunity.

Conservation Purchase or Easements - Towns and conservation groups can use these tools to provide a buffer on land adjacent to surface waters and wetlands, to protect water quality and to provide public access without creating new regulations. Prime agricultural soils, water supply recharge areas, floodplains, sites for rare and endangered species, and historic and archaeological sites can be protected in the same manner.

Incentives - Current use tax assessment programs in both states encourage landowners to keep their land undeveloped. A variety of incentive programs offered by the USDA Natural Resources Conservation Service encourage landowners, especially farmers and forest landowners, to implement best management practices that benefit water resources, such as buffer planting, fencing of livestock, roof drainage improvements, and much more.

Education programs - Education programs through schools and non-profit education and land use organizations can increase the awareness of the general public regarding private property rights and ways to control nonpoint pollution on private land. Programs should emphasize the locations and use of existing public access and asking permission before stepping on private property.

X. Tributaries

Since the Connecticut River is the sum of its parts, it is useful to know about the contributions of its tributaries. In the Wantastiquet region, a number of major tributaries enter the Connecticut River, draining the landscape from high elevation ponds and ridges in southwestern New Hampshire and the slopes of Stratton Mountain and the Green Mountains in Vermont. These tributaries are described in Appendix D. Many of them, especially in New Hampshire, have not been fully assessed, although active water quality monitoring programs have begun on the larger tributaries. Common themes are nutrient enrichment and stormwater runoff from urban development, loss of riparian buffers, erosion, sedimentation, and altered river flows from the operations of major flood control dams.

The Ashuelot River drains relatively densely developed industrial and residential areas in Keene, Sackett's Brook has a long history of industry-related water quality problems, and the West River and Whetstone Brook pass through urban Brattleboro. The Ashuelot River is by far the largest New Hampshire tributary in this region, with a watershed of 425 square miles, followed by the Cold River and its 102 square mile watershed. Both have been designated into the New Hampshire Rivers Management and Protection Program, and are under the watchful eye of dedicated local river advisory committees that have established active volunteer citizen water quality monitoring programs. The Ashuelot River watershed has also been the subject of an innovative aquatic habitat assessment led by The Nature Conservancy and the Ashuelot Valley Environmental Organization, and a major conservation planning effort by the Conservancy. Other New Hampshire tributaries in this region are Partridge and Mill Brooks in Westmoreland, both fourth order streams, and more than a dozen smaller first, second, and third order streams.

On the Vermont side, the West River is the most significant tributary, with a watershed almost exactly the size of the Ashuelot's. Smaller tributaries include the Saxtons River and a dozen smaller streams. The basin plan for the West, Williams, and Saxtons River watersheds is now complete, and is the first such plan in Vermont created by a grassroots organization. The Windham County Conservation District worked with state funds to develop this basin plan. Water quality monitoring is being done on 15 swimming holes and elsewhere, and data gaps are being filled. The smaller streams in this region, including Whetstone and Sackett's Brooks, will be examined in the near future.
On the New Hampshire side, a corridor management plan is complete for the Ashuelot River and in development for the Cold River, through their designation into the state's rivers program. In the wake of the October 2005 flood, New Hampshire sponsored a fluvial geomorphic

assessment of the Cold River. However, New Hampshire has little information about other tributaries in the region. Given this lack of knowledge, Wantastiquet Region River Subcommittee members volunteered to conduct a windshield survey during the summer of 2006. Using maps prepared by NH DES for this purpose, members used a simple field recording sheet to assess the condition of small tributaries in their towns. Summaries of their reports are included in Appendix D.

Recommendation

- Vermont should continue to investigate sources of contamination in Whetstone Brook and Sackett's Brook.

XI. Conclusion

The Wantastiquet region of the Connecticut River is a study in contrasts, where rich agricultural lands and the sites of 18th century forts share the riverfront with a nuclear power plant, a bustling downtown, and other industry. Witnessing growth both here and downstream in nearby Massachusetts, citizens and communities in this region are more aware than ever of the value of their way of life and willing to roll up their sleeves to protect their waters. Leadership in ensuring a healthy future for the river must come from private landowners and decisions by town meeting. The Subcommittee looks for all to participate in safeguarding the Connecticut River, life blood of the valley.

Appendix A. Subcommittee Members

These Local River Subcommittee members participated in development of this updated water resources chapter of the *Connecticut River Management Plan:*

Stuart Adams, *Westmoreland, NH*
Peter Barrett, *Westminster, VT*
Jim Blake, *Westmoreland, NH*
Carol Coronella, *Putney, VT*
Heather Freedman, *Brattleboro, VT*
Jim Grandy, *Westminster, VT*
Hazel Hunter, *Chesterfield, NH*
Susan Lawson-Kelleher, *Chesterfield, NH*
Daniel Marx, *Dummerston, VT*
Gwen Mitchell, *Westmoreland, NH*
Bill Roberts, *Hinsdale, NH*
Sheldon Sawyer, *Walpole, NH*
Richard Schmidt, *Westmoreland, NH*
Gordon Schofield*, *Hinsdale, NH*
Monroe Whitaker, *Brattleboro, VT*
** elected officer of the subcommittee*

The following Local River Subcommittee members participated in development of the 1997 *Connecticut River Corridor Management Plan* which formed the basis for the current plan.

Stuart Adams, *Westmoreland, NH*
Stephen Belczak, *Putney, VT*
Earl Brissette, *Vernon, VT*
Stuart Brown, *Dummerston, VT*
Robert Burns, *Putney, VT*
Linda Dierkes, *Brattleboro, VT*
Jason Doubleday, *Dummerston, VT*
Janice Kos, *Westmoreland, NH*
Susan Lawson-Kelleher, *Chesterfield, NH*
Kenneth McGill, *Walpole, NH*
Robert Miller, *Brattleboro, VT*
William Perron, *Walpole, NH*
Albert Rydant, *Chesterfield, NH*
Gordon Schofield, *Hinsdale, NH*
Howard Sherman, *Walpole, NH*
Sharron Smith, *Hinsdale, NH*
John Wilmerding, *Brattleboro, VT*

Appendix B. Progress Since 1997

In 1997, the *Connecticut River Corridor Management Plan* reported that Vermont, based in part upon the results of biological sampling of the river bottom community, considered that the uses and values of the Wantastiquet segment of the Connecticut River that depend upon high quality water are somewhat impaired, due partly to the operation of dams. Additional discharges to the Vernon Dam impoundment, with its reduced capacity for mixing and re-oxygenation, could encourage algal growth, depress oxygen levels, and result in reduced water quality in spite of the increased flow from tributaries in the region. New Hampshire conducted chemical sampling at four locations and through this identified no water quality problems along the mainstem in this area associated with the impoundments.

Since 1997, much progress has been made. New Hampshire has applied the protections of the Comprehensive Shoreland Protection Act to the New Hampshire side of the Connecticut River and to the Cold River, establishing a new local advisory committee for this tributary. In early 2007, Vermont's citizen-based basin planning program completed its draft basin plan for the West and Saxtons Rivers in Vermont. Some local governments have enacted stronger water quality protection for their shorelines.

In response to the 1997 version of this plan, the Federal Emergency Management Agency revised and updated flood insurance rate maps in the entire Wantastiquet region, and the county conservation districts have completed erosion inventories for the mainstem. Water quality monitoring programs have begun on the Cold and Ashuelot Rivers, and there is now a record of data for both rivers since 2001. On the Ashuelot River, two dams have been removed, and the U.S. Army Corps of Engineers is working with The Nature Conservancy to improve management of flood control dams here and on the West River for the benefit of water quality and aquatic habitat. Communications about flow in the major tributaries from the Army Corps to the hydropower company managing mainstem dams have improved, allowing better management of Connecticut River flows.

A hazardous waste spill of organics, oil, and grease in Whetstone Brook was cleaned up and the brook is being evaluated for potential sources of high bacteria. Trout populations are recovering following a chlorine spill in this Brattleboro tributary. The Brattleboro landfill was capped in 1996, the Walpole landfill in 2000, and the Hinsdale landfill in 2003. Most farms are now required to have nutrient management plans and are no longer using as much fertilizer that could leach into waterways. Emergency management plans are being developed.

Both states have greatly improved public access to water quality information in the last several years, through their Web sites. Vermont's regional planning commissions have made significant contributions by conducting bridge and culvert surveys for their communities, and seeking and applying hundreds of thousands of dollars to assess brownfields sites in Putney and Brattleboro, putting them on the path to redevelopment.

Perhaps even more encouraging is the energetic volunteerism of watershed groups on a number of the tributaries, including the Cold River Local Advisory Committee, Ashuelot River Local Advisory Committee, and the West River Watershed Alliance. In a first of its kind effort, The Nature Conservancy and Ashuelot Valley Environmental Observatory mustered volunteers to conduct a comprehensive survey of aquatic habitat connectivity in the Ashuelot River Watershed.

There have also been setbacks since publication of the 1997 plan. Two isolated heavy rainstorms in the Westmoreland area in 2003, considered 500-year storms, caused severe erosion and flooding in Mill Brook and nearby small streams, sending enough debris into the Connecticut River mainstem to alter the river's flow and erode the opposite Vermont bank. In October, 2005, the Cold River watershed received 17 inches of rain in 24 hours, causing a road washout and a devastating loss of lives and homes, and declaration of a federal disaster area. The Cold River Local Advisory Committee rose to the challenge, providing information and advice as the communities in its region, and the agencies assisting them, struggled to move forward in its wake.

Appendix C. Summary of Recommendations Arranged by Responsible Party

Federal	
Congress	• Reduce sources of mercury contamination. • Pursue increased energy efficiency to reduce airborne pollutants, including the carbon dioxide that contributes to climate change.
USGS	• Work with states to maintain existing stream flow gages for public safety.
US Army Corps of Engineers	• Work with The Nature Conservancy to study the West and Ashuelot River watersheds' diversity for the benefit of water quality and aquatic habitat. at periods of low flow; maintain the discharge at run of river levels, to protect aquatic life downstream. • Continue to coordinate flood control dam operations with mainstem hydro dams to avoid local flooding where possible when flood waters need to be released from the four U.S. Army Corps dams. • Put measures into place to prevent sediment releases from Ball Mountain Dam that could harm aquatic habitat. • More aggressively protect and plant vegetated buffers.
US Fish & Wildlife Service	• Work with EPA to update standards for disposing of unused and out-dated medicines, and assist area solid waste districts in educating consumers about proper disposal.
FERC	• Encourage citizen participation in dam relicensing, and fund state and federal resource agencies to review the water quality effects of dams on the Connecticut River and its tributaries to balance the hydro power generation use with water quality uses and values. • Require site specific studies of impact, usage, resource studies of fish, and erosion by the licensees at both the Vernon impoundment and downstream from the dam. • Include best management practices such as a slower, more natural raising and lowering for the ramping rate in the 2018 license for Bellows Falls and Vernon Dams. Include a provision for emergency gate operation, such as in the context of a "black start" when the dam is needed to provide immediate power in case of a blackout.
EPA	• Fund state resource agencies to monitor for toxic substances such as mercury in the water, fish, and sediments, and release the results to the public in a timely manner. • Decide upon standards for phosphorus in wastewater treatment plant effluent so that Keene can move ahead with effective phosphorus removal. • Provide funding to help towns add phosphorus removal to their wastewater treatment facilities. • Work with the U.S. Fish & Wildlife Service to update standards for disposing of unused and out-dated medicines, and assist area solid waste districts in educating consumers about proper disposal. Rather than flush these medicines, consumers should wrap them and dispose of them in household trash. Pharmacies should help educate consumers about proper disposal of unused and out-dated medicines by applying a label to the packaging. • Provide funding to pay the often high cost of cleaning up brownfields sites.
FEMA	• Advise towns on potential technical and financial assistance to help them identify potential flood and erosion hazards.
Nuclear Regulatory Comm.	• Address the storage problem of spent fuel and nuclear waste, to prevent the necessity of storing Vermont Yankee's radioactive waste near the Connecticut River.
USDA	• Cooperative Extension Service should educate homeowners about the wise use and disposal of fertilizers, pesticides, and toxic materials, and work with farmers to encourage use of best management practices and develop nutrient management plans if they don't already have one. • Natural Resources Conservation Service should ensure that all farms in region have adequate manure storage and are making the optimum use of on-farm nutrients. Continue to work with Vermont farmers to help them to make best use of the Conservation Reserve Enhancement Program. • Natural Resources Conservation Service should encourage the technology of satellite-based evaluation of soil fertility. • County conservation districts should supply waterfront landowners with information about sources of assistance and where they can find nurseries for buffer plant material. • Conduct research into bio-controls for Japanese knotweed and inform the public of the results.

Appendix C. Continued

States	
NH Legislature	• Apply the Comprehensive Shoreland Protection Act to smaller streams. • Consider enacting a bottle bill. • Fund a state Conservation Reserve Enhancement Program.
VT Legislature	• Adopt statewide shoreland protection. • Continue funding a state Conservation Reserve Enhancement Program.
Environmental Agencies (NH DES and VT DEC)	• Sponsor increased water quality monitoring activities in the region and make use of data collected by Vermont Yankee. Train and equip a team of roving volunteer monitors to track down concentrated sources of pollutants for which monitoring data suggest problems, such as elevated levels of phosphorus or copper. Such teams could focus on high priority problems and hopefully track them to sources, and assist state agencies and local conservation commissions to develop solutions to identified water quality problems. • Conduct a survey of local anglers to see how many are subsistence fishermen, in order to ensure that fish consumption advisories are well calibrated to local consumption. • Encourage a mechanism for towns to alert and include the local advisory committee, conservation commissions, and other water related organizations when plans are made for remediation of a river-related disaster. Develop a coordinated approach to river-related disasters such as floods and contaminant spills, and assign an agency staff person to ensure that there is good communication between state and local groups. Response to floods should be based on good river science. • Take an active role in educating people to promote riverbank stability, encourage riverfront homeowners to plant and maintain buffers of natural vegetation along the riverbank to help protect it during times of heavy flow. • Study further the impact of dams on water quality, look closely during dam relicensing at whether the historic low flow is an adequate minimum flow requirement, and conduct regular safety inspections of dams in the region. • Survey the condition of dams and seek funding to remove hazardous dams or those that obstruct fish passage, with landowner permission. • Consider tiered user fees for consumptive water withdrawals over a threshold which will not impact small users but which will encourage water conservation by larger users. • Determine whether local approval of water withdrawals over a certain amount is needed. • Distribute accurate maps of aquifers and aquifer recharge areas to the towns as soon as they are available. • Do not permit landfills, salvage yards, and junkyards to be located on aquifers. • Be vigilant about possible MtBE contamination, and investigate the use of alternative fuels. • Study proposed new discharges to the river, examining the specific area to see if it can assimilate the additional waste load and still meet the water quality standards of both Vermont and New Hampshire. • Assign more value toward the river when weighing the cost of running the cooling towers at Vermont Yankee and the cost to the river. • Continue to monitor and enforce procedures at wastewater treatment facilities. • Identify and eliminate the source of raw sewage observed in the river between Westminster/Westmoreland and Putney/Chesterfield. • Develop best management practices for separation and treatment of construction and demolition debris. Encourage emulation of the ReNew Salvage organization. • Continue to educate fishermen on the need to replace lead fishing tackle with non-hazardous substitutes. • Discourage construction of new marinas on the river. • Provide information to real estate brokers to explain the special challenges of owning and managing riverfront land, including the benefits of riparian buffers and, in NH, the requirements of the NH Comprehensive Shoreland Protection Act. Take an active role in educating people to promote riverbank stability, encourage stream and riverfront homeowners to plant and maintain buffers of natural vegetation along the riverbank, and encourage the use of vegetative bank stabilization techniques, in combination with riprap only where necessary, to control erosion and sedimentation. • Educate town road agents about BMPs for road, ditch, and culvert maintenance. • Continue to reduce sources of mercury contamination. • Pursue increased energy efficiency to reduce airborne pollutants, including the carbon dioxide that contributes to climate change. • Provide funding to pay the often high cost of cleaning up brownfields sites. Update information posted on agency web sites for brownfields and other contaminated properties. • Minimize thermal discharges to the river in anticipation of increasing ambient river temperatures resulting from climate change.

Appendix C. Continued

Transportation Agencies	• Ensure that culverts are properly sized when replacing them during road work. Ensure that there is an adequate abutment around bridges for protection during heavy flow. • Ensure that road salt supplies are properly stored so they do not contaminate surface or groundwater. Offer support to towns to cover engineering costs for sizing culverts and bridges. • Include riparian buffer restoration in road projects near streams and rivers. • NH DOT should repair the stone arch railroad trestle at Gilboa Mountain Road in Westmoreland to avoid potential flooding.
NH DES	• Sample the CT River above and below the mouth of the Ashuelot, in order to verify that the Ashuelot River is causing elevated levels of phosphorus and copper in the Connecticut River. • Cooperate with USGS to restore or add gages at the four locations identified by the agency and maintain existing gages for public safety. • Aggressively promote bridge and culvert surveys, by providing funds to the regional planning commissions to work with town road agents. • Investigate whether the Hinsdale Landfill at the end of River Road was adequately capped and whether its contents are leaching into the river.
Vermont DEC	• Investigate the economic value of clean waters to the state. • Determine whether sudden releases from the Ball Mountain and Townsend Dams for whitewater recreation are affecting water quality and aquatic habitat in the West River, such as trout holdouts in warm water periods. • Work with USGS to maintain existing gages for public safety. • Provide funds to Windham Regional Commission to assist Vernon with a bridge and culvert survey. • Provide funding for more frequent household hazardous waste collections. • Explore a water withdrawal registration program. • Map Vermont aquifers. • Consider establishing regulations for salt storage. • Continue to investigate sources of contamination in Whetstone Brook and Sackett's Brook.
NH Dept. of Safety	• Increase boating law enforcement to help reduce boat wake-induced riverbank erosion.
Towns	
Town Management	• Meet regularly to discuss emergency planning, and include local watershed groups in river-related discussions. Ensure that new town emergency management plans include water quality considerations. • More aggressively protect vegetated buffers. • Pursue increased energy efficiency to reduce airborne pollutants, including the carbon dioxide that contributes to climate change. • Work with regional planning commissions or larger neighboring towns to offer more frequent hazardous waste collections. • Require construction and demolition debris to be separated and recycled where practical. • Ensure that septic systems meet minimum state standards. • Ensure that road crews follow BMPs for road, ditch, and culvert maintenance. • Ask for help from regional planning commissions to survey culverts and bridges to identify those that are undersized; also note if they block fish passage and seek grants for replacing them where necessary. • Test the areas where road crews have piled snow for many years, to see if lead has accumulated in the soil. • Insist that best management practices be used when logging on steep slopes near the river, and in the riparian buffer.

Appendix C. Continued

Planning Boards & Commissions	• Adopt ordinances prohibiting building in the 100-year floodplain to protect properties and businesses from damage, to avoid contributing to flooding of downstream neighbors, and to reduce the public cost of disaster relief. Ensure that buildings are set a safe distance back from the river even when outside of the floodplain, to reduce the risk of property loss in erodible areas. Be mindful of state shoreland protection laws. • Determine whether local approval of water withdrawals over a certain amount is needed. • Protect groundwater recharge areas and consider a wellhead protection program such as Hinsdale's to save money in sampling costs; provide information on wellhead protection to new property owners. • Do not permit landfills, salvage yards, and junkyards to be located on aquifers. • Enforce setback requirements for buildings such as garden sheds and garages that could be used to store hazardous materials. • Minimize addition of impervious cover because of its effects on storm water runoff and harm to aquatic systems. • Consider discouraging roads and development on steep slopes to control stormwater runoff, and consider sizing culverts in anticipation of runoff from future cleared slopes. • Look at ways to include "low impact development" ideas as they review projects, and at how to change existing development to reduce runoff and promote stormwater infiltration. Encourage infiltration of all stormwater on-site and limit the percentage of impervious cover. • Require additional treatment to remove oil for new discharges to surface waters and dry wells. Require treatment to remove toxic metals for redevelopment projects with discharges to surface waters. Ensure that developers installing stormwater management devices such as vortex units will maintain them into the future. • Preserve agricultural uses and forest lands along the river. • Discourage construction of new marinas on the river. • Encourage developers and landowners to establish and/or maintain buffers of native vegetation along rivers and streams for privacy and pollution control. • Adopt new Flood Insurance Rate Maps. • Enforce sedimentation and erosion controls during and after construction. • Consider working with state geologists to map varves to be sure major construction does not take place on unsafe soils. • Do not allow construction of new roads near rivers and streams. • Consider a cost of community services study to investigate how conservation easements can help keep town service and school costs down if the land is not developed into house lots or into second homes which could later become year-round residences. • Require developers to follow BMPs for erosion and sedimentation control, and ensure that riverside construction activities do not impact riverbanks and riparian buffers.
Conservation Commissions	• Raise funds to support local volunteer water quality monitoring efforts that follow state protocols. • Educate people to keep their septic systems in good shape, to handle automotive fluids, pesticides, and other chemicals properly so they don't contaminate their own wells, and to select less hazardous alternatives. • Strongly encourage citizens to use regular household hazardous waste collections at Keene and Brattleboro. • Encourage more recycling, especially for mercury products. Encourage paint swaps and educate homeowners on how to dispose of paint. • Hold an annual spring "Green Up" Day. • Provide information to every new riverfront landowner to explain the special challenges of owning and managing riverfront land, including the benefits of riparian buffers and the requirements of the NH Comprehensive Shoreland Protection Act. • Encourage developers and landowners to establish and/or maintain buffers of native vegetation along rivers and streams for privacy and pollution control. • Conduct a campaing against Japanese knotweed and other invasive plants, educating homeowners to identify and remove them.

Appendix C. Continued

Road Crews	• Ensure that culverts are large enough to handle a heavy flow. Ensure that there is an adequate abutment around bridges for protection during heavy flow. • Ensure that culverts are regularly cleared of debris, especially if there is beaver activity in the area, to prevent blocking during storms. Watch for fallen trees upstream of smaller culverts and bridges, and cut large woody debris into smaller pieces or remove it in these locations. • Ensure that road salt supplies are properly stored so they do not contaminate surface or groundwater. • Ensure that fire and highway departments have up to date training in the proper handling of spills. • Follow BMPs for applying salt to roads, and consider using environmentally friendly de-icing products and establishing limited salt areas near waterways. • Follow snow disposal best management practices (BMPs). Snow should be stored on flat, pervious surfaces, such as grass, and at least 100 feet from the edge of a stream or river, with a silt fence between the snow and the stream. There are larger setbacks for snow disposal near public wells. By June 1 or once snow melts, debris should be quickly cleared from the site and brought to the landfill. • Include riparian buffer restoration in road projects near streams and rivers.
Regional Planning Commissions	
	• Include culvert issues in transportation planning. • Work with towns to offer more frequent hazardous waste collections. • Educate people to keep their septic systems in good shape, to handle automotive fluids, pesticides, and other chemicals properly so they don't contaminate their own wells, and to select less hazardous alternatives. • Offer training and model ordinances on low impact development to town planning boards/commissions.. • Encourage mercury product recycling; encourage paint swaps and educate homeowners on how to dispose of various kinds of paint • Assist towns with surveying culverts and bridges to identify those that are undersized; also note if they block fish passage and seek grants for replacing them where necessary. • Update information posted on web sites for brownfields and other contaminated properties.
County	
Cheshire County	• Allow no additional buildings to be built on the floodplain at the Cheshire County Farm, except for agricultural buildings, and protect the County Farm with a conservation easement.
Volunteer Groups	
Watershed Groups	• Pursue an aggressive volunteer water quality monitoring program for the Connecticut River and encourage participation by area schools, members of the academic and scientific community who live in the region, and the Bonnyvale Environmental Education Center in Brattleboro. • Participate in the relicensing process for Vernon and Bellows Falls Dams. • Citizens discovering a suspicious pipe or pollutant should contact the Department of Environmental Services (NH) or the Department of Environmental Conservation (VT). • Work with governmental agencies, landowners, and watershed associations to survey streambank erosion and siltation on Connecticut River tributaries in the Wantastiquet region.
Recreation Groups	• Fishermen should replace their lead sinkers and jigs with non-hazardous substitutes. • Check for trails that need water bars to keep stormwater from eroding compacted soils.
Youth Groups	• Raise funds to support local volunteer water quality monitoring efforts that follow state protocols.
Landowners	
Dam Owners	• Strongly consider removing dams whose costs outweigh the benefits they offer or are a threat to areas downstream, and investigate sources of funding assistance for dam removal.
Developers	• Keep natural drainage patterns and use pervious paving, swales and depressions ("rain gardens") in project designs to reduce runoff and capture it for groundwater recharge. • Landowners with concerns about possible contaminants on their property should contact their regional planning commission and the state to take advantage of available assistance, including loans and expertise.
Farmers	• Work with conservation districts and Cooperative Extension Service to reduce potential for water contamination from on-farm pollutants. • Retain riparian buffers to help prevent erosion of valuable soils and to trap nutrients that may wash off the land. • Preserve agricultural uses along the river and minimize negative impacts from agricultural practices on the river.
Forest Landowners	• Seek the advice of professional foresters to ensure responsible forest management. • Preserve forest lands along the river and minimize negative impacts from forestry on the river.

Appendix C. Continued

Waterfront Landowners	• Learn about the proper use and disposal of fertilizers, pesticides, and toxic materials; refrain from using fertilizer within 250' of rivers. Maintain and enhance the native riparian buffer vegetation, and avoid mowing to the water's edge. Select vegetative stabilization methods or where necessary, vegetative methods in combination with a rock toe to slow serious erosion problems that threaten structures. Recognize that people cannot stop erosion, they can only speed it up or slow it down. • Have sufficient flood insurance to offset a total loss if property is located in a floodplain.
All Landowners	• Keep culverts clear of debris. • Obey the ban on barrel burning of trash. • Know the location of and regularly maintain on-site septic systems. • Pursue increased energy efficiency to reduce airborne pollutants, including the carbon dioxide that contributes to climate change.

- Add a section for loggers?

Appendix D. Tributaries to the Connecticut River

New Hampshire

Tributary (watershed area, where known)	**State Assessment draft 2008 NH 303(d) List of Impaired Surface Waters**	**Local Observations**
Town where tributary enters Connecticut River: Walpole		
Mad Brook	water quality unknown	
Great Brook	water quality unknown	
Cold River (102 sq mi)	60 miles of the Cold River and more of its tributaries are on the TMDL list due to low pH, and 20.93 miles of the Cold River are also impaired by *E. coli*. Bio-assessments carried out after major flooding in 2005 indicate that the benthic macro-invertebrate community is impaired in 6.91 miles of the Cold River, and impaired fish communities, aluminum, and *E. coli* appear in another 4.86 miles affected by the flood.	Safe for swimming except at 5 sites, including 3 swimming holes, where *E. coli* levels exceed state standards. pH problems threaten aquatic life in some areas. One aluminum measurement exceeded the applicable standard. Copper, lead, and zinc were not detected. (Cold River Local Advisory Committee 2006 report) Sediment-laden water observed after heavy storm in 2004. Massive flooding 10/05, by 1/06 no riparian buffer left for 9 miles, vast gravel plain. 2006 Water quality monitoring at 29 sites by Cold River Local Advisory Committee: Portions of the watershed damaged by the October 2005 flood were the focus of detailed macro-invertebrate and fish community studies by DES and the NH Fish & Game Department. Preliminary findings from the studies suggest that insect and fish populations destroyed by the flood may be beginning to partially recover and that aquatic habitat damage remains severe with increased sedimentation and fewer deep pools. Most turbidity readings were very low but high levels continued to be observed in portions of the watershed damaged by the October 2005 flood. These areas remain highly vulnerable to erosion by rain stormsthat wash sediment from exposed stream banks into the water. Temperature data from Warren Brook and the lower Cold River (Walpole) suggest that those stream reaches are marginally suitable for wild brook trout in the summer. Low temperatures were generally observed but elevated temperatures were periodically recorded for the river, Warren Brook and Crane Brook.
Houghton Brook	water quality unknown	
Town where tributary enters Connecticut River: Westmoreland		
Aldrich Brook	water quality unknown	Third order stream 3.8 miles long, watershed 3.2 sq mi. Stream corridor mostly forested, significant agriculture. Isolated areas of road runoff, lack of buffer, erosion. No culvert problems. Garlic mustard. Bottom type largely cobbles and gravel, some ledge and sandy bottom. Some erosion, no riprap. Nearby well. Stream has no evident water quality problems, flow tends to be consistent, no trash, no monitoring, not used for irrigation or drinking water. No recreational use.

Appendix D. Continued

Tributary (watershed area, where known)	State Assessment draft 2008 NH 303(d) List of Impaired Surface Waters	Local Observations
unnamed brook	water quality unknown	Second order stream, 1.3 miles long, 0.55 sq mi watershed. Enters CT River ½ mile below Aldrich Brook. Largely forested corridor, good riparian vegetation, some areas intensively cropped and lawns. Perched and undersized culverts, honeysuckle. Bottom type largely sandy, some gravel. Stream has no evident water quality problems, flow tends to be consistent, no trash, no monitoring, not used for irrigation or drinking water. No recreational use.
unnamed brook	water quality unknown	Second order stream, 1.6 miles long, 0.79 sq mi. watershed. Enters CT River 1/4 mile above Mill Brook. Corridor mostly forested and agricultural. Banks 50-75% vegetated. Some intensive cropping and landscaped areas. Perched, undersized culverts. Glossy Buckthorn. Bottom type mostly cobbles and gravel, some silty areas. Stream has no evident water quality problems, flow tends to be consistent, no trash, no monitoring, not used for irrigation or drinking water. No recreational use.
Mill Brook	water quality unknown	Third order stream, 5.5 miles long, 11.5 sq. mi watershed. Massive flooding in April 2003 caused erosion, fish habitat degraded. Stream corridor partly forested, some dispersed and concentrated development. No culvert problems. Glossy Buckthorn. Route 12 follows closely along much of waterway. Bottom largely cobbles and gravel, some ledge or large boulders, ruffles, riprap. Stream has no evident water quality problems, flow tends to be consistent, no trash, no monitoring, not used for irrigation or drinking water.
unnamed brook	water quality unknown	First order stream, 0.58 miles long. watershed 0.16 sq.mi. Enters CT River ½ mile below Mill Brook. Stream corridor largely forested with 25-50% riparian vegetation. No public access.
unnamed brook	water quality unknown	First order stream, 0.63 miles long. watershed 0.16 sq.mi. Enters CT River 1 mile above Partridge Brook. Corridor mostly wooded, significant agriculture. Some intensively cropped land. No evident water quality problems, no trash.
Partridge Brook	16.26 miles unsafe for swimming due to *E. coli* from unknown source; fully supports use as drinking water after treatment	Fourth order stream, 5.1 miles long, watershed 26.5 sq. mi. Heavy flooding 2003 and 2005. Stream corridor is shaded from Westmoreland village until it reaches the CT River floodplain at the county farm. Residential area, many lawns to water's edge. Bottom type ledge to cobble, small cascades and waterfalls until it reaches the floodplain, where it has a silty bottom. Remnant floodplain forest at mouth. Regularly uses floodplain along lower Partridge Brook Road. Stream corridor includes some dispersed development, concentrated development, conserved land, and agriculture. Significant recreational use at Spofford Lake; some road runoff, intensive cropping with exposed soil, erosion, and lawns. Bottom type largely cobble and some ledge and silt. Riprap. Stream has no evident water quality problems, flow tends to be consistent, no trash, no monitoring, not used for irrigation or drinking water. Coldwater fishery, scenic.
unnamed brook	water quality unknown	First order stream, 0.87 miles long. watershed 0.19 sq.mi. Enters CT River 1/3 mile below Partridge Brook. Stream corridor mostly forested, significant agriculture below, where there is no buffer. Some intensive cropping, but grazing animals have no access. Some erosion, recreational use, road runoff. Culvert with 6" drop. Bottom type largely cobbles and gravel, some ledge, erosion, silt, riprap. 12" waterfall. Walking trail in corridor. Scenic. Stream has no evident water quality problems, flow tends to be consistent, no trash, no monitoring, not used for irrigation or drinking water
unnamed brook	water quality unknown	First order stream, 0.65 miles long, watershed .175 sq mi. enters CT River slightly below the brook described above. Stream corridor largely forested, small amount of agriculture. Some road runoff and erosion. Dump, perched culvert with 18" drop, undersized culvert, glossy buckthorn and honeysuckle. Bottom type mostly cobbles and gravel, some ledge, sand, and erosion. Stream has no evident water quality problems, flow tends to be consistent, no trash, no monitoring, not used for irrigation or drinking water. Scenic. Walking trail

Appendix D. Continued

Tributary (watershed area, where known)	**State Assessment draft 2008 NH 303(d) List of Impaired Surface Waters**	**Local Observations**
Ox Brook	water quality unknown	Third order stream 2.18 miles long, watershed 2.9 sq mi. Stream corridor mostly forested, some agriculture. Perched and undersized culverts, glossy buckthorn, honeysuckle, garlic mustard. Stream bottom varies from ledge to small boulders, gravel, and silt. Stream has no evident water quality problems, flow tends to be consistent, no monitoring, not used for irrigation or drinking water Trash in brook near River Road.
unnamed brook	water quality unknown	First order stream 0.65 miles long, watershed .16 sq mi. enters CT River 3/4 mile below Ox Brook. Stream corridor largely forested with some agriculture and some dispersed development. Some dumping, road runoff, riprap and erosion. undersized and perched (12″) culverts. Buckthorn, honeysuckle, garlic mustard. Bottom type largely cobbles and gravel, with some ledge and silt. 12″ waterfall.
unnamed brook	water quality unknown	Second order stream 0.48 miles long, watershed .07 sq mi. enters CT River ½ mile below stream described above. Stream corridor half forested, half in agriculture, some dispersed development. Some road runoff, erosion. Glossy buckthorn. Bottom type largely gravel, some ledge. Riprap. Stream has no evident water quality problems, flow tends to be consistent, no trash, no monitoring, not used for irrigation or drinking water. Very high quality.
unnamed brook	water quality unknown	First order stream 1.18 miles long, watershed .71 sq mi. enters CT River 1 ½ miles above Chesterfield line. Stream corridor largely forested, some agriculture. Some road runoff, erosion, culvert with 4″ drop, glossy buckthorn. Stream bottom mostly cobbles and gravel, some ledge and silty bottom. Some erosion. No trash on bank.
Town where tributary enters Connecticut River: Chesterfield		
Governor's Brook	water quality unknown	hanging culvert is being replaced with larger culvert that provides fish passage
Catsbane Brook	water quality unknown	some riprap and culvert replacement along Route 63.
Gulf Brook	water quality unknown	
Town where tributary enters Connecticut River: Hinsdale		
Ash Swamp Brook	5.37 miles impairments to benthic macro-invertebrates	Watershed largely forested, with some conserved land and dispersed development. Bottom varies from ledge and boulders to sand and silt. Some riprap; beaver dams. Minor road runoff. No evident water quality problems; flow tends to be relatively consistent. Not used for irrigation or drinking water. No trash on banks. Coldwater and warmwater fisheries. Has public access. No boating. No water quality monitoring. No scenic areas.
Liscomb Brook	water quality unknown	Watershed largely forested, with some conserved land, farming, and dispersed development. Some erosion. Bottom type largely sandy with some gravel. Beaver dams. No water quality monitoring underway; no evident water quality problems. Flow tends to be relatively consistent. Coldwater fishery. Has public access. No boating. Not used for irrigation or drinking water. No trash on banks. No trails in corridor.
Sprague Brook	water quality unknown	Watershed largely forested, with some commercial/industrial land.. Significant erosion and sedimentation, some undersized culverts. Purple loosestrife. Bottom type is sandy/silty. Stream is not a source of drinking water or irrigation. No evident water quality problems or trash. Flow tends to be consistent. No swimming, fishing, or boating. No scenic areas or trails in corridor.
Stage Road Brook	water quality unknown	Watershed largely forested with good riparian vegetation. Significant perched culverts blocking fish passage. Sandy bottom. Not used for irrigation or as source of drinking water. No water quality monitoring, no evident water quality problems. Flow tends to be relatively consistent. No trash. No swimming, fishing, or boating. Rail trail in corridor.

Appendix D. Continued

Tributary (watershed area, where known)	**State Assessment draft 2008 NH 303(d) List of Impaired Surface Waters**	**Local Observations**
Olde Brook	water quality unknown	Watershed largely forested, with some dispersed development and agriculture. Some intensively cropped land, and a perched culvert. Bottom type tends to be ledge, boulders, cobbles, gravel, and sand, with a waterfall and beaver dam. No water quality monitoring, no evident water quality problems. Flow tends to be relatively consistent. No trash. Coldwater fishery. No trails in corridor.
Holbrook Brook	water quality unknown	Watershed largely forested with some agriculture. No land use problems observed. Bottom tends to be ledge, boulders, gravel, and sand. No water quality monitoring, no evident water quality problems. Flow tends to be relatively consistent. No trash. No trails in corridor. No fishing or boating.
Ashuelot (420 sq mi)	10.82 miles low pH, 37.46 miles both low pH and contamination by *E. coli*, and another 7.89 miles contaminated by *E. coli* alone. Aluminum is a problem on 4.58 miles. A 2.57 mile stretch in Swanzey is contaminated by urban runoff that creates problems of low dissolved oxygen and pH.	Ashuelot River Corridor Management Plan, Ashuelot River Local Advisory Committee, 2006: Ashuelot 64 miles long, 425-square mile watershed in southwestern New Hampshire. The water quality in the upper reach is very good, but threats exist. The River Corridor varies from a precipitous gorge in highland forest through a narrow steep-sloped valley in Surry to a broad flat plain through farm fields and floodplain forest in Keene. The river transitions from a high energy upland stream of rapids and riffles coursing downhill through boulders, stones, and forest to a gentle meandering river flowing through backyards, floodplain forest, and farm fields toward the Connecticut River. Water quality above the Surry Mt. Dam is considered very good. The flood control reservoir has uncertain impacts on downstream water quality and habitat. The suburban development arising in Keene introduces non-point pollution. Pollution of ground and river water with chemical fertilizers, herbicides and pesticides used at a golf course is a concern. Suburbanization and the golf course have eliminated much of the riparian buffer below the Surry Mt. dam. Knotweed is present. As it runs through Keene, water quality is rated as good by the state. However, the river water is subject to suburban and urban non-point source pollution, including subsurface contamination from Keene's industrial heritage. Due to the presence of two flood control dams, the River channel is filling with sediment that would have been scoured out or deposited on the floodplain areas. Also noted downstream of Keene was the increase in total phosphorus. From Keene south to the Connecticut River, cleaning up contaminated soil, protecting floodplain from development, and cleaning up storm water runoff are priorities for action.

Appendix D. Continued

Vermont

Tributary (watershed area, where known)	State Assessment sources listed below	Local Observations
Town where tributary enters Connecticut River: Westminster		
Saxtons River	The Saxtons River rises on the eastern slopes of the southern Green Mountains and flows southeasterly across the Vermont Piedmont to the Connecticut River. Its length is 20 miles draining an area of 78 square miles with a total drop of 1800 feet. The upper watershed is characterized by narrow steep gorges cut through rugged hilly uplands with outcropping bedrock and poor drainage. Public swimming holes at Twin Falls and Saxtons River Falls. Upper reaches support healthy populations of wild native brook trout but high summer water temperatures limit trout populations in the lower river. Stocked with Atlantic salmon since 1988; several adults have returned. Popular for spring kayaking. Threats to fishing and aesthetics due to erosion, removal of riparian vegetation and encroachment, channel modification. 600' riprap project installed 2005. Used for ag irrigation. Dynamic stream, prone to flooding; priority candidate for stream geomorphic assessment. Plans in place to remove defunct dam near mouth. Lower river has poor riparian condition leading to sediment and temperature impacts.	Sediment-laden water observed after heavy storm in 2004.
Morse Brook	water quality unknown	
Mill Brook	water quality unknown	
Fullum Brook	water quality unknown	

Town where tributary enters Connecticut River: Putney		
East Putney Brook	threatened with nutrients and pathogens; excellent biological condition 1994-5	
Sackett's Brook	undefined pollutants; habitat degradation; possible periodic spills at paper company; needs additional upstream monitoring	6/04 - reported seeing a white plume of discharge at the mouth that had a paper sludge smell. Sediment-laden water observed after heavy storm in 2004; hillsides are being cleared on Windmill Hill Road for development of new houses
Town where tributary enters Connecticut River: Dummerston		
Salmon Brook	aquatic health good, 1992	watershed largely forested, with some dispersed development and roads. Significant erosion; some problems with road runoff, lack of buffer, landscaped areas, old dump, perched culvert, and buckthorn. Bottom tends to be cobbles and gravel or sand. Old tires from homeowner's attempt at bank stabilization. Coldwater fishery. Pleasant forested area, some orchards. School stocks Atlantic salmon.

Appendix D. Continued

Tributary (watershed area, where known)	State Assessment sources listed below	Local Observations
Crosby Brook	lowest 0.7 miles: habitat alterations due to sedimentation, channelization and buffer loss	Several large paved areas shed water to the brook, which is impaired. Of the brook's two branches, the Brattleboro one appears in worse condition. Monitoring is being conducted by VT DEC. Turbidity, silting, and erosion are observed, and there is trash on the bank. No fishing. The brook's watershed is largely wooded with some urban development. A perched culvert blocks fish passage, and buckthorn is growing near the stream.
Mill Brook	aquatic health good, 1992	
Canoe Brook	aquatic health good, 1992	
Town where tributary enters Connecticut River: Brattleboro		
West River	The mainstem of the West River originates in Mount Holly, 2,400 feet above sea level. It flows south through Weston and Londonderry then southeasterly to Brattleboro where it meets the Connecticut River. The length of the mainstem is 46 miles and the river drains a 423 square mile watershed. The uppermost section flows through forested then partially open country. It has a stony bottom with extensive gravel bars and is considered good trout and salmon habitat. The river continues in a southerly direction below Winhall Station with the valley narrowing in the mile before the river flows into the Ball Mountain reservoir. From Ball Mountain Dam to the bridge at Jamaica, the West River flows in through a wooded undeveloped area defined by a steep, wooded ravine. The river is fairly deep and rocky. This section is famous as a white water boating run. Below Wardsboro Brook, the river widens and enters a flat basin in the backwater for Townshend Dam. From Williamsville Station to the mouth, the riparian corridor is more developed with Route 30 running along the riverbank for the last 8 miles. This lower section is fairly wide with bedrock exposures and wooded banks. One mile above the mouth is a wetland area called Retreat Meadows, a backwater created by the Vernon Dam on the Connecticut River. Fishing is affected by high summer temperatures and loss of riparian vegetation, flow modification from Townsend Dam. Threatened by pathogens from land development, streambank erosion, road runoff, and impoundment de-silting. Possible septic system discharges and/or discharge of septage in Londonderry. Lowest 12 miles show wide shallow channel, loss of riparian vegetation causing temperature modification, and flow affected by operations at Army Corps flood control dams.	
Whetstone Brook	*E. coli* from unknown sources, sediment; urban runoff, encroaching urbanization; riparian development; potentially faulty sewer line/septic system. hazardous waste spill was cleaned up; annual sampling shows contaminants declining.	high bacteria levels, sediment, receives urban runoff
Broad Brook	little or no riparian vegetation in half of stream; silted; excellent biological condition 1998	
Town where tributary enters Connecticut River: Vernon		
Newton Brook	lowest 2 miles: contaminated with sediment from agricultural activity.	
Scooter Brook	fair biological condition 1998	

Basin 11 - West, Williams & Saxtons Rivers Assessment Report, VT Agency of Natural Resources Water Quality Division, Nov. 2001, ALSO Preliminary Draft Basin Management Plan; West River, Williams River, Saxtons River, Windham County Natural Resources Conservation District, January 2007
Basin 13 - Lower Connecticut River Direct Drainage Assessment Report, VT Agency of Natural Resources Water Quality Division, April 2002
2008 VT draft 303(d) List of Impaired Surface Waters and 2008 draft VT List of Priority Surface Waters Outside the Scope of Clean Water Act Section 303(d)

Appendix E. Water & Sediment Quality

Water Quality

Results of 2004 water quality assessment by the New Hampshire Department of Environmental Services, with support from CRJC and US EPA Region I.

Connecticut River mainstem segment	Sampling Location	Towns	Miles	Assessment - 2004
Bellows Falls Dam to end of bypassed section of the River	Vilas Bridge	Walpole	½ mile	Safe for swimming, boating, fishing Meets state standards for supporting aquatic life **Fish consumption unsafe - mercury**
End of Bellows Falls bypass to confluence with Houghton Brook, Walpole	Route 123 Bridge	Walpole Westminster	7.5 miles	Safe for swimming, boating, fishing Meets state standards for supporting aquatic life **Fish consumption unsafe - mercury**
Confluence with Houghton Brook to confluence with Partridge Brook	Cheshire County Farm just above Partridge Bk.	Walpole Westmoreland Westminster	4.5 miles	Safe for swimming, boating, fishing Meets state standards for supporting aquatic life **Fish consumption unsafe - mercury**
Confluence with Partridge Brook to confluence with West River	Route 9 Bridge	Westmoreland Westminster Chesterfield Putney Dummerston Brattleboro	11 miles	Safe for swimming, boating, fishing Meets state standards for supporting aquatic life **Fish consumption unsafe - mercury**
One mile below Route 9 Bridge to Vernon Dam	Route 119 Bridge	Chesterfield Brattleboro Hinsdale Vernon	6 miles	Safe for swimming, boating, fishing Meets state standards for supporting aquatic life **Fish consumption unsafe - mercury**
Vernon Dam to Route 10 Bridge, Northfield, MA	Route 10 Bridge	Hinsdale Vernon	6 miles	Safe for swimming, boating, fishing Does not meet state standards for supporting aquatic life due to aluminum and copper **Fish consumption unsafe - mercury**

Swimming, fishing, and boating - determined by measurements of bacteria (*E. coli*)
Aquatic habitat - determined by measurements of dissolved oxygen, pH, specific conductance, and temperature
Fish consumption advisories: Information is available on the web at: www.wildlife.state.nh.us/Fishing/fish_consumption.htm.

Appendix E. Continued

Sediment Quality

Sampling Location	Town	Contaminants Identified
Connecticut River downstream of confluence of Sackett's Brook	Putney VT	***Levels above those expected to have ecological effects*** • nickel • copper • chrysene ***Levels below those expected to have ecological effects*** • breakdown products of pesticide DDT • polyaromatic hydrocarbons (PAHs)
Connecticut River downstream of confluence of West River, Vernon Pool	Brattleboro VT	***Levels above those expected to have ecological effects*** • nickel • copper ***Levels below those expected to have ecological effects*** • polyaromatic hydrocarbons (PAHs)
Connecticut River downstream of confluence of Ashuelot River	Hinsdale NH	***Levels above those expected to have ecological effects*** • none ***Levels below those expected to have ecological effects*** • polyaromatic hydrocarbons (PAHs)

1998 Upper Connecticut River Sediment/Water Quality Analysis, US EPA, Region 1. A study of 10 locations on the mainstem from Stewartstown to Hinsdale NH.

Appendix F. Invasive Aquatic Species

Invasive Aquatic Species (may not be a complete list)		**New Hampshire**		**Vermont**		**Present in Conn. River mainstem**	**Present in Wantastiquet Region?**
		present	**prohibited by state**	**present**	**prohibited by state**		
Floating Plants	European Naiad - *Najas minor*	X	X	X		X	X
	Water Chestnut - *Trapa natans*	X	X	X			
	Yellow Floating Heart - *Nymphoides peltata*		X	X			
Submerged Plants	Rock Snot - *Didymosphenia geminata*	X		X		X	
	Variable Milfoil - *Myriophyllum heterophyllum*	X	X				
	Fanwort - *Cabomba caroliniana*	X	X		X		
	Eurasian Water-Milfoil - *Myriophyllum spicatum*	X	X	X		X	X
	Brazilian Elodea - *Egeria densa*	X	X		X		
	Curly-leaf Pondweed - *Potamogeton crispus*	X	X	X		X	X
	Parrot Feather - *Myriophyllum aquaticum*		X				
	Hydrilla - *Hydrilla verticillata*		X		X		
	European Frogbit - *Hydrocharis morsus-ranae*		X	X	X		
	Indian Water Star - *Hygrophila polysperma*				X		
	Giant Salvinia - *Salvinia auriculata*				X		
	Giant Salvinia - *Salvinia herzogii*				X		
	Giant Salvinia - *Salvinia molesta*				X		
	Giant Salvinia - *Salvinia biloba*				X		
	Great Water Cress - *Rorippa amphibia*			X			

Appendix F. Continued

Emergent Plants	Purple Loosestrife - *Lythrum salicaria*	X	X	X		X	X
	Common Reed - *Phragmites australis*	X	X	X		X	X
	Flowering Rush - *Butomus umbellatus*		X	X			
	Japanese Knotweed - *Fallopia japonica*	X		X		X	X
	Yellow Flag Iris - *Iris pseudoacorus*	X		X		X	X
	True forget-me-not - *Myosotis scorpioides*	X		X		X	X
Animals	Zebra Mussel - *Dreissena polymorpha*			X			
	Faucet Snail - *Bithynia tentaculata*			X			
	Chinese mystery snail - *Cipangopaludina chinensis*			X			
	Common Carp - *Cyprinus carpio*	X		X			X
	Gizzard Shad - *Dorosoma cepedianum*	X		X			X
	White Perch - *Morone americana*	X		X			X
	Rusty Crayfish - *Orconectes rusticus*		X	X			
	European Rudd - *Scardinius erythrophthalmus*		X	X			
	Walking Catfish - *Clarias batrachus*		X				
	Grass carp - *Ctenopharyngodon idella*		X				
	Round goby - *Neogobius monachus*		X				

Appendix G. Local Shoreland and Water Quality Protection

New Hampshire Towns

Town Tools	Walpole	Westmoreland	Chesterfield	Hinsdale
1. Master Plan is in effect (most recent update)	Yes (1998)	Yes (2003)	Yes (1996)	Yes (2003)
2. River is mentioned in master plan	Yes	Yes	Yes	Yes
3. Scenic or historic resources mentioned in master plan and/or zoning	Yes	Yes	Yes	Yes
4. Zoning is in effect	Yes (2003)	Yes (2002)	Yes (2004)	Yes (2004)
5. Subdivision Regulations are in effect	Yes (2003)	Yes (2002)	Yes (2001)	Yes (2002)
6. Site Plan Review is in effect	Yes (2004)	Yes (2002)	Yes (2001)	Yes (2004)
7. Excavation Regulations are in effect	Yes	Yes	Yes	No
8. Shoreland Protection Regulations	No	No	Yes	No
a. Building setback required from waterways? *(50′ setback on CT River - state law)*	No	Yes - 75′ town wide	Yes - 50′ town wide	No
b. Development prohibited in flood hazard area? *(100 year floodplain)*	No	No	No	No
c. Riparian buffer protected? *(150′ buffer on CT River where exists -state law)*	No	No	Yes -150′	No
d. Overlay district for rivers & streams?	No	No	Yes	No
e. Minimum frontage required for shore lots? *(150′ min. on CT. River if no sewer-state law)*	No	No	No	No
f. Local regulation of docks in effect?	No	No	No	No
9. Wetlands Regulations	No	Yes	No	No
a. Uses regulated in wetlands?	No	Yes	No	No
b. Activities regulated in a buffer zone around wetlands?	No	Yes -75′	No	No
10. Groundwater Protection Regulations	No	No	No	No
a. Uses regulated over aquifers ?	No	No	No	No
b. Well-head protection area defined?	Yes	No	No	No
c. On-site sewage disposal buffer around water supplies?	No	No	No	No
11. Agricultural Soils Protection Regulations	No	No	No	No
12. Steep Slopes Regulations	No	No	No	No
13. Town has a conservation commission	Yes	Yes	Yes	Yes

Source: Southwest Region Planning Commission, January 2005

Appendix G. Continued

Vermont Towns

Town Tools	Westminster	Putney	Dummerston	Brattleboro	Vernon
1. Master Plan is in effect (most recent update)	Yes (2002)	Yes (2000)	Yes (2004)	Yes (2003)	Yes (2003)
2. River is mentioned in master plan	Yes	Yes	Yes	Yes	Yes
3. Scenic or historic resources mentioned in master plan and/or zoning	Yes	Yes	Yes	Yes	Yes
4. Zoning is in effect (most recent update)	Yes (1994)	Yes (2002)	Yes (2001)	Yes (1938, 2004)	No; 1992 sewer ord.
5. Subdivision Regulations are in effect	Yes (2001)	Yes (2002)	No	Yes (1981)	No
6. Site Plan Review is in effect	Yes (1994)	Yes (2002)	No	Yes	No
7. Excavation Regulations are in effect	Yes	Yes	Yes	Yes	No
8. Shoreland Protection Regulations	Yes (1994)	Yes - w/ in 500′ of CT R.	Yes – w/in 500′ CT R., 250′ brooks	Yes	No
a. Building setback required from waterways? *(No state protection)*	Yes - 50′ from water courses	Yes	Yes - sewers 100′, principal 50′	Yes - CT & West Rivers; 100′or 50′ dep. on site	No
b. Development prohibited in flood hazard area? *(100 year floodplain)*	No	No	No	No	No
c. Riparian buffer protected? *(No state protection)*	Yes - 50′	50′-110′ varies with slope; > 41% = 20′ @ 10%	No	Yes - CT & West Rivers; 100′or 50′ dep. on site	No
d. Overlay district for rivers & streams?	Yes	Yes - 75′ from stream center	Yes	Yes	No
e. Minimum frontage required for shore lots? *(No state protection)*	No	Yes - 50′	No	No	No
f. Local regulation of docks in effect?	No	Yes	No	No	No
9. Wetlands Regulations	Yes	Yes	No	No	No
a. Uses regulated in wetlands?	Yes	Yes	No	No	No
b. Activities regulated in a buffer zone around wetlands?	Yes - 50′	No	No	No	No
10. Groundwater Protection Regulations	No	Yes	No	Yes	No
a. Uses regulated over aquifers ?	No	Yes	No	No	No
b. Well-head protection area defined?	No	Yes	No	Yes	No
c. On-site sewage disposal buffer around water supplies?	Yes - 150′	No	No	Yes	No
11. Agricultural Soils Protection Regulations	Yes	No	No	No	No
12. Steep Slopes Regulations	No	No	No	No	No
13. Town has a conservation commission	No	Yes	Yes	Yes	No

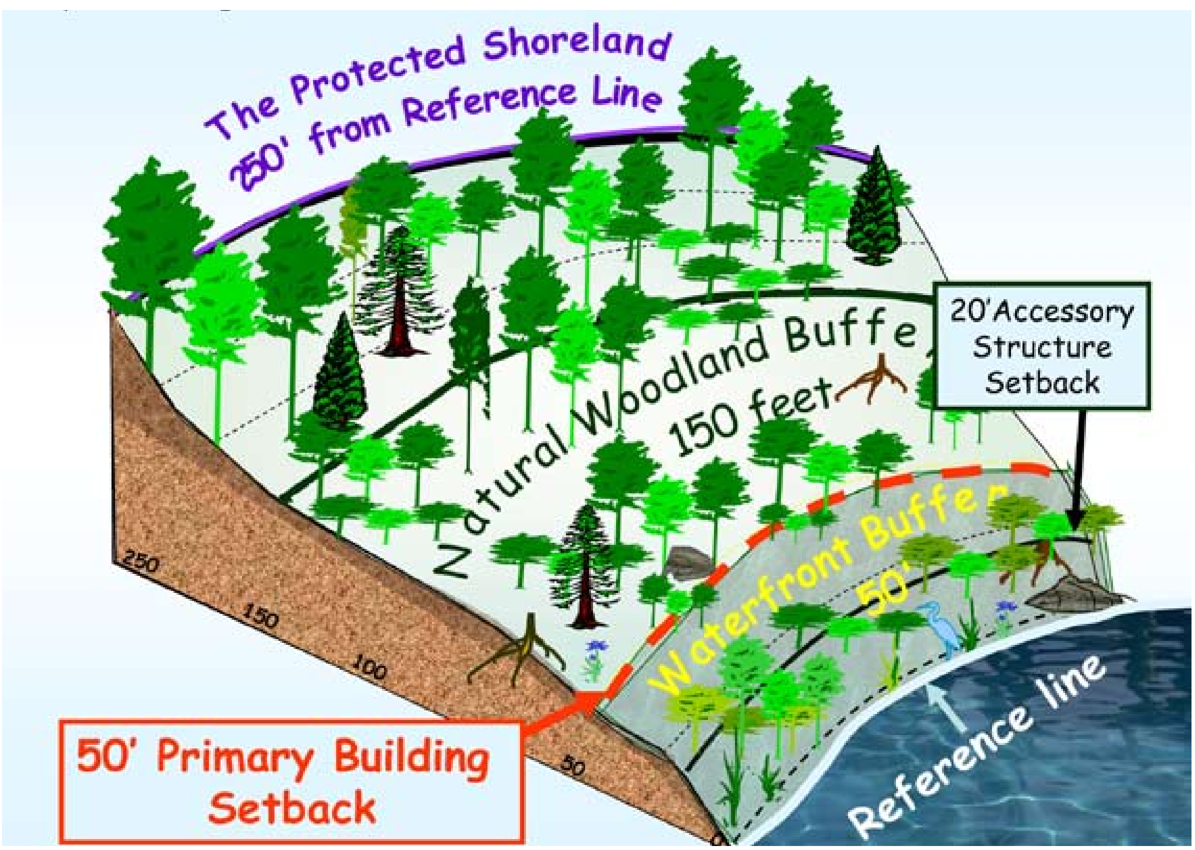
Appendix H. Registered Water Withdrawals

Type	Name	Facility	Source	Town
water supplier	North Walpole Vil Dist	Water Works	groundwater	Walpole
water supplier	Walpole Water Department	Water Works	groundwater	Walpole
mining	Lane Construction Corp	Cold River Materials	Cold River	Walpole
institutional	Cheshire County Complex	Nursing Home and Jail	Connecticut River	Westmoreland
irrigation	Pine Grove Springs	Pine Grove Springs	Spofford Lake	Chesterfield
water supplier	Hinsdale Water Works	Hinsdale Water Works	groundwater	Hinsdale

Source: NH DES

Appendix I. Rivers Covered by the N.H. Comprehensive Shoreland Protection Act

City/ Town	River/ Stream	Stream Order	Beginning of Fourth Order or Higher Segment
Walpole	Connecticut River	7	Juncture of Scott Brook in Pittsburg
	Cold River	4 & 5	Juncture of Dodge Brook in Acworth
Westmoreland	Connecticut River	7	Juncture of Scott Brook in Pittsburg
	Mill Brook	4	Juncture of unnamed 3rd order stream
	Partridge Brook	4	Juncture of Glebe Brook
Chesterfield	Connecticut River	7	Juncture of Scott Brook in Pittsburg
Hinsdale	Connecticut River	7	Juncture of Scott Brook in Pittsburg
	Ashuelot River	7	Outflow of Butterfield Pond in Washington



The protected shoreland in New Hampshire. Source: NH DES.

Appendix I. Continued

RSA 483-B

Comprehensive Shoreland Protection Act (CSPA)

A Summary of the Standards

Effective July 1, 2008, **A STATE SHORELAND PERMIT is required for many construction, excavation or filling activities within the Protected Shoreland**. Forest management not associated with shoreland development or land conversion and conducted in compliance with RSA 227-J:9 or under the direction of a water supplier for the purpose of managing a water supply watershed, and agriculture conducted in accordance with best management practices as required by RSA 483-B, III is exempted from the provisions of the CSPA. Projects that receive a permit under RSA 482-A, e.g., beaches, do not require a shoreland permit. A complete list of activities that do not require a shoreland permit can be found in the Shoreland Administrative Rules, Env-Wq 1406.

250 feet from Reference Line—THE PROTECTED SHORELAND:

Impervious Surface Area Allowance. Twenty percent of the area within the protected shoreland may be impervious surface. This may be increased up to 30 percent if there are 50 points of tree coverage in each 50 foot x 50 foot grid segment in the waterfront buffer (WB), and a storm water management plan is submitted and approved by DES.

Other Restrictions:

- No establishment/expansion of salt storage yards, auto junk yards, solid waste and hazardous waste facilities.
- All new lots, including those in excess of 5 acres are subject to subdivision approval by DES.
- Setback requirements for all new septic systems are determined by soil characteristics.
    - 75 feet for rivers and areas where the there is no restrictive layer within 18 inches and where the soil down gradient is not porous sand and gravel (perc>2 min.).
    - 100 feet for soils with a restrictive layer within 18 inches of the natural soil surface.
    - 125 feet where the soil down gradient of the leachfield is porous sand and gravel (perc rate equal to or faster than 2min/in.).
- Minimum lot size in areas dependent on septic systems determined by soil type.
- Alteration of Terrain Permit standards reduced from 100,000 square feet to 50,000 square feet.
- For *new* lots with on-site septic, the number of dwelling units per lot shall not exceed 1 unit per 150 feet of shoreland frontage.

150 feet from Reference Line—NATURAL WOODLAND BUFFER (NWB) RESTRICTIONS:

- For lots that contain ½ acre or more within the NWB, between 50 feet and 150 feet of the reference line, the vegetation within at least 50 percent of the area, exclusive of impervious surfaces, shall be maintained in an unaltered state.
- For lots that contain less than ½ acre within the NWB, between 50 feet and 150 feet of the reference line, the vegetation within at least 25 percent of the area shall be maintained in an unaltered state.

50 feet from Reference Line—WATERFRONT BUFFER and PRIMARY BUILDING SETBACK:

- Effective April 1, 2008, all primary structures must be set back at least 50 feet from the reference line. Towns may maintain or enact their own setback only if it is greater than 50 feet.
- Within 50 feet, a waterfront buffer must be maintained. Within the waterfront buffer, tree coverage is managed with a 50-foot x 50-foot grid and points system. Tree coverage must total 50 points in each grid. Trees and saplings may be cut as long as the sum of the scores for the remaining trees and saplings in the grid segment is at least 50 points.
- No natural ground cover shall be removed except for a footpath to the water that does not exceed 6 feet in width and does not concentrate stormwater or contribute to erosion.
- Natural ground cover, including the duff layer, shall remain intact. No cutting or removal of vegetation below 3 feet in height (excluding lawns) except for the allowable footpath. Stumps, roots, and rocks must remain intact in and on the ground.
- Pesticide or herbicide applications must be by a licensed applicator only.
- Low phosphorus, slow release nitrogen fertilizer may be used for the area that is beyond 25 feet from the reference line. No fertilizer, except limestone, shall be used between the reference line and 25 feet.

REFERENCE LINE: For ***coastal waters*** it is the highest observable tide line; for ***rivers*** it is the ordinary high water mark; for ***natural fresh waterbodies*** it is the natural mean high water level; and for ***artificially impounded fresh waterbodies*** it is the elevation at the spillway crest or, if there are flowage rights, the elevation of the flowage rights.

NON-CONFORMING STRUCTURES Are structures that, either individually or when viewed in combination with other structures on the property, do not conform to the provisions of the CSPA, including but not limited to the impervious surface limits of RSA 483-B:9V(g). They may be repaired, renovated, or replaced in kind using modern technologies, provided the result is a functionally equivalent use. Such repair or replacement may alter the interior design or existing foundation, but shall result in no expansion of the existing footprint except as authorized by the department pursuant to paragraph II of RSA 483-B.

A SITE ASSESSMENT is required prior to executing a purchase and sale agreement for any "developed waterfront property" using a septic disposal system and which is contiguous to or within 200 feet of a great pond (a public water of more than 10 acres) as defined in RSA 4:40-a and upon which stands a structure suitable for either seasonal or year-round human occupancy.

For more information, please visit the DES Shoreland Website at www.des.nh.gov/cspa

Appendix J. List of Acronyms

BMP = best management practices
CFS = cubic feet per second
CREP = Conservation Reserve Enhancement Program
CRJC = Connecticut River Joint Commissions
CSO = combined sewer overflow
EPA = United States Environmental Protection Agency
FEMA = Federal Emergency Management Administration
NH DES = New Hampshire Department of Environmental Services
NPDES = National Pollutant Discharge Elimination System
NRCS = Natural Resources Conservation Service of USDA
TMDL = total maximum daily load
USDA = United States Department of Agriculture
USGS = United States Geological Survey
UST = underground storage tank
VRAP = Volunteer River Assessment Program
VT DEC = Vermont Department of Environmental Conservation of ANR
VT ANR = Vermont Agency of Natural Resources
WWTF = wastewater treatment facility

Appendix K. Water Resources Maps

Data Sources:
NH base map features, including roads and railways, from 1:24,000 Digital Line Graph (DLG) data supplied by Complex Systems Research Center, UNH (CSRC). VT base map features from 1:5,000 orthophotos distributed by VT Center for Geographic Information (VCGI). VT roads from Enhanced 911 Board, distributed by VCGI. VT railway from USGS 1:100,000 DLG data, distributed by VCGI, 1987.

NH watershed boundaries by US Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) and NH Department of Environmental Services (NHDES), 1:24,000 scale, distributed by CSRC, 1983. VT watershed boundaries by USDA NRCS, 1:24,000 scale, from USGS DLG's and Digital Raster Graphics (DRG), distributed by VCGI.

Wetlands data provided by the US Fish & Wildlife Service, National Wetlands Inventory (NWI). NH wetlands distributed by CSRC, 1:24,000 scale. VT wetlands distributed by VCGI, 1:80,000 scale.

Aquifers mapped by US Geological Survey (USGS) in cooperation with NHDES, 1:24,000 scale, distributed by CSRC, 2000. For detailed information, see Geohydrology and Water Quality of Stratified-Drift Aquifers in the Middle Connecticut River Basin, West-Central NH, USGS Water-Resources Investigations Report 94-4181 or Geohydrology and Water Quality of Stratified-Drift Aquifers in the Lower Connecticut River Basin, Southwestern NH, USGS Water-Resources Investigations Report 92-4013. No digitized aquifers available in the state of VT.

NH public drinking water supply sources from NHDES, 1:24,000 scale, distributed by NHDES, 1997. VT public drinking water sources by Halliburton NUS Corporation, funded by US Environmental Protection Agency (EPA), distributed by Vermont Agency of Natural Resources (VTANR), 1994.

Sediment locations from US Environmental Protection Agency--New England, 1999, Office of Environmental Management and Evaluation Ecosystem Assessment Unit. This study sampled river sediments in 10 locations along the mainstem between Pittsburg, NH and the confluence of the Ashuelot River in Hinsdale, NH. Sediments were analyzed for the presence of heavy metals, pesticides/PCBs, polyaromatic hydrocarbons, total petroleum hydrocarbons, and total organic carbon. "High risk priority" means that the concentration of the pollutant(s) found in the sediment suggests a strong likelihood of impacts to aquatic life. "Moderate risk priority" means that the concentration of the pollutant(s) found in the sediment suggests a moderate likelihood of impacts to aquatic life.

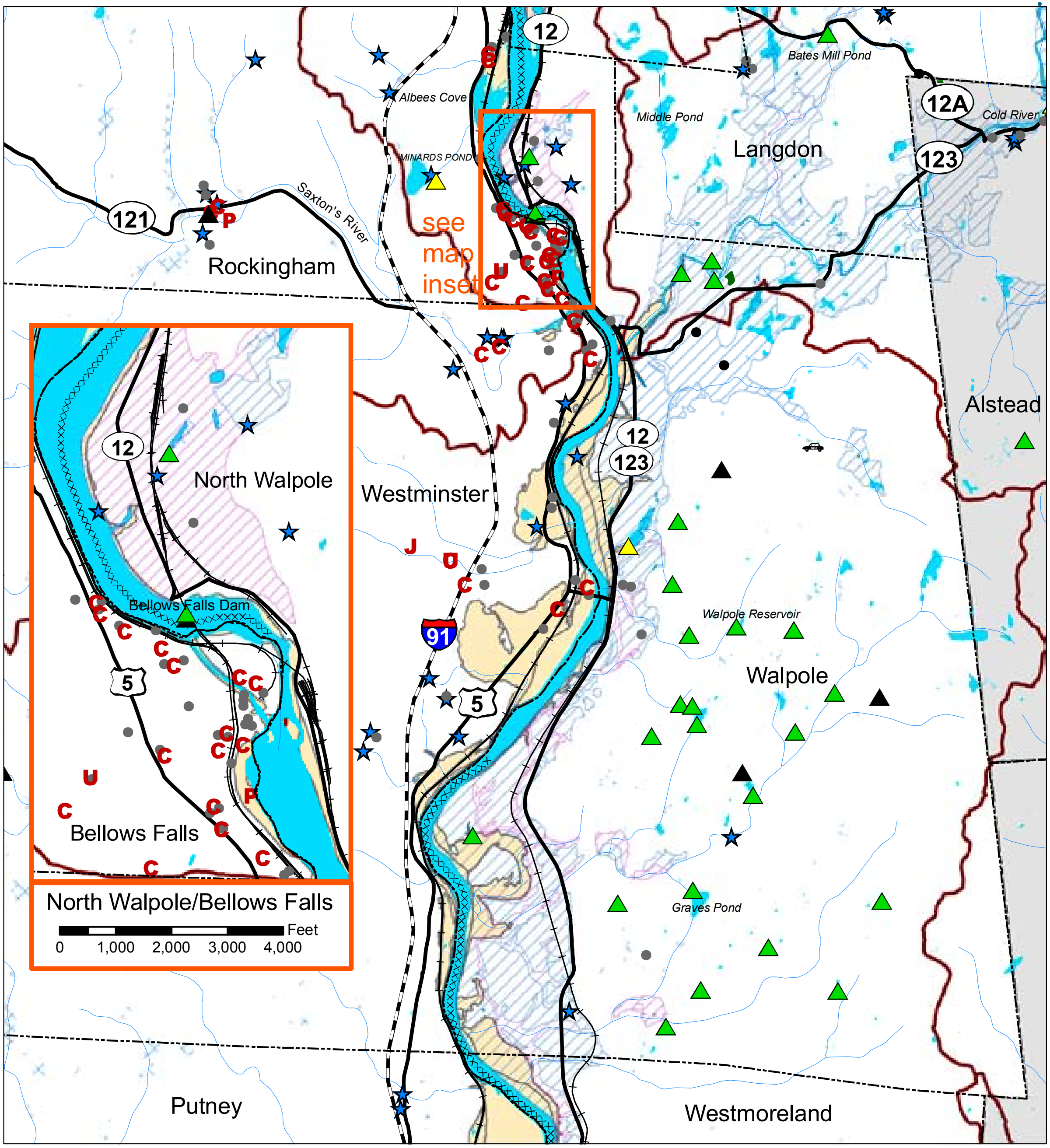
Potential water quality threats in NH distributed by NHDES include the following:
Underground Storage Tank Facilities, 2004.
Automobile Salvage Yards, 1991.
Point/Non-point Potential Pollution Sources**
Groundwater Hazard Inventory, 2003 **
**Refer to written report for more detailed information on each potential water quality threat categories.

Potential Water Quality Threats in VT from VTANR distributed by VCGI include Underground Storage Tank Facilities and the Pollution Source Inventory of 1980.

Floodplains from ENSR International, Westford, MA, funded by Federal Emergency Management Agency, 2003.

The impoundment zone, or upstream extent of impoundments, generated by MicroData, 1994, based on source data provided by Connecticut River Joint Commissions.

Maps created by Upper Valley Lake Sunapee Regional Planning Commission, by R. Ruppel, GIS Analyst.



Water Resources - Walpole, NH

Wantastiquet Subcommittee

Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway

Major Water Bodies
Wetlands
Aquifers
Stratified-Drift Aquifers
Glacial Lake Bottom Deposits

100-Year Floodplain
Public Water Supply
Sediment Locations
High Risk Priority
Moderate Risk Priority

Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned
XXXXX Impoundment Zone

N W E S

Water Quality Threats

VT Pollution Source Inventory of 1980
C Petrochemicals
J Junk Yard/Salvage Yard
K Liquid Waste to Land Surface/Subsurface
L Landfilll/Dump
P Lagoon-Municipal
U Salt/Salted Sand

Underground Storage Tank Facilities

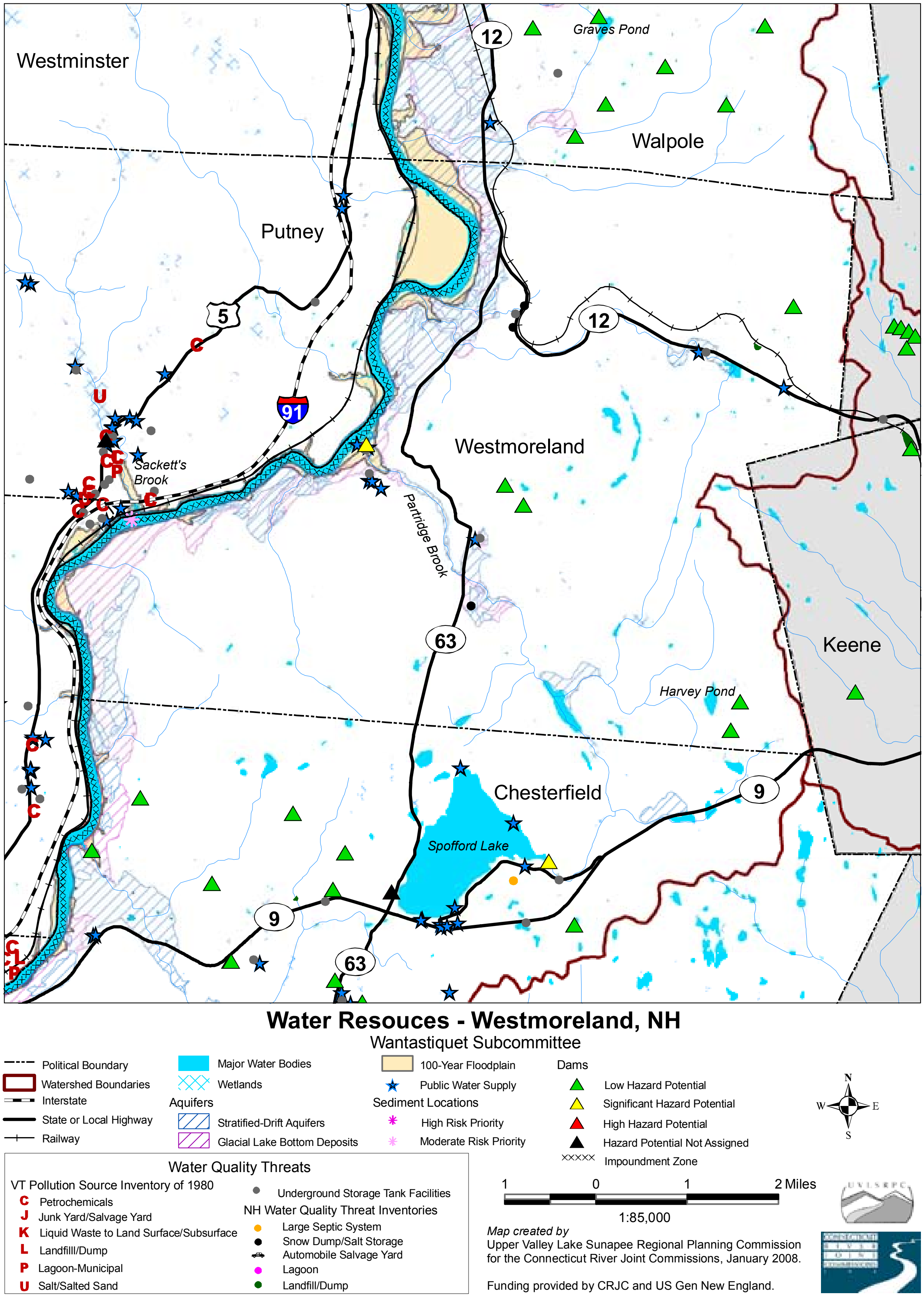
NH Water Quality Threat Inventories
Large Septic System
Snow Dump/Salt Storage
Automobile Salvage Yard
Lagoon
Landfill/Dump

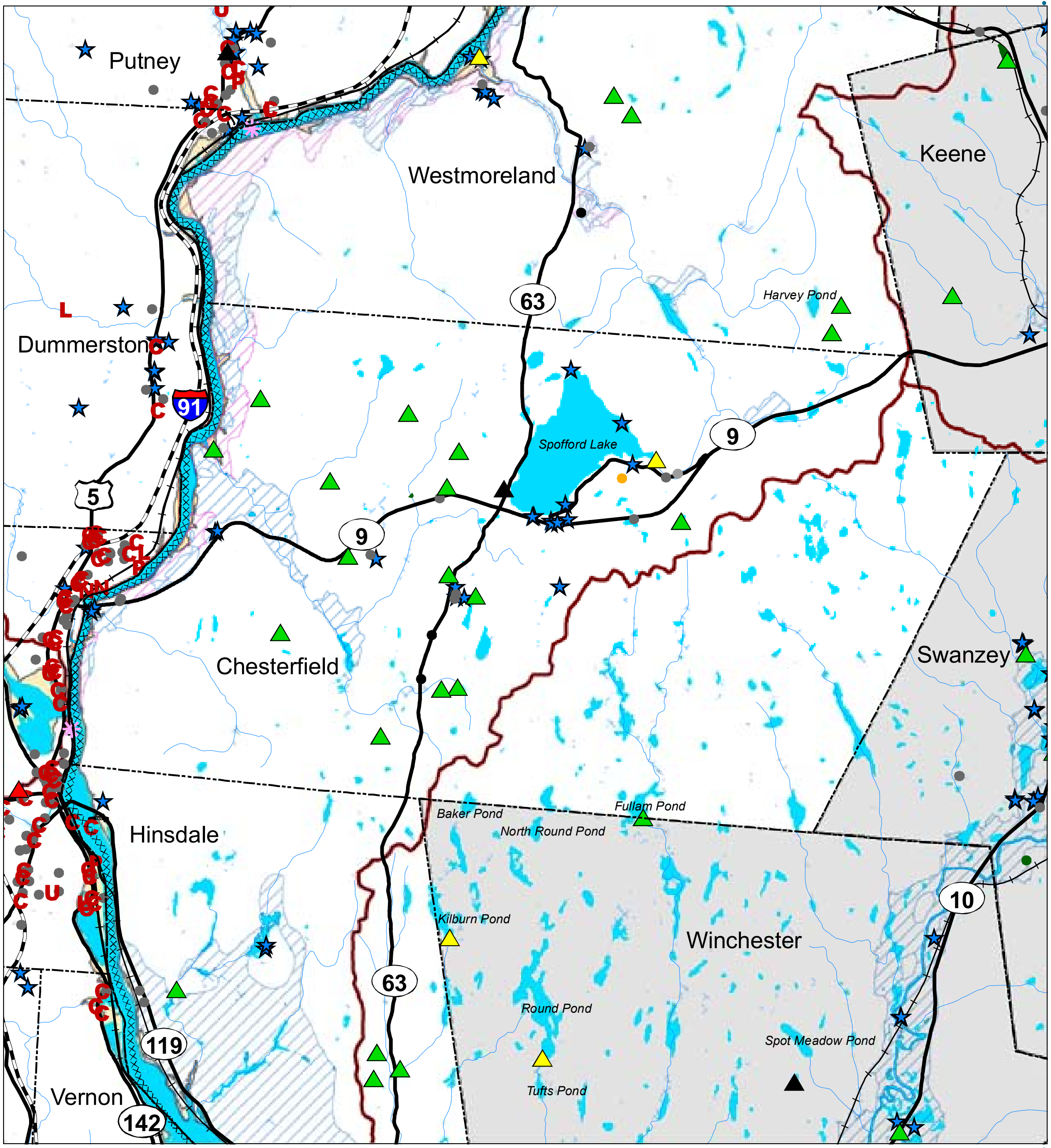
0.7 0 0.7 1.4 Miles

1:85,000

Map created by
Upper Valley Lake Sunapee Regional Planning Commission
for the Connecticut River Joint Commissions, January 2008.

Funding provided by CRJC and US Gen New England.


Westminster
Graves Pond
Walpole
Putney
Westmoreland
Sackett's Brook
Partridge Brook
Keene
Harvey Pond
Chesterfield
Spofford Lake
12
5
91
63
9
Water Resouces - Westmoreland, NH
Wantastiquet Subcommittee
Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway
Major Water Bodies
Wetlands
Aquifers
Stratified-Drift Aquifers
Glacial Lake Bottom Deposits
100-Year Floodplain
Public Water Supply
Sediment Locations
High Risk Priority
Moderate Risk Priority
Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned
Impoundment Zone
Water Quality Threats
VT Pollution Source Inventory of 1980
C Petrochemicals
J Junk Yard/Salvage Yard
K Liquid Waste to Land Surface/Subsurface
L Landfilll/Dump
P Lagoon-Municipal
U Salt/Salted Sand
Underground Storage Tank Facilities
NH Water Quality Threat Inventories
Large Septic System
Snow Dump/Salt Storage
Automobile Salvage Yard
Lagoon
Landfill/Dump
1 0 1 2 Miles
1:85,000
N
W
E
S
Map created by
Upper Valley Lake Sunapee Regional Planning Commission
for the Connecticut River Joint Commissions, January 2008.
Funding provided by CRJC and US Gen New England.



Water Resouces - Chesterfield, NH

Wantastiquet Subcommittee

- Political Boundary
- Watershed Boundaries
- Interstate
- State or Local Highway
- Railway

- Major Water Bodies
- Wetlands

Aquifers
- Stratified-Drift Aquifers
- Glacial Lake Bottom Deposits

- 100-Year Floodplain
- Public Water Supply

Sediment Locations
- High Risk Priority
- Moderate Risk Priority

Dams
- Low Hazard Potential
- Significant Hazard Potential
- High Hazard Potential
- Hazard Potential Not Assigned
- XXXXX Impoundment Zone

Water Quality Threats

VT Pollution Source Inventory of 1980
- C Petrochemicals
- J Junk Yard/Salvage Yard
- K Liquid Waste to Land Surface/Subsurface
- L Landfilll/Dump
- P Lagoon-Municipal
- U Salt/Salted Sand

- Underground Storage Tank Facilities

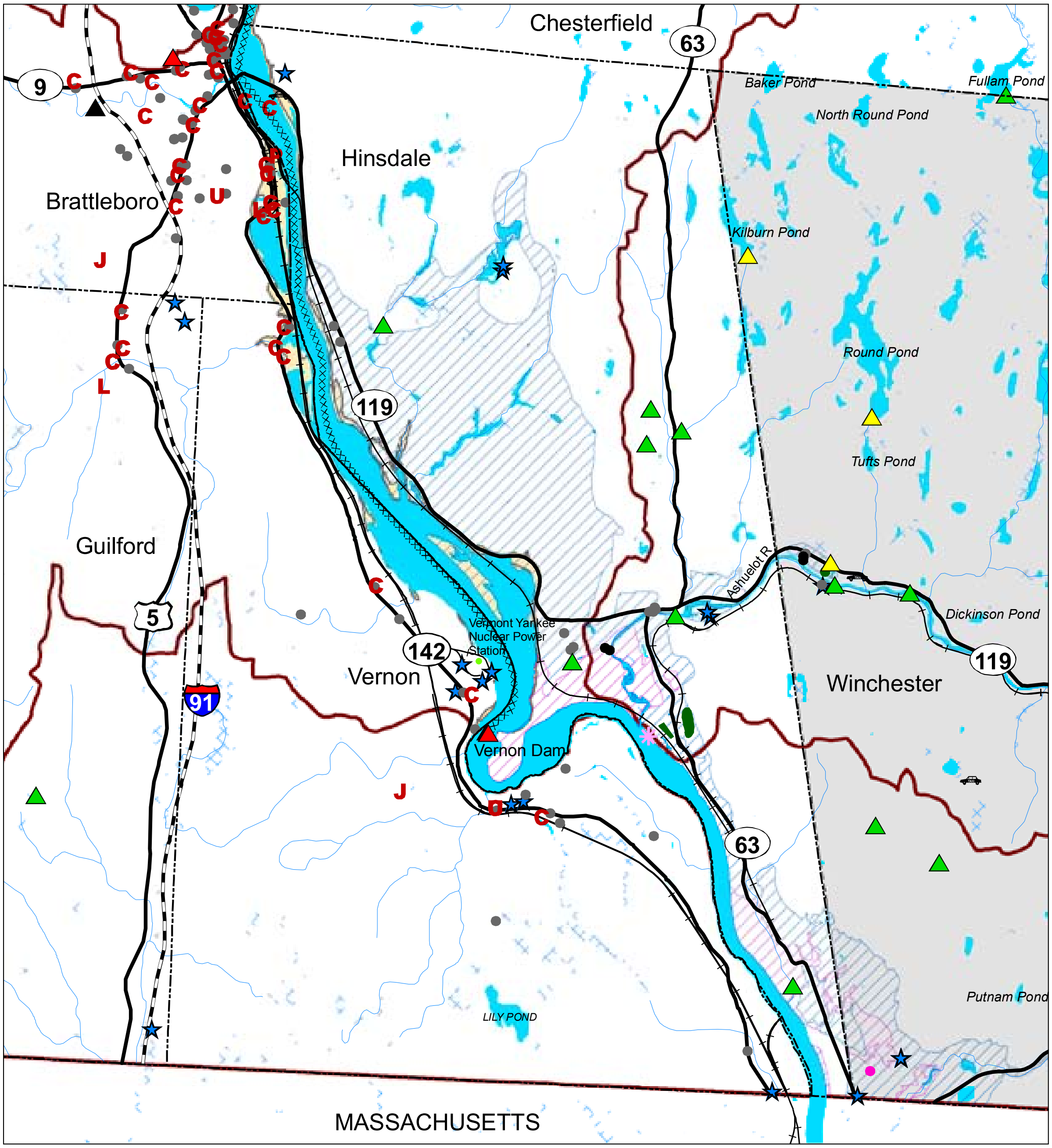
NH Water Quality Threat Inventories
- Large Septic System
- Snow Dump/Salt Storage
- Automobile Salvage Yard
- Lagoon
- Landfill/Dump

1 0 1 2 Miles

1:100,000

Map created by
Upper Valley Lake Sunapee Regional Planning Commission
for the Connecticut River Joint Commissions, January 2008.

Funding provided by CRJC and US Gen New England.



Water Resources - Hinsdale, NH

Wantastiquet Subcommittee

- Political Boundary
- Watershed Boundaries
- Interstate
- State or Local Highway
- Railway

- Major Water Bodies
- Wetlands

Aquifers
- Stratified-Drift Aquifers
- Glacial Lake Bottom Deposits

- 100-Year Floodplain
- Public Water Supply

Sediment Locations
- High Risk Priority
- Moderate Risk Priority

Dams
- Low Hazard Potential
- Significant Hazard Potential
- High Hazard Potential
- Hazard Potential Not Assigned
- xxxxx Impoundment Zone

N S W E

Water Quality Threats

VT Pollution Source Inventory of 1980
- C Petrochemicals
- J Junk Yard/Salvage Yard
- K Liquid Waste to Land Surface/Subsurface
- L Landfilll/Dump
- P Lagoon-Municipal
- U Salt/Salted Sand

- Underground Storage Tank Facilities

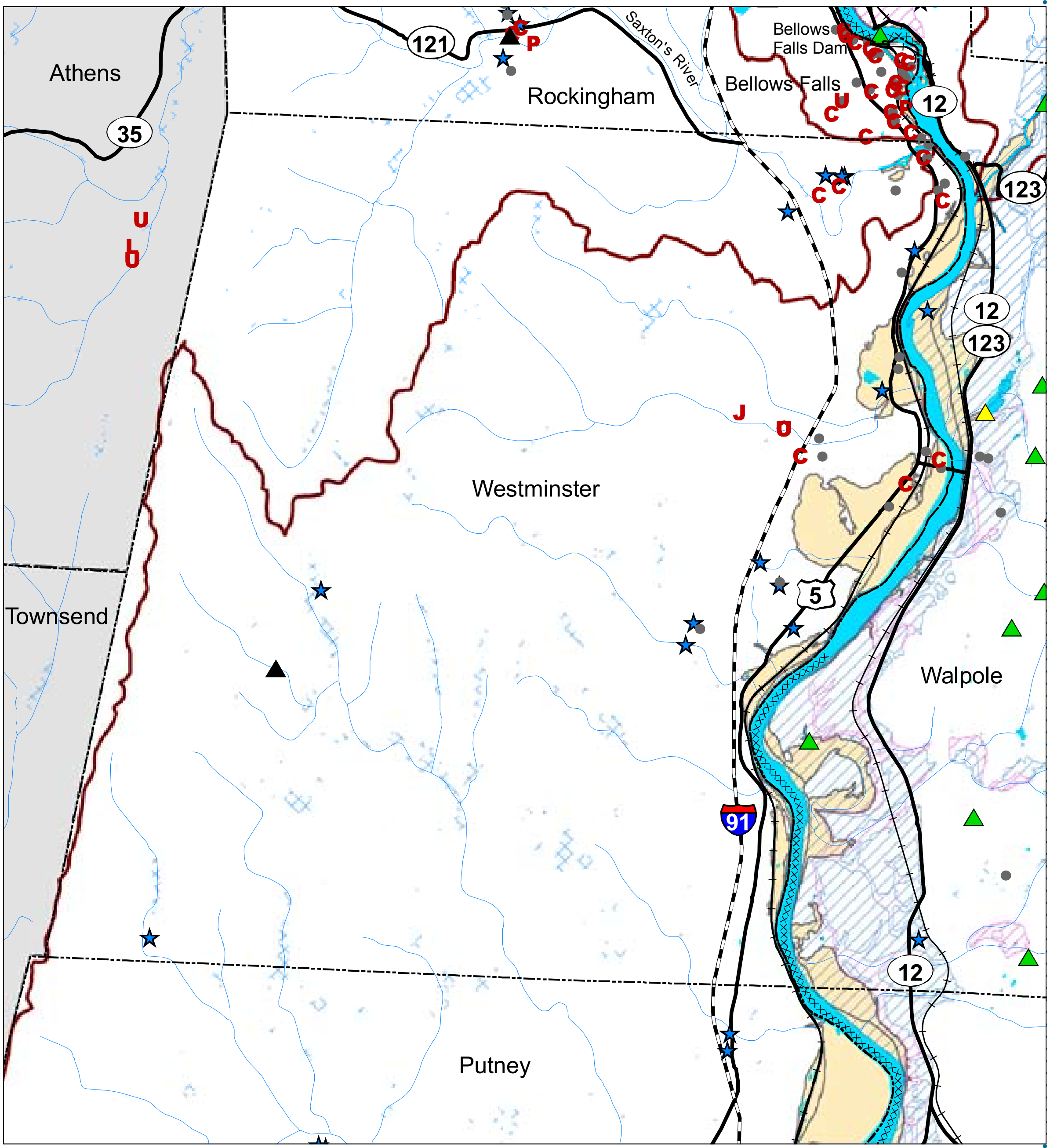
NH Water Quality Threat Inventories
- Large Septic System
- Snow Dump/Salt Storage
- Automobile Salvage Yard
- Lagoon
- Landfill/Dump

0.7 0 0.7 1.4 Miles

1:75,000

Map created by
Upper Valley Lake Sunapee Regional Planning Commission
for the Connecticut River Joint Commissions, January 2008.

Funding provided by CRJC and US Gen New England.



Water Resouces - Westminster, VT

Wantastiquet Subcommittee

Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway

Major Water Bodies
Wetlands
Aquifers
Stratified-Drift Aquifers
Glacial Lake Bottom Deposits

100-Year Floodplain
Public Water Supply
Sediment Locations
High Risk Priority
Moderate Risk Priority

Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned
Impoundment Zone

N
W E
S

Water Quality Threats

VT Pollution Source Inventory of 1980
C Petrochemicals
J Junk Yard/Salvage Yard
K Liquid Waste to Land Surface/Subsurface
L Landfilll/Dump
P Lagoon-Municipal
U Salt/Salted Sand

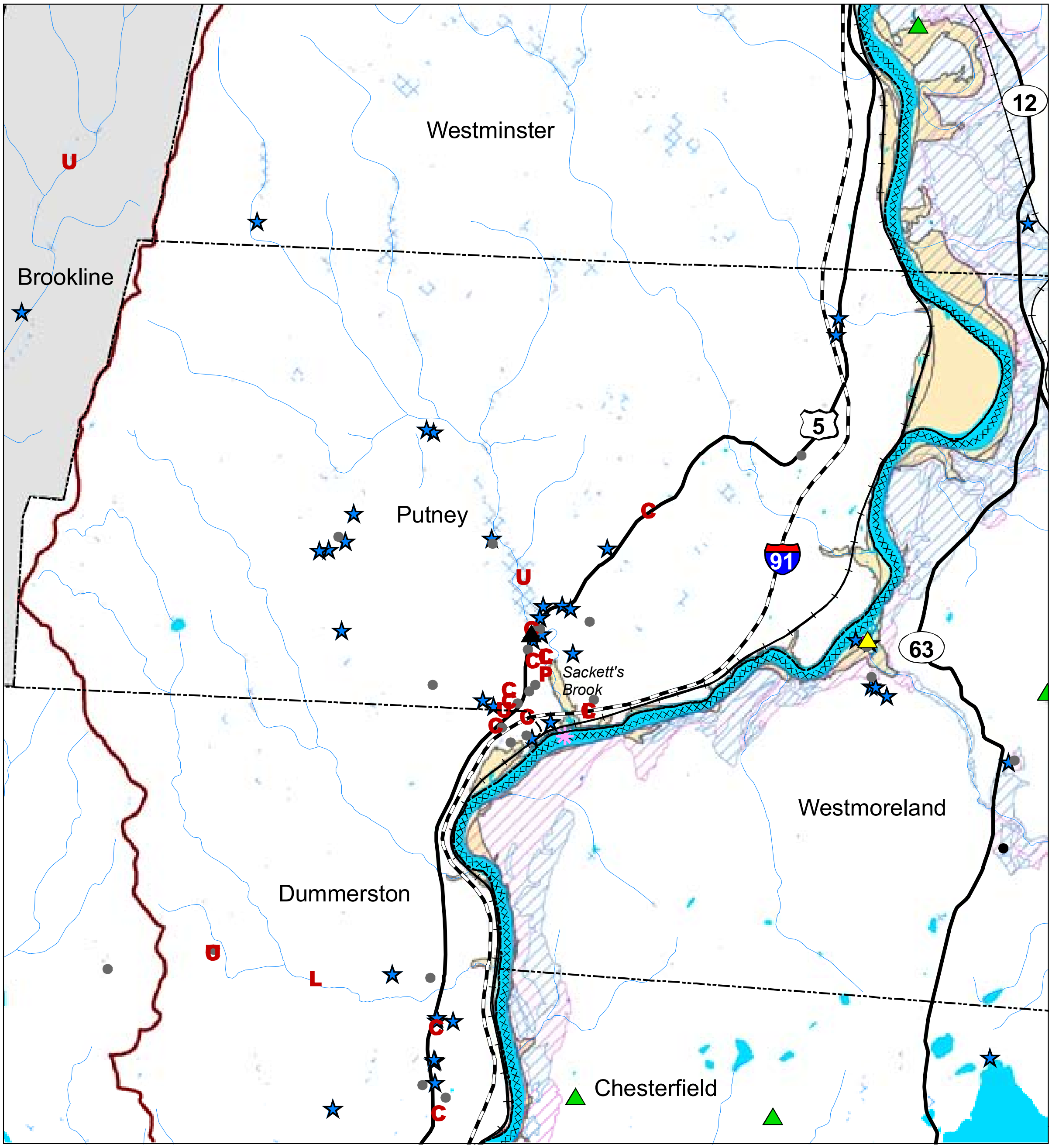
Underground Storage Tank Facilities
NH Water Quality Threat Inventories
Large Septic System
Snow Dump/Salt Storage
Automobile Salvage Yard
Lagoon
Landfill/Dump

1 0 1 2 Miles

1:75,000

Map created by
Upper Valley Lake Sunapee Regional Planning Commission
for the Connecticut River Joint Commissions, January 2008.

Funding provided by CRJC and US Gen New England.



Water Resouces - Putney, VT

Wantastiquet Subcommittee

Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway

Major Water Bodies
Wetlands
Aquifers
Stratified-Drift Aquifers
Glacial Lake Bottom Deposits

100-Year Floodplain
Public Water Supply
Sediment Locations
High Risk Priority
Moderate Risk Priority

Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned
XXXXX Impoundment Zone

N
W E
S

Water Quality Threats

VT Pollution Source Inventory of 1980
C Petrochemicals
J Junk Yard/Salvage Yard
K Liquid Waste to Land Surface/Subsurface
L Landfill/Dump
P Lagoon-Municipal
U Salt/Salted Sand

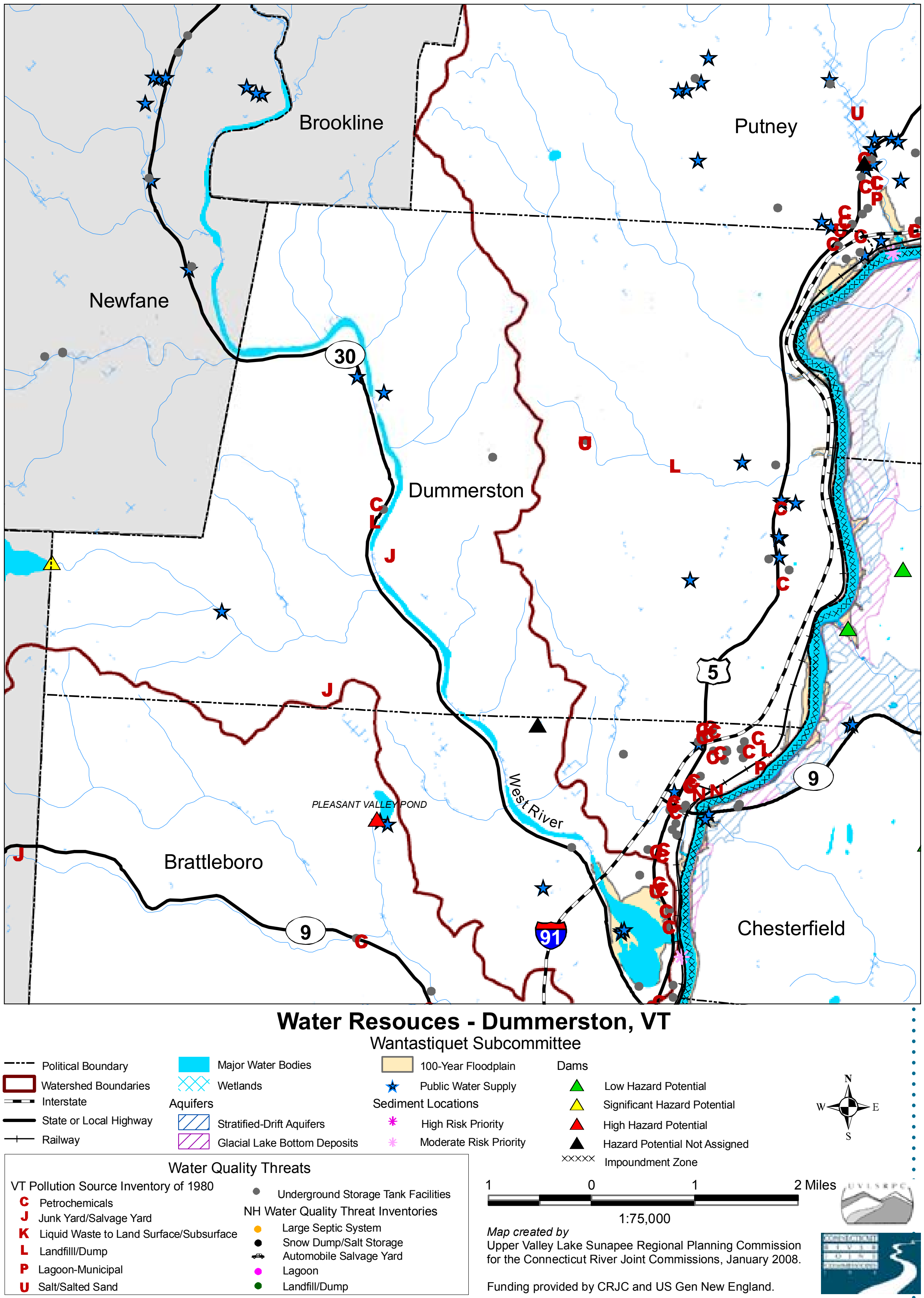
Underground Storage Tank Facilities
NH Water Quality Threat Inventories
Large Septic System
Snow Dump/Salt Storage
Automobile Salvage Yard
Lagoon
Landfill/Dump

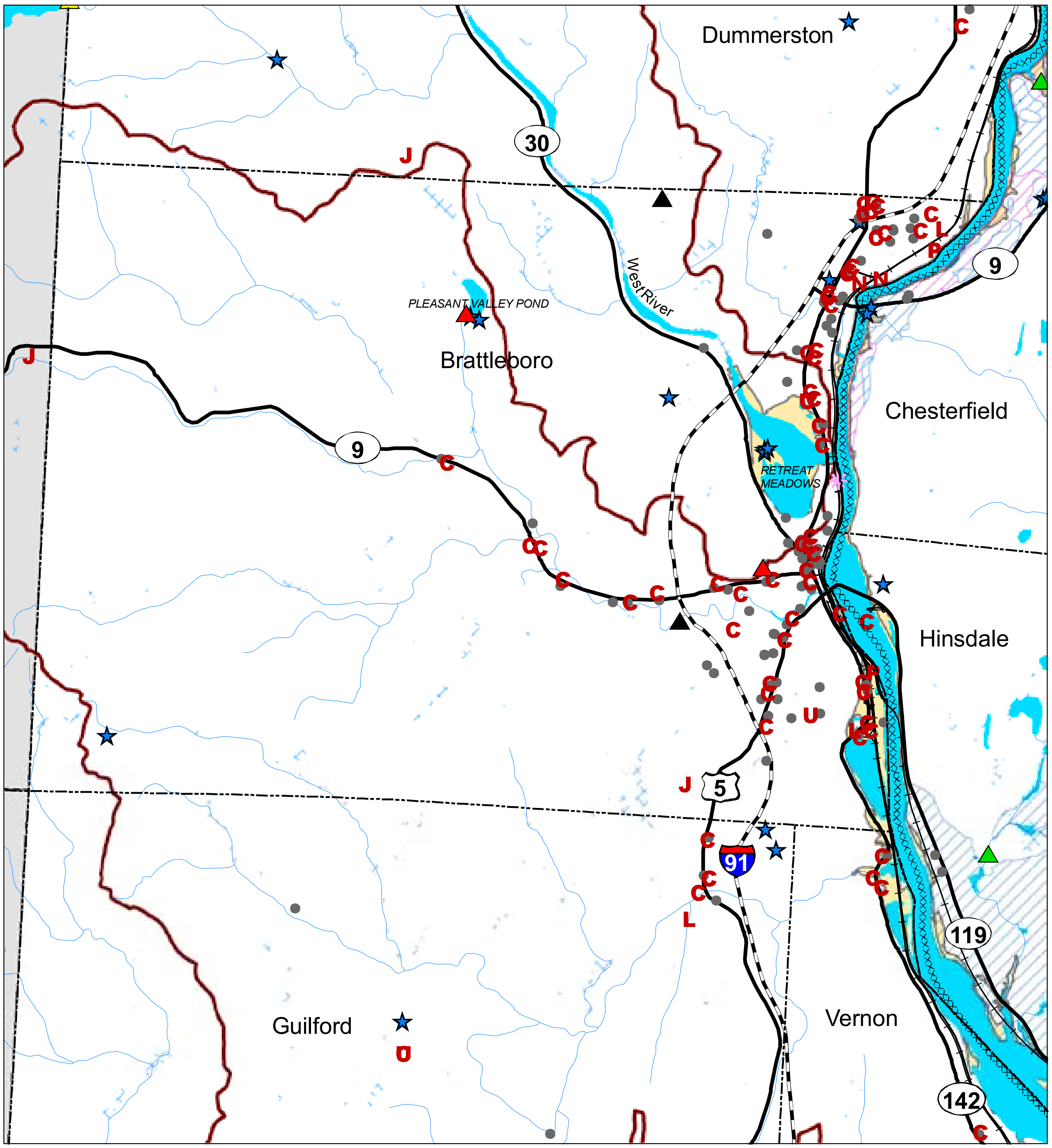
1 0 1 2 Miles

1:75,000

Map created by
Upper Valley Lake Sunapee Regional Planning Commission
for the Connecticut River Joint Commissions, January 2008.

Funding provided by CRJC and US Gen New England.


Brookline
Putney
Newfane
Dummerston
West River
PLEASANT VALLEY POND
Brattleboro
Chesterfield
30
5
9
91
Water Resouces - Dummerston, VT
Wantastiquet Subcommittee
Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway
Major Water Bodies
Wetlands
Aquifers
Stratified-Drift Aquifers
Glacial Lake Bottom Deposits
100-Year Floodplain
Public Water Supply
Sediment Locations
High Risk Priority
Moderate Risk Priority
Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned
Impoundment Zone
Water Quality Threats
VT Pollution Source Inventory of 1980
C Petrochemicals
J Junk Yard/Salvage Yard
K Liquid Waste to Land Surface/Subsurface
L Landfilll/Dump
P Lagoon-Municipal
U Salt/Salted Sand
Underground Storage Tank Facilities
NH Water Quality Threat Inventories
Large Septic System
Snow Dump/Salt Storage
Automobile Salvage Yard
Lagoon
Landfill/Dump
1 0 1 2 Miles
1:75,000
Map created by
Upper Valley Lake Sunapee Regional Planning Commission
for the Connecticut River Joint Commissions, January 2008.
Funding provided by CRJC and US Gen New England.
N
S
E
W



Water Resources - Brattleboro, VT

Wantastiquet Subcommittee

- Political Boundary
- Watershed Boundaries
- Interstate
- State or Local Highway
- Railway

- Major Water Bodies
- Wetlands

Aquifers

- Stratified-Drift Aquifers
- Glacial Lake Bottom Deposits

- 100-Year Floodplain
- Public Water Supply

Sediment Locations

- High Risk Priority
- Moderate Risk Priority

Dams

- Low Hazard Potential
- Significant Hazard Potential
- High Hazard Potential
- Hazard Potential Not Assigned
- xxxxx Impoundment Zone

N W E S

Water Quality Threats

VT Pollution Source Inventory of 1980

- C Petrochemicals
- J Junk Yard/Salvage Yard
- K Liquid Waste to Land Surface/Subsurface
- L Landfilll/Dump
- P Lagoon-Municipal
- U Salt/Salted Sand

- Underground Storage Tank Facilities

NH Water Quality Threat Inventories

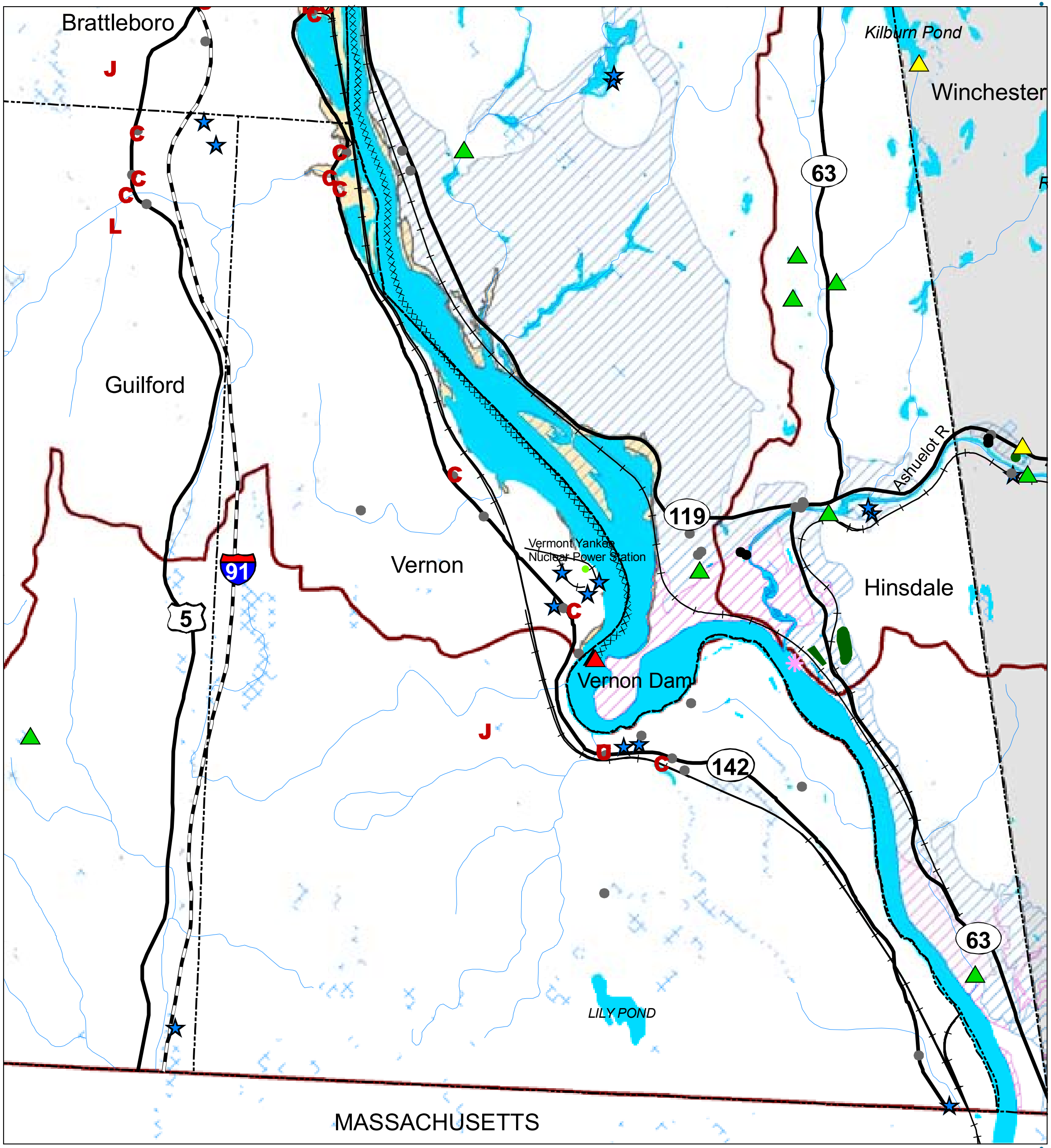
- Large Septic System
- Snow Dump/Salt Storage
- Automobile Salvage Yard
- Lagoon
- Landfill/Dump

0.75 0 0.75 1.5 Miles

1:70,000

Map created by
Upper Valley Lake Sunapee Regional Planning Commission for the Connecticut River Joint Commissions, January 2008.

Funding provided by CRJC and US Gen New England.



Water Resources - Vernon, VT

Wantastiquet Subcommittee

Political Boundary
Watershed Boundaries
Interstate
State or Local Highway
Railway

Major Water Bodies
Wetlands

Aquifers
Stratified-Drift Aquifers
Glacial Lake Bottom Deposits

100-Year Floodplain
Public Water Supply

Sediment Locations
High Risk Priority
Moderate Risk Priority

Dams
Low Hazard Potential
Significant Hazard Potential
High Hazard Potential
Hazard Potential Not Assigned
XXXXX Impoundment Zone

N
W E
S

Water Quality Threats

VT Pollution Source Inventory of 1980
C Petrochemicals
J Junk Yard/Salvage Yard
K Liquid Waste to Land Surface/Subsurface
L Landfilll/Dump
P Lagoon-Municipal
U Salt/Salted Sand

Underground Storage Tank Facilities

NH Water Quality Threat Inventories
Large Septic System
Snow Dump/Salt Storage
Automobile Salvage Yard
Lagoon
Landfill/Dump

0.75 0 0.75 1.5 Miles

1:60,000

Map created by
Upper Valley Lake Sunapee Regional Planning Commission
for the Connecticut River Joint Commissions, January 2008.

Funding provided by CRJC and US Gen New England.

Notes

Connecticut River
Joint Commissions
PO Box 1182
Charlestown, N.H. 03603
www.crjc.org
603-826-4800