Souhegan River Watershed Management Plan

March 2006

Photo of a Spine-crowned Clubtail dragonfly, a state endangered species taken by Tom Young, NH Audubon Society, along the Souhegan River

Prepared by the

Nashua Regional Planning Commission

Prepared with the assistance of a NH Department of Environmental Services Watershed Assistance Grant

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CHAPTER 1 EXECUTIVE SUMMARY

The Souhegan River is the pathway that connects communities, provides year round recreation to swim, fish, paddle, walk along, and enjoy scenic views. The river adds to the quality of life to both residents and visitors. Anglers, paddlers, and others enjoying recreational opportunities along the shores of the Souhegan and its tributaries contribute to the economy each year. The river flows through several town centers and provides scenic vistas, recreation, a sense of history, and access opportunities.

The watershed that surrounds the Souhegan River covers 140,621 acres and includes all or a portion of the land in seventeen communities in New Hampshire and two in Massachusetts. A watershed is defined as the geographic area in which all water drains to a given stream, lake, wetland, or other waterbody. For planning purposes, the primary Souhegan Watershed communities are considered those with 50 percent or more land area within the boundaries of the watershed. These towns are Amherst, Bedford, Greenville, Lyndeborough, Merrimack, Milford, Mont Vernon, New Ipswich, Temple, and Wilton.

Managing water resources at a watershed scale has been identified as ecologically sound and practical. Monitoring and modeling studies indicate that pollutant loads are directly or indirectly related to land use and watershed imperviousness. For these reasons, managing activities in a watershed is critical to its future well-being. A watershed plan is a holistic framework which enables the application of management tools so that the water resources goals for the entire watershed are met.

The Souhegan River is seen as a community asset in all of the towns through which it flows. The corridor towns of New Ipswich, Greenville, Wilton, Milford, Amherst, and Merrimack take great pride in the River and all the opportunities it provides. The Souhegan Watershed Association has been actively involved in water quality monitoring, education, and outreach and recreation events. The Souhegan River Local Advisory Committee (SoRLAC), made up of representatives from each of the Corridor communities, is involved in providing comments and recommendations to the New Hampshire Department of Environmental Services (NHDES) regarding permit requests for activities within the quarter mile corridor to the Souhegan River. The Souhegan River is covered by the NHDES Rivers Management and Protection Act and the NHDES Comprehensive Shoreland Protection Act. There is no doubt that the Souhegan River is viewed as both a significant community and State asset that deserves a high priority for protection by both the local communities and NHDES.

Regular water quality monitoring conducted by the Souhegan River Watershed Association over the last eight years and monitoring by NHDES as part of the 2004 Surface Water Quality Assessment indicate the presence of pollutants such as fecal coliform, and nutrients in the Souhegan River and other watershed water bodies. Impairments have been found in segments of the Souhegan River that limit the water's ability to provide suitable chemical and physical conditions for supporting a balanced, integrated, and adaptive community of aquatic organisms. Map B-2, Watershed Assessment, showing NHDES assigned attributes, indicates that many of the water bodies in the watershed are either impaired or threatened. Precipitation runoff or non-point source from roads, parking lots, farm fields, and lawns is now considered by EPA to be the leading cause of water pollution in America today. Stormwater runoff from hard surfaces such as roadways, pavement, and buildings is likely to be the largest source of pollution to the Souhegan River and other water bodies within the watershed.

A. FINDINGS AND CONCERNS

The Souhegan River Local Advisory Committee (SoRLAC) surveyed public officials within the corridor communities about their perceptions, concerns, and opinions regarding the Souhegan River. Based on existing conditions, assessment of threats and opportunities, and the survey of public officials in the corridor communities, the following statements are the primary findings and concerns:

- The Souhegan River is an important community resource that provides recreational opportunities including fishing, swimming, boating, bird watching, walking, picnicking, scenic views, and historic resources.

- The Souhegan River is an integral component of the downtown and urban centers in several corridor communities. Riverfront access, use, development, and redevelopment are focal points. The River is part of the industrial heritage in parts of the corridor communities.

- Top quality of life issues mentioned in responses to the SoRLAC survey for all of the corridor communities include water quality, scenic values, fishing, open space, wildlife/waterfowl habitat, and water supply.

- Several hazardous waste disposal sites are located in close proximity to the Souhegan River. Remedial actions are ongoing at The Savage Well, OK Tools, and Fletcher Paint EPA Superfund sites in Milford and the N.H. Plating Company Superfund site in Merrimack.

- Water quality impairments and threats exist on the Souhegan River, its tributaries, and other water bodies within the watershed. NHDES has categorized the Souhegan River as in need of protection and restoration. Water quality concerns identified for the Souhegan River, its major tributaries and water bodies in the watershed include bacteria problems, elevated levels of pH, aluminum, copper, chlorophyll-a, low dissolved oxygen, and chloride. NHDES listed the suspected source of copper as municipal point source discharges. Elevated bacteria counts in Baboosic Lake are suspected to be from septic systems. Other sources of pollution are listed as unidentified.

- Water quality suffers cumulative effects of sediment and upstream non-point source pollution. Potential sources of pollution include stormwater runoff from impervious surfaces, and erosion and sedimentation from land development and other land use activities. Sediment washed into the Souhegan River upstream may settle to the bottom in slow moving water and may not be completely removed.

- Results of the SoRLAC survey show that water quality and protecting fisheries habitat are very important to the corridor communities. The NHDES 1997 Souhegan River Watershed Report found that one of the most limiting factors in supporting an abundant and diverse fish population was stream bank erosion worsened by lack of adequate buffers. Improving habitat conditions was noted as important to the ecological health of the river.

- According to a recent US Environmental Protection Agency report, the nation's aquatic resources are among its most valuable assets. Although environmental protection programs in the United States have improved water quality during the past several decades, many challenges remain. Of special concern are the problems in our urban streams, lakes, estuaries, aquifers, and other water bodies caused by runoff that is inadequately controlled or treated. These problems include

changes in flow, increased sedimentation, higher water temperature, lower dissolved oxygen, degradation of aquatic habitat structure, loss of fish and other aquatic populations, and decreased water quality due to increased levels of nutrients, metals, hydrocarbons, bacteria, and other constituents. The National Water Quality Inventory: 2000 Report to Congress identified urban runoff as one of the leading sources of water quality impairment in surface waters (USEPA, 2002). Of the 11 pollution source categories listed in the report, "urban runoff/storm sewers" was ranked as the fourth leading source of impairment in rivers, third in lakes, and second in estuaries.[1]

- Local regulatory protection measures vary within the River corridor communities. Structure setbacks for the Souhegan River itself range from no structure setbacks in Greenville, 50-foot structure setbacks in New Ipswich, Wilton, Milford and Amherst and a 40-foot structure setback in Merrimack. Structure setbacks under the NHDES Comprehensive Shoreland Protection Act (CSPA) are set at 50 feet.

- Protected wetland buffers specified under local ordinances for the Souhegan River range from none in Greenville, 25 feet in New Ipswich and Merrimack, 50 feet in Wilton and Milford, and 100 feet in Amherst. Generally, impacts within the buffer are reviewed by the local Conservation Commission. Some of the communities specify standards in their local ordinances regarding removal of vegetation within the buffer. Merrimack specifies a 25 foot no-cut buffer with special exceptions allowed. New Ipswich specifies that within the buffer area not more than 50% of the basal area of trees or 50% of the number of saplings shall be removed for any purpose in a 20 year period. Uses allowed within the protected buffers vary in the local ordinances. For instance, in New Ipswich structure setbacks for wetlands and surface waters include but are not limited to parking lots, streets, and driveways.
- Inadequate or lack of vegetative buffers on aquatic resources within the watershed has the potential to contribute to water quality degradation, erosion and sedimentation, water temperature increases, lack of canopy cover, and wildlife and fish habitat impairments. Buffers can also provide pedestrian access along riverfronts and other water bodies.

- The results of the SoRLAC survey list the following measures that Town boards, public officials, and others surveyed believed are needed to protect the Souhegan River and its watershed:

    - Coordination of planning among watershed towns;
    - Limit shoreline development through land use zoning;
    - Stricter enforcement of local and state regulations related to wetlands; and
    - Stronger local regulations.

- Public access within the River Corridor was rated as very important or important to a majority of the respondents to the SoRLAC survey. Establishment of a River Corridor Trail is a priority for many of the Corridor communities. While Towns have established trails along the river, coordinated work is needed to complete a continuous trail. Recreation abuses were noted by a majority of those surveyed as a concern along the Souhegan River.

[1] National Management Measures to Control Non-point Source Pollution from Urban Areas. US EPA, November, 2005.

- Education of landowners, communities, and within school programs was rated as the top three actions public officials and others surveyed stated were important in order to protect the Souhegan River and its watershed. The Souhegan Watershed Association, local Conservation Commissions, and other environmental organizations are vital education and outreach resources. Education and raising the awareness of effective and comprehensive stormwater management practices and low impact development for local officials, the development community, and landowners will be needed to address water pollution within the watershed.

- Removal of the Merrimack Village Dam has been proposed by its owners, Pennichuck Water Works (PWW). Removal would open up a 14 mile stretch of the Souhegan to fish passage. A study was conducted by a consultant to PWW that outlines the benefits, concerns, and recommendations for additional actions. The Final Report of the dam removal feasibility study was completed in January 2005. Additional studies are ongoing. Addressing public concerns and accepting comments and recommendations from SoRLAC will be important steps prior to dam removal.

B. PRIORITY MANAGEMENT ISSUES

Based on the findings and concerns outlined above, the following are priority management issues for the Souhegan River Corridor and Watershed:

1. Adoption of a watershed planning approach that protects, preserves, and restores valuable resources and avoids or minimizes negative impacts.

2. Encouragement of responsible public access to the Souhegan River by providing adequate parking, maintenance, signage, monitoring, trash removal, and enforcement of regulations.

3. Encouragement of land conservation within the watershed and promotion of awareness that one of the many benefits of open space includes the offset of the affects of urbanization on water resources.

4. Prevention of the loss of wetlands and associated uplands. Loss of wetlands, like the loss of riparian forests and floodplains, is known to have serious negative implications for biological diversity, water quality, and watershed hydrology.

5. Prevention of the development of floodplain lands. The building and paving on floodplains can lead to a critical loss of floodwater storage. Loss of flood storage has both economic and ecological consequences: increased flooding down stream and disturbance of the natural cycles of flooding.

6. Maintenance and restoration of vegetated buffers on the aquatic resources within the watershed.

7. Adoption of site design practices that protect aquatic resources. Promotion and utilization of low impact development techniques and standards.

8. Soil erosion prevention. Require, monitoring and enforcement of the use of Best Management Practices (BMPs) for erosion and sediment control at new and redevelopment sites.

9. Require, monitoring and enforcement of the use of water quality BMPs and technologies to help mitigate the impacts of stormwater runoff on receiving waters.

10. Prevention or minimization of non-stormwater discharges through the: identification and control of illicit discharges into the municipal or natural drainage system identification and prevention of private septic system failure, and the establishment and enforcement of set back requirements to prevent the release of pathogens, chemicals, and nutrients to surface water.

11. Promotion of watershed stewardship activities and programs. Increased funding levels to local watershed education and outreach groups through grant proposals and fundraising.

12. Continuance of funding and expansion of water quality and biological monitoring programs. Monitoring and data collection conducted by the Souhegan River Watershed Association and NHDES provide valuable information on the conditions and management issues within the watershed.

Adoption of the Souhegan River Watershed Management Plan by the Corridor communities as part of their Master Plans will be an important step in ultimately implementing the management strategies that have been outlined in the Plan. Implementation of the management strategies is envisioned to include both short term, mid term, and long term timeframes which can be modified and adapted over time. Partnerships and collaboration among the numerous stakeholders in the watershed will be the key to assuring success in protecting the vitality of the Souhegan River watershed. In this case, partnerships mean that the people most affected by management decisions are involved throughout the planning process and are an integral part of shaping key decisions.

It should be noted that the Management Plan represents the first step of a multi-stage process to protect the water resources in the Souhegan River watershed. As management activities are implemented and conditions change in the watershed, priority management issues will need to be changed and the plan will need to be amended to reflect these changes. As watersheds are in a constant state of change, so too should management plans reflect their ever-changing nature.

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CHAPTER 2 INTRODUCTION

This Management Plan was developed by the Nashua Regional Planning Commission (NRPC) and the Souhegan River Local Advisory Committee (SoRLAC) in accordance with the guidelines of RSA 483 to create a framework for long-term use and protection of the Souhegan River and its associated watershed. It attempts to define an ecologically sound future for the River which respects the legitimate interests of property owners while recognizing that the River is an important community resource with fish and wildlife habitats of statewide significance. The content of this Plan has been developed through a partnership between the Nashua Regional Planning Commission, the Souhegan River Local Advisory Committee, the local Town Boards, the Souhegan Watershed Association and the public. The Nashua Regional Planning Commission obtained a New Hampshire Department of Environmental Services (NHDES) Watershed Assistance grant to assist in the development of this Plan.

The purpose of the plan can be summarized as the following:

- Identify Current Conditions;
- Identify and Assess Existing Threats and Opportunities;
- Identify Priority Management Issues;
- Recommend a tool-box of options to maintain and improve water quality and protect the natural, scenic, recreational and cultural values of the river; and
- Develop Implementation Strategies to achieve Management Priorities.

A. BACKGROUND

In 1988, the NH General court passed the Rivers Management and Protection Act. This was in recognition of the fact that the protection of these shorelands was essential to the integrity of the public waters. The Rivers Management and Protection Program were implemented by RSA 483 which allows any New Hampshire organization or resident to nominate a river for protection. In 2000, the Souhegan River Corridor was protected by the Rivers Management and Protection Act of 1990. Under this Act, Section 483:10 states that the New Hampshire Department of Environmental Services River's Coordinator," shall provide technical assistance to regional planning commissions, municipalities, and river corridor commissions and shall encourage the development and implementation of river corridor management plans."

The specific criteria for river classification (i.e.; Natural, Rural, Rural-Community, or Community) is provided in RSA 483:7-a. Most of the Souhegan River is designated as a Rural river with the remaining portions designated as Rural-Community or Community.

RSA 483 also calls for the appointment of a local river management advisory committee for all designated rivers. Each municipality along the NHDES Designated River must have at least one member on the committee. Members are nominated by the local governing body and appointed by the Commissioner of the New Hampshire Department of Environmental Services (NHDES). The river corridor communities which make up the Souhegan River Local Advisory Committee (SoRLAC) are Amherst, Greenville, Merrimack, Milford, New Ipswich and Wilton. The Local Advisory Committees are to have at least seven members, representing a broad range of interests in the vicinity of the NHDES Designated River.

The 220 square mile watershed includes portions of the following towns: Amherst, Bedford, Brookline, Goffstown, Greenfield, Greenville, Lyndeborough, Mason, Merrimack, Milford, Mont Vernon, New

Boston, New Ipswich, Peterborough, Sharon, Temple and Wilton, in New Hampshire and Ashby and Ashburnham in Massachusetts. Figure 2-1 shows the general location of the watershed. Table 2-1 shows the total acres for each town located within the watershed and the percentage of each town's land within the watershed.

Figure 2-1: Souhegan River Watershed

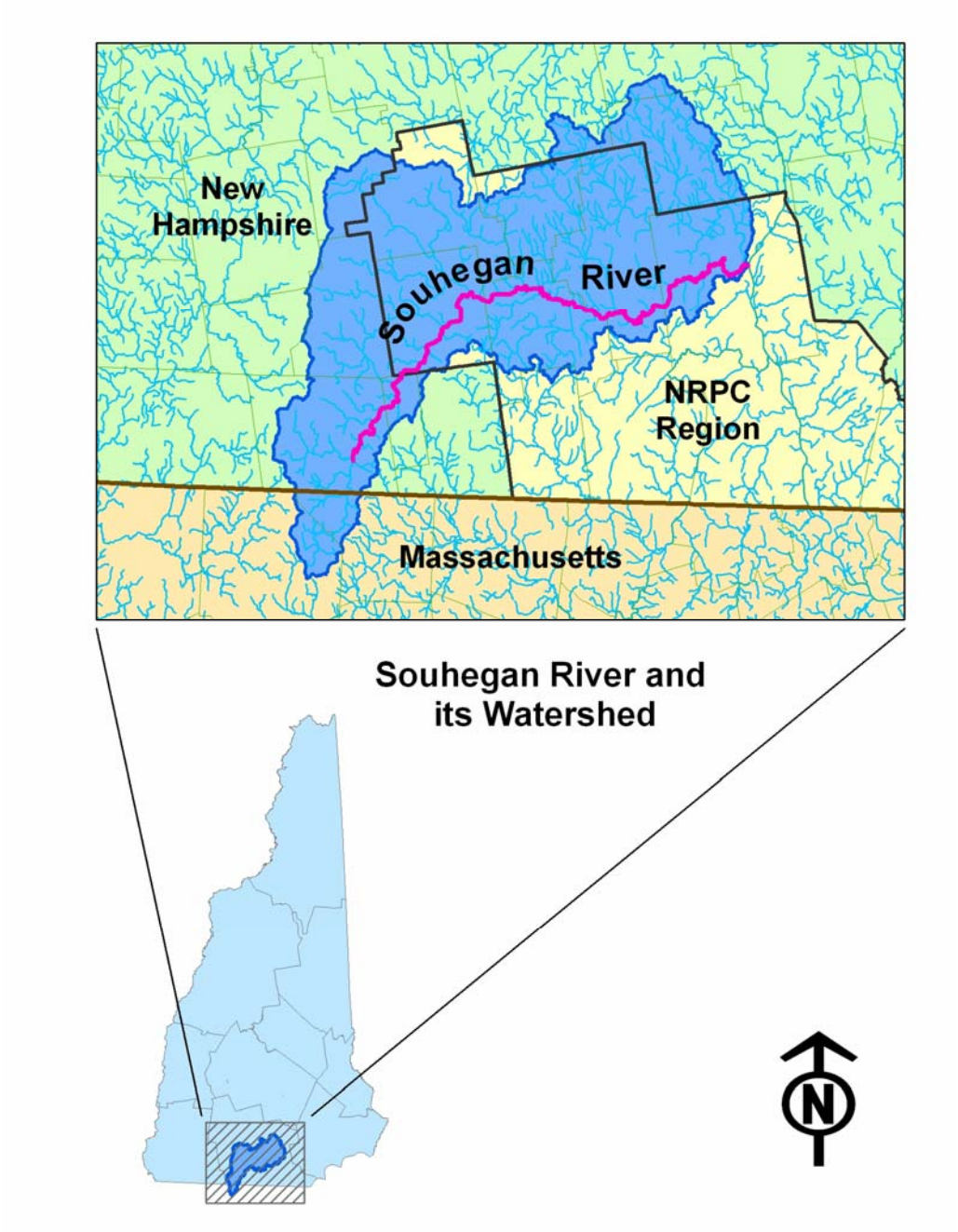

Table 2-1: Total Acres by Community within the Souhegan Watershed

Total Watershed Acres	**14,0621**	
Number of Acres in each Town within the watershed		**Percentage of Town in Watershed**
Amherst	20,237	92%
Bedford	12,333	58%
Brookline	253	2%
Goffstown	1006	4%
Greenfield	4,280	25%
Greenville	2,083	47%
Lyndeborough	14,815	76%
Mason	230	1%
Merrimack	11,649	54%
Milford	13,065	80%
Mont Vernon	9,238	85%
New Boston	2,196	8%
New Ipswich	14,606	69%
Peterborough	56	<1
Sharon	1.5	<1
Temple	13,480	94%
Wilton	15,485	94%
Ashburnham	2,787	10%
Ashby	2,824	18%
Total	**14,0621**	

Source: NRPC GIS data

For Purposes of the Management Plan, major watershed communities are defined as those with 50% or greater land area located within the watershed boundaries. These nine communities are:

- Amherst
- Bedford
- Greenville
- Lyndeborough
- Merrimack
- Milford
- New Ipswich
- Temple
- Wilton

B. PROCESS FOR DEVELOPMENT OF THE MANAGEMENT PLAN

A primary goal for developing the Souhegan River Watershed Management Plan was to involve many different individuals, groups and town boards in the process. As an initial task, a State of the Watershed educational fair was planned and coordinated by NRPC. The goal of the fair was to educate the public on the Souhegan River Watershed and its resources and to inform them of the development of the Management Plan. This event was held in mid-May of 2004 at the Milford Town Hall auditorium. The event featured numerous educational booths including the USEPA, NHDES, Souhegan River Watershed Association, Town of Milford DPW Stormwater Committee, and the Peabody Mill Environmental Center.


State of the Watershed Fair

Educational tips on how to be good stewards of the watershed were provided. The Souhegan River Local Advisory committee (SoRLAC) was introduced as a key partner in developing the Management Plan. Raffle tickets for prizes were handed out at the event that attracted a good crowd.

A Management Plan subcommittee consisting of three members of SoRLAC from different Corridor Towns was formed to work directly with the NRPC. The Management Plan subcommittee met with NRPC monthly at the Milford Town library to review and update the work plan and later in the process to provide comments on draft chapters of the Management Plan. The Management Plan Subcommittee members coordinated obtaining input and comments on draft chapter of the Plan from the other SoRLAC members.

In the spring/summer of 2005 SoRLAC, working with NRPC, developed a survey to obtain feedback from local officials and citizens on their perceptions of important issues regarding the Souhegan River. Target groups included Conservation Commissions, Planning Boards, Zoning Board of Adjustments, Board of Selectmen, Department of Public Works, Heritage Commission, Town Clerks and Administrators, and Building Inspectors. Members of SoRLAC from each Corridor Community attended local Board and other official meetings to inform them of the survey, the status of the Management Plan and asked the Boards to fill out the surveys. Surveys were returned to NRPC for tabulation and incorporation into the Plan. Seventy-two responses were received representing all the Corridor Communities.

A working meeting of the SoRLAC was held in November 2005 to review and provide comments on the Draft Implementation Strategies. Comments were forwarded to NRPC for incorporation into the Plan.

Another source of input for the Management Plan was the watershed audit that NRPC requested be completed by the Planning Boards or staff of the Corridor towns. The audit was based on the Center for Watershed Protection audit but modified by NRPC to better fit regional conditions. The purpose of a watershed audit is to collect baseline information about watershed protection activities at the local level. The NRPC scheduled meetings with the communities in the Corridor and gave a presentation that introduced the Souhegan River Watershed Management plan project and the process for conducting a watershed audit. The NRPC recommended that the audit be completed as a Planning Board workshop or by planning staff. Communities were given a two-month timeframe to complete the audit. Audit responses were forwarded to NRPC where results were compiled into a spreadsheet. Results of the audit have been incorporated into the Management Plan.

In addition to the NRPC GIS database, water quality data was obtained from the NHDES 2004 Surface Water Quality Assessment database. This information was incorporated into a Watershed Assessment Map included in the Plan. The NRPC developed two 30"x40" maps, a Watershed Conditions map and a Watershed Assessment map, that can be used by the SoRLAC and others for presentation at public meetings or for educational display.

NRPC conducted an extensive literature and database review in addition to GIS analysis as part of developing the Management Plan. A partial list of information reviewed includes:

- Community Master Plans;
- Community Zoning Regulations, Ordinances and Site Plan Regulations;
- Natural Resource Inventories;
- Town Web Sites;
- Souhegan River Reports;
- Souhegan Watershed Association Water Quality Monitoring Annual Reports;
- NHDES 2004 Water Quality Assessments;
- NHDES regulations;
- NHDES Reports on Non-Point Sources of Pollution;
- Center For Watershed Protection Information;
- USEPA Stormwater Regulations; and
- Information on Low Impact Development Techniques.

A presentation covering watershed audit results and a Draft Executive Summary of the Management Plan was made to each of the corridor community planning boards in December 2005 by the NRPC and SoRLAC members. A Draft of the Management Plan was provided to NHDES for review in mid-December, 2005. Copies of the Management Plan will be provided to each of the primary watershed communities by the end of December 2005.

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CHAPTER 3 WATERSHED CONDITIONS

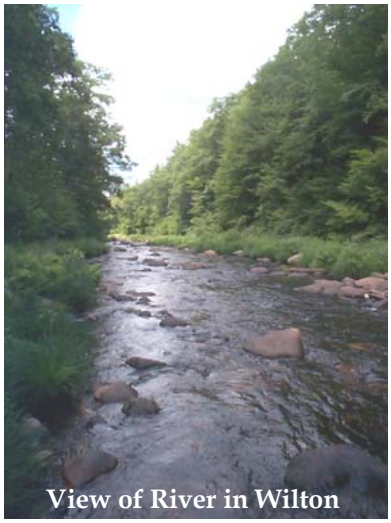
A. AQUATIC RESOURCES

The Souhegan River originates in the town of Ashburnham, MA and flows in a northeasterly direction approximately 17 miles until it turns easterly in the town of Wilton before flowing approximately 17 miles to the Merrimack River as shown in Map B-1: Watershed Conditions (see Appendix B). The South and West Branches of the Souhegan Rivers join together in the Town of New Ipswich, forming its headwaters. The approximately 34-mile long river flows through the communities of New Ipswich, Greenville, Wilton, Milford, Amherst and Merrimack before discharging into the Merrimack River. The drainage area of the basin is approximately 220 square miles (mi^2).

The Souhegan River channel cuts through numerous ledges that define its morphological character. The morphological character of the Souhegan ranges from a high gradient, straightened stream to a low gradient meandering river. The high gradient portion of the Souhegan is located upstream of the confluence with Stony Brook in Wilton, NH and is approximately nine miles long. In this upstream portion, the average width is 5 to 15 meters and is characterized by a relatively shallow and fast flowing current. Below the confluence with Stony Brook, the River maintains a high gradient. Further downstream, the Souhegan River is a low gradient for almost the entire length. It meanders through the landscape, dotted with oxbows and remnants of side arms. Nevertheless, the 5-9 ft banks are steep suggesting a possible entrenchment tendency that is controlled by sporadic bedrock ledges and large cobble rapids.[2]

1. Water Quantity

Stream flow information for the Souhegan River is collected by the United States Geological Survey (USGS) at a stream gage located just above Wildcat Falls in Merrimack. The USGS operated the gauge as a "full-record" station from July 13, 1909 until September 30, 1976 when it was converted to a "partial record station". It is now used only during periods of extreme weather to estimate flooding conditions or drought severity. Historic flows at the USGS gauging station have ranged from a high of 818 cubic feet per second in April to a low of 39 cubic feet per second in September.[3]


View of River in Wilton

2. Tributaries

The Souhegan River Watershed contains numerous tributary streams of varying sizes. There are approximately 271 miles of rivers and streams contained within the watershed and 103 miles of intermittent streams.[4] Many of the small intermittent streams are not mapped and are therefore not included in these figures. These streams form an interconnected network, which perform many functions such as providing fisheries and wildlife habitats, conveying floodwaters, supplying water for industrial and irrigation uses, providing recreational opportunities and presenting scenic views. Because of

[2] Instream Protected Uses, Outstanding Characteristics, and Resources of the Souhegan River and Proposed Protective Flow Measures for the Flow Dependent Resources.[IPOUCR] Final Report, 2004. Prepared for NHDES by Normandeau Associates, University of Massachusetts, University of New Hampshire.
[3] Souhegan River- Report to the General Court, January 2000
[4] NRPC GIS data

this interconnected relationship, any activity with a negative impact on a stream, such as a chemical spill or an erosion problem may result in a corresponding negative impact on the stream or river into which it flows. Likewise, any positive impact on the stream, such as the elimination of leachate from malfunctioning septic systems, will have an overall positive impact on the receiving water. Therefore, the activities that take place within the Souhegan River Watershed have a direct impact on the quality and the quantity of surface water and groundwater in the watershed.

The major tributaries to the Souhegan River are listed in Table 3-1. Map A-1, Watershed Conditions, shows the location of the major tributaries. In addition to these major tributaries, numerous other smaller streams are located within the watershed, some of which are connected by surface water to the Souhegan River.

Table 3-1: Major Tributaries to the Souhegan River

Stream Name	*Length in Miles*	*Free-flowing or Dammed*	*Legislative Classification*
S. Branch Souhegan R.	4.0	dammed	B
W. Branch Souhegan R.	2.0	dammed	B
Furnace Brook	3.2	dammed	B
Temple Brook	4.2	dammed	B
Blood/Gambol Brook	7.0	dammed	B
Stony Brook	9.6	dammed	B
Mill Brook	7.4	dammed	A
Tucker Brook	4.5	free-flowing	B
Purgatory Brook	5.7	free-flowing	B
Caesar's & Beaver Brook.	7.7	free-flowing	B
Great Brook	4.4	dammed	B
Hartshorn Brook	3.2	dammed	B
Baboosic Brook	unknow	unknown	B
McQuade Brook	n	unknown	B
	unknow		
	n		

Source- NRPC Watershed 1995 Report and GIS data

Furnace Brook originates in New Ipswich and flows approximately 3.2 miles east to the Souhegan River near the Greenville Town line. *Temple Brook* originates in southeast Temple and flows approximately 4.2 miles northeast to West Wilton where it converges with Blood Brook. *Blood Brook* flows approximately 7 miles southeast from Sharon through Temple to West Wilton where it converges with Temple Brook to form *Gambol Brook* which flows into the Souhegan River. *Mill Brook*, the only Class A water in the watershed, originates in Temple and flows 7.4 miles through Wilton to its convergence with Stony Brook. *Stony Brook*, approximately 9.6 miles, rises in the hills of Lyndeborough, flows west into Greenfield and swings back southeast through Lyndeborough into downtown Wilton where it converges with the Souhegan River. *Purgatory Brook* originates in Mont Vernon and flows approximately 5.7 miles south to the Souhegan River in Milford. *Tucker Brook* originates in a wetland in southeast Wilton and flows approximately 4.5 miles northeast to its convergence with the Souhegan River in Milford. *Caesar's Brook* originates at a pond in Mont Vernon and flows approximately 2.5 miles into Amherst where it joins with Beaver Brook. *Beaver Brook* starts in the Mont Vernon hills and flows approximately 7.7 miles through Mont Vernon and Amherst before converging with the Souhegan River. *Great Brook*, which is contained entirely within Milford, originates in the southern Milford hills and flows approximately 4.4 miles through Osgood Pond and into the Souhegan River. *Hartshorn Brook* starts at the outlet of Stearns Pond

in Mont Vernon and flows 3.2 miles through Mont Vernon and Milford before converging with the Souhegan River. *McQuade Brook* starts in Bedford and flows to the Souhegan River in Merrimack. *Baboosic Brook* starts at Baboosic Lake and flows to the Souhegan River in Merrimack.

3. Lakes and Ponds

Approximately 1,707 acres of small ponds and water bodies exist in the Souhegan River watershed (NRPC GIS data). A majority of the ponds are less than 10 acres in size and are associated with wetland systems or tributary streams. Information on these small ponds is limited since State efforts are directed to the larger ponds which provide greater opportunities for public use.

A list of the significant lakes and ponds is contained in Table 3-2 and shown on Map A-1, Watershed Conditions. These waterbodies were identified from the EPA 305(b) report, the NHDES list of water bodies covered under the Shoreland Protection Act and USGS topographic maps.

Table 3-2: Souhegan River Watershed Significant Lakes and Ponds

Lake or Pond Name	*Size in Acres*	*Municipality*
Honey Pot Pond	12	Amherst
Little Baboosic Pond	15	Amherst
Baboosic Lake	222	Amherst
Tobey Reservoir		Wilton
Osgood Pond	20	Milford
Heald Pond	69	Temple/Wilton
Horton's Pond	14	Mont Vernon
Badger Pond	12	Lyndeborough
Putnam Lake	50	Lyndeborough
Burton Pond	26	Lyndeborough
Water Loom Pond	43	New Ipswich
Wheeler Pond	10	New Ipswich
Pratt Pond	38	New Ipswich

Sources: New Hampshire Water Quality Report to Congress (305-B), and GIS data...

4. Wetlands

Once thought of as wastelands and areas to be filled, awareness of the important role wetlands play in the hydrologic and ecological systems has increased significantly over the last decade. Wetlands perform many important functions such as flood control and natural stream flow regulation, erosion and sedimentation control, and water purification while providing nursery grounds and habitat for numerous species of vegetation and wildlife.

Wetlands within the Souhegan River Watershed are confined to low-lying areas adjacent to the river and its tributaries and depressions located throughout the watershed. There are 8,217 acres of wetlands within the watershed according to the NRPC GIS database. Map B-1, Watershed Conditions, shows both forested wetlands and open wetlands. This information was obtained from the state GIS land cover data. Within the Corridor, the most extensive wetlands are located in Milford and Amherst and are often connected to wetland systems along tributary streams. As discussed, the topography in the western sections of the watershed is relatively steep. Steep slopes with shallow soils do not promote the development of wetlands.

The floodplain of the Souhegan River includes floodplain forest and oxbows and backwater areas with emergent wetlands. NHDES is in the process of conducting an instream flow study of the Souhegan River. The primary objective of the initial phase of this effort is to establish a comprehensive list of flow dependent Instream Protected Uses, Outstanding Characteristics and Resources (IPUOCR) entities of the Souhegan River and to propose methods for assessing their flow dependence.[5] During this study, several marshes were observed between the Amherst Country Club and Turkey Hill Road. Another large marsh was noted to be located just upstream of the Dam in Merrimack, and another large wetland complex above the dam in Greenville was observed. Emergent wetlands are seasonally flooded to permanently flooded. Prolonged changes in depth or duration of water levels during the growing season could cause vegetation stress and changes and/or affect habitat functions of these wetlands. Numerous small fish, Painted Turtles (Chrysemys p. Picta), and Green Frogs (Rana clamitans melanota) were observed in these marshes.

5. Aquifers/Groundwater

Bedrock in the basin consists of hard crystalline Paleozoic rock. Soils are composed of variable, unstratified, silty, gravelly sand and clays with interspersed cobbles and boulders. The geology of the Souhegan River corridor provides many of the communities with their only source of public water supplies. The stratified drift aquifers that follow the river corridor provide a source of high quality/high quantity drinking water used for public supplies by the Towns of Merrimack, Milford, and Wilton.

The most significant stratified drift deposits are located along the river corridor in Amherst and Milford and are referred to as the Souhegan Aquifer. The Souhegan Aquifer is highly prolific in terms of water yield. Using water yield as a measure of this aquifer's potential, it ranks in the highest 10% for the entire state.[6] Figure 3-1 shows transmissivity levels associated with the sand and gravel deposits in the watershed. The Amherst aquifer along the Souhegan River extends from Merrimack to Milford. Transmissivity is greater than 8,000 square feet per day throughout this area. Milford's municipal water supply wells are located in this aquifer, with average yields of 400 and 700 gallons per minute, respectively. This most productive aquifer in Milford is located in the central portion of the study corridor. Transmissivity in this portion aquifer exceeds 8,000 square feet per day. Six high yield wells with sustained yields of 200 to 500 gallons per minute are located in this area: Milford's Savage and Keyes wells; the Milford Fish Hatchery well; and three industrial wells. In addition, Wilton's two municipal water supply wells are located in the River Corridor, as are the Monadnock Spring Water Company wells.

The groundwater flow is governed by the hydraulic connection between the Souhegan River and its tributaries. The western reaches of the Souhegan River recharges the aquifer and the direction of ground water flow is away from the river. In the eastern reaches ground water discharges into the river and ground-water flow is towards the river.[7]

Stratified drift deposits located in the surrounding watershed tend to be discontinuous and shallow when compared to those within the river corridor. These relatively small, stratified drift deposits are located in the towns of New Ipswich, Temple, Greenfield, Lyndeborough, Wilton, Mont Vernon, Amherst, and Milford.

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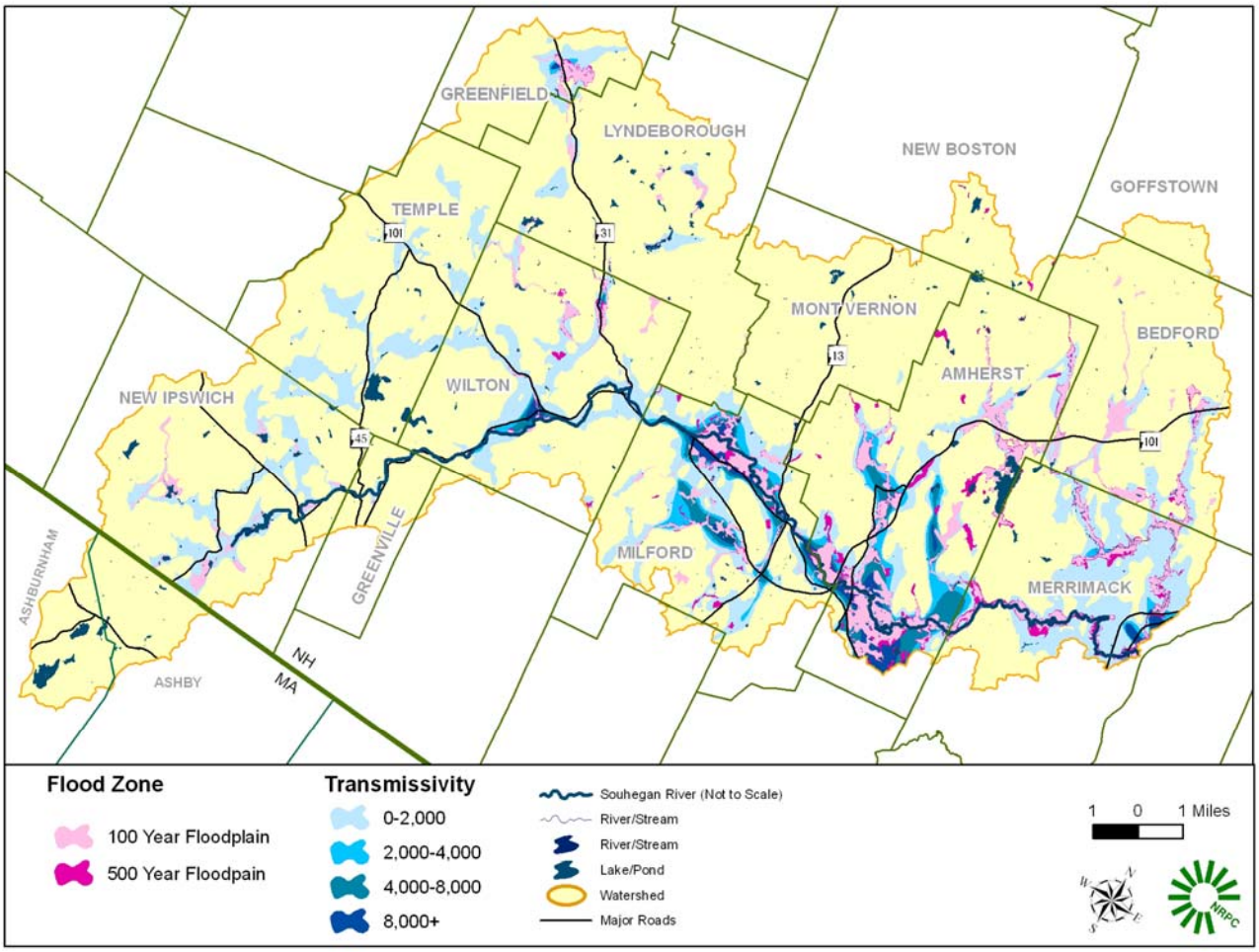
[5] Instream Protected Uses, Outstanding Characteristics, and Resources of the Souhegan River and Proposed Protective Flow Measures for the Flow Dependent Resources.[IPOUCR] Final Report, 2004. Prepared for NHDES by Normandeau Associates, University of Massachusetts, University of New Hampshire.
[6] EPA web page on the Savage Municipal Water Supply Superfund site.
[7] Harte, P. T.; Mack, T. J. Geohydrology of and simulation of ground-water flow in, the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire." 1992 Report Number 91-4177

Figure 3-1: Flood Zones and Transmissivity within the Watershed



B. NATURAL RESOURCES

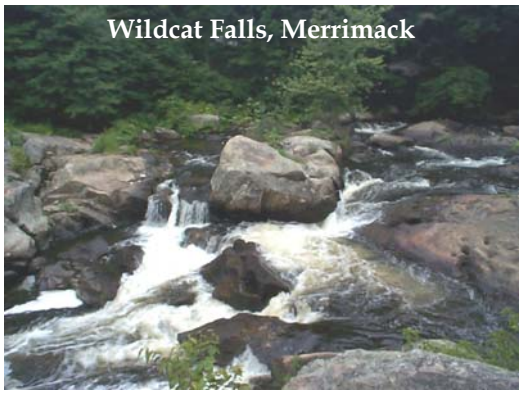
1. Floodplains

Aside from transmitting floodwaters, floodplains provide areas for groundwater recharge, wildlife habitat, open space and recreation. Flood zones showing the 100 and 500 year floodplain are shown above in Figure 3-1.

While there are floodplains adjacent to the entire length of the Souhegan River, the most extensive floodplains are found in Amherst, Milford and Merrimack. The most substantial floodplains in Merrimack are located in the western part of Town between Wilson Hill Road and Amherst Road with an average width of 0.5 miles. The largest floodplain area in Milford surrounds the Souhegan River. The floodplain is widest near the inlets of Purgatory, Tucker, and Hartshorn Brooks.

The floodplain in Amherst is more extensive than anywhere else in the corridor, encompassing almost the entire Souhegan River corridor between Boston Post Road and Stearns Road, and extending outside the corridor to NH Route 101A. The width of the floodplain in this area ranges from 1,400 feet to over one mile. The floodplain narrows to 200-400 feet through downtown Milford and begins to widen west of the oval. Floodplains dominate the Souhegan River corridor between North River Road and Elm Street with a maximum width of about 4,000 feet. West of the river crossing at the NH Route 101-Elm Street intersection the floodplain follows a defined river channel and decreases significantly in width. The width of the floodplain decreases to the west as the topography changes from broad flat floodplains to rolling hills.

The 1979 Flood Insurance Study prepared by the United States Department of Housing and Urban Development, Federal Insurance Administration, identified the principal flood problems in Amherst which are likely typical of the River Corridor: major floods occur on the Souhegan River during the spring, fall, and winter seasons. Some of the most severe flooding occurs in early spring as a result of snow melt and heavy rains in conjunction with ice jams. Autumn is another critical season for flood danger because of heavy rainfall and the possibility of storms of tropical origin. Minor flooding in Amherst can occur at any time of the year, as even heavy thunderstorms can result in rapid runoff and flooding in the downstream portions of the smaller streams.


Wildcat Falls, Merrimack

2. Topography

Overall, the topography of the corridor varies widely from flat, expansive floodplains to rolling hills and steep embankments. Corridor elevations range from the highest point of 1,050 feet in New Ipswich to the lowest point of 50 feet in Merrimack. In its 31.8 miles from New Ipswich to Merrimack the river drops approximately 900 feet in elevation. At 950 feet above Mean Sea Level (MSL) in New Ipswich to 50 feet above MSL at the Merrimack River, this is an average drop of 28 feet per mile. This average drop in elevation is misleading since there are places where the river drops off more quickly forming rapids in Greenville, Wilton and Merrimack. Of note is Wildcat Falls in Merrimack where the River drops 83 feet over a series of three falls.

The most extensive areas of steep slopes are located in the western reaches of the watershed in Greenfield, Lyndeborough, Temple, Wilton and New Ipswich. This is to be expected since the western boundary of the watershed follows the Wapack Range. Overall, 28.4 percent of the land within the watershed is categorized as having steep slopes, while one-third or greater of the watershed areas in

Greenville, Temple, New Ipswich, Lyndeborough and Wilton are included in this category. (NRPC GIS data)

Rare, Threatened or Endangered Fish, Wildlife, Vegetation or Natural/Ecological Communities
The New Hampshire Natural Heritage Inventory (NHI), a program of the Department of Resources and Economic Development (DRED), is the agency responsible for cataloging and tracking endangered, threatened and rare animal species in the State. Table 3-3 presents a list of rare, threatened or endangered fish, wildlife or natural/ecological communities identified in the NHDES Instream Protected Uses, Outstanding Characteristics, and Resources of the Souhegan River and Proposed Protective Flow Measures for Flow Dependent Resources, Final Report, September 2004 prepared for NHDES.

Table 3-3: Rare, Threatened or Endangered Fish, Wildlife or Natural/Ecological Communities Located in the Souhegan Corridor

Entity	Location
Banded Sunfish	
Fowler's Toad	Milford, Amherst
Pied-billed Grebe	Amherst
Long's Bitter Cress	Greenville
Emergent Wetlands	Greenville, Amherst, Merrimack
Wood Turtle	Amherst, Merrimack
Osprey	Milford
Common Loon	Amherst
S. New Eng. High Energy Riverbank community	Greenville, Wilton
S. New Eng. Floodplain Forest community	Merrimack, Amherst
Wild Garlic	Merrimack
Eastern Hognose Snake	Amherst, Merrimack
Grasshopper Sparrow	Amherst, Merrimack
Giant Rhododendron	Greenville, Milford, Wilton
Siberian Chives	Merrimack
Birds Foot Aster	Merrimack
Skydrop Aster	Merrimack
Goat's Rue	Merrimack
Stiff Tick Trefoil	Merrimack

3. Fish

The river is habitat for the endangered Banded Sunfish (Enneacanthus obesus) which occurs in slow-water areas and impoundments and prefers heavily vegetated areas.[8]

Native species of fish in the Souhegan River include American Eel, Atlantic Salmon, Blacknose Dace, Brook Trout, Brown Bullhead, Chain Pickerel, Common Shiner, Common White Sucker, Creek Chub Sucker, Fallfish, Golden Shiner, Longnose Dace, Longnose Sucker, Margined Madtom, Pumpkinseed, Redbreast Sunfish, Spottail Shiner, Yellow Bullhead, and Yellow Perch. Introduced fish species present in the Souhegan River include Brown Trout, Largemouth Bass, Smallmouth Bass, and Rainbow Trout. Although these species are not native, they have been introduced and are now part of the aquatic

[8]Cairns, S, 2004. Personal communication to NHDES for the Instream Flow Study. New Hampshire Natural Heritage Inventory (NHI). Concord, NH.

community.[9] A more detailed inventory and habitat assessment of native fish species is being conducted as part of the NHDES Instream Flow Project.

In addition, the River is stocked annually by the New Hampshire Department of Fish and Game (NHFG) with Brown Trout, Rainbow Trout and Eastern Brook Trout. In 2003, trout aged one year or older were stocked along the Souhegan River in Merrimack, Milford, Amherst, Wilton, Greenville, and New Ipswich. The NHFG records report 10,260 trout were stocked in the River in 2003: 2,740 Rainbow Trout, 3,290 Eastern Brook Trout, and 4,230 Rainbow Trout. Virtually all of the trout in the Souhegan River Watershed are the result of the stocking program.[10] When released, the trout are typically of a legal size for angling, representing what is called a "put and take" program.

The Souhegan River is an important part of the Merrimack River Anadromous Fish Restoration Program and is considered by fisheries biologists to be one of the most productive rivers in the Merrimack River Watershed. The upper reaches of the Souhegan River provide the appropriate habitat (gravelly, sloping bottoms and adequate water temperatures, oxygen levels and food sources) for excellent growth and survival of Atlantic Salmon fry. Approximately 100,000 Atlantic Salmon fry are stocked in the Souhegan annually. These fish will remain in the river system for two years before making their way to the Atlantic Ocean. The dams on the Souhegan River are equipped with only downstream fish passage measures, since natural reproduction is not expected.

Students throughout the Merrimack Watershed raise baby salmon in classroom aquariums as an educational component of the U.S. Fish and Wildlife Service Adopt-A-Salmon program. Virtually all of these salmon are released into the Souhegan River. The Souhegan Watershed Association aids with the releasing of the fish in the springtime.

4. Turtles

The wood turtle (Clemmys insculpta) is a rare species that was observed basking on a log in the reach between Milford and Merrimack. This turtle over-winters on the bottoms of streams and feeds both on land and in the water eating aquatic and upland plants and animals (Taylor 1993). This mobile semi-aquatic species is not likely to be directly harmed by seasonal low flow reductions. However, this species is reported to be intolerant of pollution (DeGraaf and Yamasaki 2000), and therefore also indirectly flow dependent. Wood turtles could also be harmed by a major decrease in winter water levels that could expose a hibernating turtle to freezing conditions

5. Toads

Historical records of the rare Fowler's Toad (Bufo fowleri) include several locations along the Milford to Merrimack reach of the Souhegan River, and although this species was not observed during the field investigation, suitable habitat is certainly present. This species prefers sandy outwash soils. As with the common American Toad (Bufo a. americanus), which was observed, Fowler's Toads are water dependent for breeding, eggs, and larval stage, and would likely use the same shallow, still margins of the Souhegan River in which American Toad tadpoles were observed. Although, breeding in other water bodies is also possible. Reduction in flows that expose the shallow river margins, backwaters, and oxbows during larval development may strand and eliminate cohorts of toad tadpoles. Fowlers Toad breeds from late May to August, about one month later than American Toads, with tadpoles transforming in midsummer (DeGraaf and Yamasaki 2000).

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[9] NHDES Souhegan River Watershed Report,1997.
[10] Souhegan River Nomination, 1999

6. Vegetation

The types of vegetation found in the Souhegan River Watershed are generally those species indigenous to southern New Hampshire which include, White Pine, Hemlock, Red Maple, Red Oak, Sycamore, Mountain Laurel, and numerous species of grasses and shrubs. Forested land is the dominant land use in the watershed outside of each community's Town center and the urbanized areas along the NH Route 101 and 101A corridors. Much of the forested land within the watershed is actively managed for timber harvesting, as well as for wildlife management.

There is a great diversity of plant species found in the Souhegan River corridor. The New Hampshire Natural Heritage Inventory lists nine state-endangered plant species as occurring along the Souhegan River. They are Long's Bitter Cress, Wild Lupine, Bird's Foot Violet, Siberian Chives, Wild Garlic, Skydrop Aster, Goat's Rue, Stiff Tick-trefoil, and Giant Rhododendron. Long's Bittercress (*Cardamine longlii*), an endangered aquatic plant, exists primarily in sandy muck or cobbles (Cairns 2004).

Long's Bitter Cress (Cardamine longii Fern) is an obligate aquatic plant that has only been recorded from one location in NH (Greenville) and this was prior to 1984. It was not observed during the IPUOCR survey conducted by the field team on June 28-30, 2004.

Another twelve threatened or endangered plant species that are listed at the state or federal level occur elsewhere in the Souhegan River Watershed. These are Wild Sienna, Maryland Tick-Trefoil, Northern Blazing Star, Sweet Goldenrod, Fall Witch-Grass, Blunt-Leaved Milkweed, Virginian Mountain Mint, Burgrass, Butterfly-Weed, Slender Bush-Clover, Climbing Fumitory, and Sweet Coltsfoot.

There are historical records of the State Endangered Wild Sienna (Cassia hebecarpa) in three of the towns along the Souhegan River (Amherst, Merrimack, and Milford) as well as a more recent record from Robin Warren of the Amherst Country Club who reports that this plant grows on the banks of the Souhegan River. The New England Wildflower Society reports that typical habitat for this species includes disturbed habitats (roadsides, fields, and edges of streams), often in damp or alluvial soils. The few colonies in Massachusetts are found in annual floodplains, meadows and roadsides (Clark 2000). Wild Sienna is classified as a Facultative Species in New England, which means it is equally likely to be found in uplands and wetlands. Colonies that are located on the river floodplain may flow dependent to the extent that they are reliant on periodic disturbance (such as scouring) and moist soils, and could be adversely affected by prolonged flooding. The location of this plant colony will be verified in the field if possible and flow dependence will be assessed based on location relative to the channel and floodplain.

The Souhegan River Corridor contains the following species of endangered or threatened flora that are potentially flow dependent: Siberian/Wild Chives (Allium schoenoprasum) and Giant/Great-laurel Rhododendron (Rhododendron maximum) (Cairns 2004, NHI 2004). Siberian Chives typically require pristine floodplain forest or mid-river island habitat. Giant Rhododendron typically requires acidic moist soils associated with heavily wooded, low lying forests. Potential and existing locations of these species will be examined in the field as part of the In-Stream Flow Study to better determine flow dependence.

7. Natural Communities

The New Hampshire Natural Heritage Bureau Natural defines natural communities as "assemblages of plants and animals ecologically related to one another and their physical environment." These areas, identified by the dominant plants, vegetation, structure, and major features of the physical environment represent intact examples of New Hampshire's native flora, fauna and vegetation.

Southern New England High-Energy Riverbank Community
Sand and cobble bars with plant communities resembling the Southern New England High-Energy Riverbank Community (listed by New Hampshire Natural Heritage Inventory NHNHI) were observed in several locations along the Souhegan River. Dominant species included twisted sedge (Carex torta), dogbanes (Apocynum sibiricum; A. cannabinum), Joe-pye weeds (Eupatorium ssp.), Reed Canary grass (Phalaris arundinacea), Swamp Candles (Lysimachia terristris), Willow (Salix spp.), and Grapes (Vitis sp.). At slightly higher elevations, shrubs such as silky dogwood (Cornus amomum) and Alder (Alnus incana) along with several species of ferns and other herbaceous plants are often dominant. These habitats are dependent on periodic high flow scouring to reduce competition from plants less tolerant of flooding and coarse soils. The communities most dependent on scour are those at the lowest elevations in the channel. Prolonged absence of high seasonal storm flows or ice scouring or prolonged flooding during the growing season could adversely affect these communities. Reductions in seasonal low flows are unlikely to endanger these communities.

Southern New England Floodplain Forest
Two types of Southern New England Floodplain Forest were observed along the Souhegan River upstream of the Town of Milford. The Red Maple (Acer rubrum) Floodplain Forests typical of smaller rivers were observed. Dominant plants observed also included Sycamore, White Ash, Ironwood, False Nettle, Ferns, Grapes, and Sedges. Within the Towns of Amherst and Merrimack, Silver Maple (Acer saccharinum) was observed. Floodplain forest plant communities are dependent on periodic flooding and scouring to provide nutrients and reduce competition from flood-intolerant plant species. These communities often have a mesic moisture regime during the rest of the growing season, and are less dependent on low flows than flood flows.

8. Macroinvertebrates

Mayflies (Ephemeroptera), stoneflies (Plecoptera), and caddisflies (Trichoptera), are diversely represented in the Souhegan River system. These taxa are generally considered to be clean-water organisms, so their presence tends to be correlated with good water quality and stream flow. Other macro-invertebrates such as freshwater mussels and Odonates (dragonflies and damselflies) are also often dependent upon good water quality, thus their presence can be an indicator of a healthy water body. As with most macro-invertebrates, not much is presently known about their habitat needs. It is likely that habitat used by these animals can differ from fish habitat.

9. Mussels

There are twelve species of freshwater mussels found in the northeast. These species are important in water bodies as they maintain clean water by filtering algae and plankton, and are eaten by many species of wildlife. The species with potential to be present in the Souhegan River include Eastern Pearlshell, Triangle Floater, Brook Floater, Creeper, Eastern Elliptio, Eastern Floater, Alewife Floater, Eastern Pondmussel, Tidewater Mucket, Yellow Lampmussel, and Eastern Lampmussel. [11]

Most freshwater mussels live burrowed in sand and gravel substrates, often occurring in the shallows of rivers and streams. Many species prefer a habitat that offers highly oxygenated water and moderate current. Only a few species have adapted to life in lacustrine zones such as lakes, ponds, and reservoirs. Mussels play an important role in river ecology as their filtering ability makes them natural water purifiers. They are an integral part of the food web as a food source for raccoons and muskrats. Mussels

[11] Instream Protected Uses, Outstanding Characteristics, and Resources of the Souhegan River and Proposed Protective Flow Measures for the Flow Dependent Resources.[IPOUCR] Final Report, 2004. Prepared for NHDES by Normandeau Associates, University of Massachusetts, University of New Hampshire.

also depend on many different fish species as a means of dispersal. Some of the identified hosts include tessellated darters, blacknose dace, golden shiner, longnose dace, margined madtom, pumpkinseed, slimy sculpin, and yellow perch. Mussels are good indicators of water quality. Factors such as water pollution, siltation, and impoundments have been known to cause declines in mussel populations. Well-established, diverse mussel colonies generally indicate a healthy aquatic environment.

10. Insects

There are a variety of insects, which are dependent upon a river system for habitat and breeding grounds. There are many different species of dragonflies and damselflies located in Hillsborough County, the county in which much of the Souhegan River and its watershed is found. Dragonflies and damselflies are good indicators of water quality and are identifiable by their shed exoskeletons and adult forms.


Spine-crowned Clubtail dragonfly

Tom Young, a member of New Hampshire Audubon Society, has photographed numerous dragonflies and damselflies along the Souhegan River including the Spine-crowned Clubtail a state endangered species. A photo of a Spine-crowned Clubtail, taken by Mr. Young along the Souhegan River, is shown on the cover of the Plan. In addition to the endangered Spine-crowned Clubtail, the other notable species that Mr. Young has found along the Souhegan River at Route 122 is the Brook Snaketail, which is listed as a species of Special Concern.[12] According to Mr. Young, most Clubtails rely on clean rivers, so it is important that their habitat is conserved. Mr. Young lists the section along Route 122 in Amherst as one of the premiere observation locations of dragonflies and damselflies in the state. He emphasizes that the critical habitat extends the entire stretch of the river and that dragonflies are not very tolerant of poor water quality conditions. Some species rely on rapidly flowing water and sandy river bottoms during their larval stage.

If water is impacted through sedimentation, an increase or decrease in stream flow or other drastic event, these insects are affected, as their presence depends upon high quality water. The flow needs of these macroinvertebrates vary through the season, as they emerge from rivers spring through early fall (Lenz 1997).

11. Wildlife

Mammals represented in the watershed are those commonly found in southern New Hampshire. These include raccoons, skunks, muskrats, beavers, porcupines, white tail deer, woodchucks, squirrels, mice, bats, rabbits, and other indigenous species adapted to living near humans. The more rural areas of the watershed may also provide habitat for larger animals that require extensive habitat areas, or species that require solitude such as moose, black bear and lynx.

Depending on the season, the watershed is host to a wide diversity of bird species. Similar to the animal species, the birds found in the corridor are those indigenous to southern New Hampshire. Species of gulls, doves, woodpeckers, chickadees and jays are found throughout the year, while other species such as warblers, flycatchers, wrens, swallows, and several species of raptors are only seasonal residents. Other species, including a variety of ducks, geese and waterbirds, nest in the area or migrate through the

[12] Dragonflies and Damselflies of Massachusetts by Blair Nikula et al.

watershed. An important great blue heron rookery can be found in Milford. The Department of Fish and Game defines any wetland in the watershed as important habitat for migratory waterfowl.

12. Birds

The State-endangered Pied-Billed Grebe (Podolymbus podiceps) was reported from the Amherst Country Club. This species was not observed during the field visit June 28-30, 2004. Preferred habitat is densely vegetated emergent and deep marsh interspersed with open water that is more than 12 acres in size (DeGraaf and Yamasaki 2000; Banner 1998). To the extent that such a marsh is dependent on river flow, this marsh bird species would be flow dependent. A preliminary inspection of aerial photos of the Souhegan River floodplain indicates that there are several marshes that could be habitat for the Pied-billed Grebe, and some of these have a direct connection to the Souhegan River. Specific needs of the Pied-billed Grebe are that standing water must always be present.


Heron

The Osprey (Pandion haliaetus) is a State-threatened bird-of-prey observed foraging over the fish hatchery in Milford and over the river during the field survey, and reported from the Amherst Country Club. Ospreys observed along the Souhegan River in summer could be transient individuals. Ospreys primarily consume fish from clear, unobstructed water bodies. They dive up to three feet into the water, and so are most likely to feed in the pools and reservoirs, not shallow riffle areas. Only changes in flow that eliminate pools reduce fish abundance, increase turbidity, or increase aquatic plant cover, are likely to affect Ospreys. Flows that are protective of a healthy fish community will be protective of this species.

The Common Loon (Gavia immer) was reported from the Amherst Country Club, although it is unlikely to be nesting along the river. This State–threatened bird could be using river seasonally to forage for fish, its primary food. The Souhegan River is not likely to be a primary habitat for the Common Loon, but foraging opportunities for loons would be indirectly affected by changes in flow as for the Osprey. Like the Osprey, flows that are protective of a healthy fish community will be protective of this species.

13. Scenic Areas and Views

Areas identified as notable for aesthetic beauty or scenic values in the NHDES Instream Flow Study include the following:

- In New Ipswich along River Road along scenic Water Loom Pond and under High Bridge.
- In Greenville a scenic gorge.
- Route 31 proceeds through a 3.2 mile corridor protected by a scenic easement. The easement starts in Greenville at the Green Bridge and continues to Goldsmith Brook in Wilton.
- The Horseshoe in Wilton is an area where the River passes through a series of ledges that are steep on one side.
- In Downtown Wilton the River passes under an old railroad bridge. Wilton was accepted into the National Main Street Program with the River being an important element of the downtown character.

- In Milford the river passes under historic Green Bridge (aka Jones Crossing), Granite Bridge (aka Shepards Bridge) and the Swing Bridge.
- The Souhegan River Trail in Milford follows the river along the state owned fish hatchery property and the adjacent Town owned property.
- The stretch of the river in Amherst between Route 122 and the Canoe Port on Boston Post Road. High gravel bank are home to many birds, as are nearby oxbows.
- In Merrimack Indian Ledges and Wildcat Falls are both scenic resources.

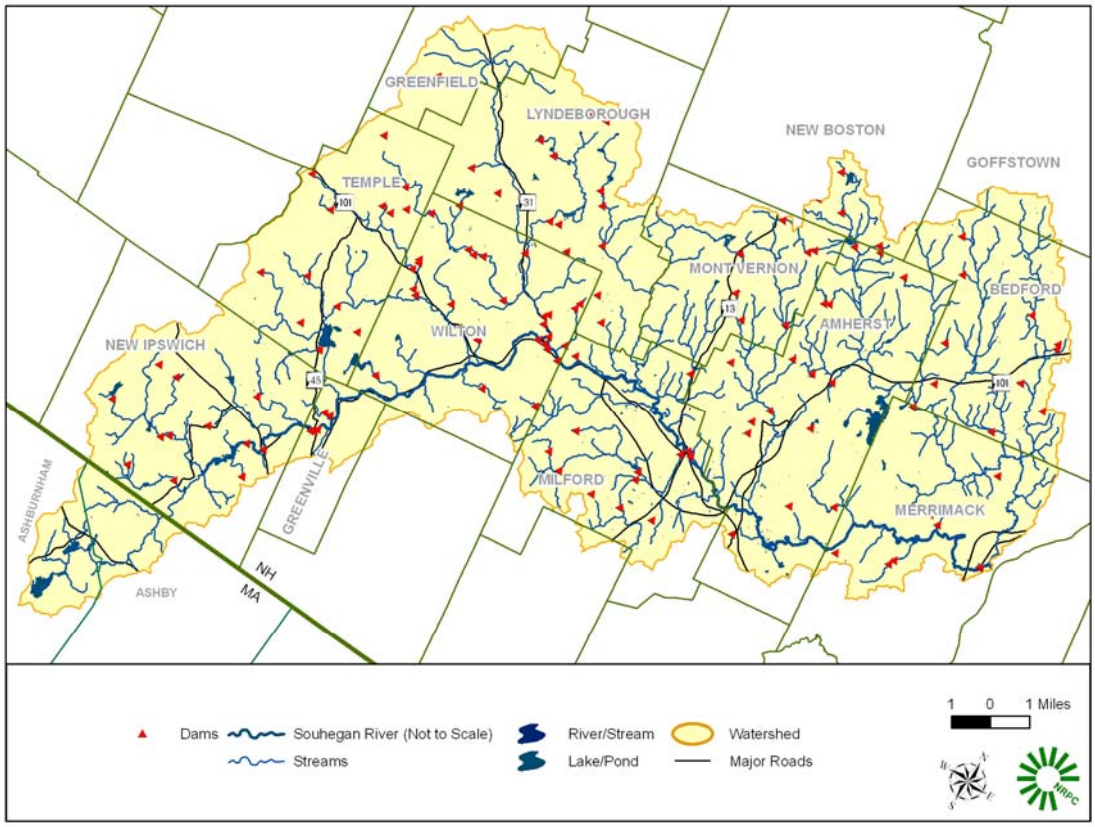
These areas have been highlighted with a symbolic icon on Map B-1, Watershed Conditions.

C. WATER USE

1. Dams

Dams created for flood control or other purposes are widespread throughout the watershed. Figure 3-2 shows the location of dams in the watershed that are included in the NHDES GIS database. Water has also been used throughout history to generate power. The Souhegan River exemplifies this history as it first powered saw and gristmills, and later textile and other industrial mills. All of the dams on the Souhegan River are operated essentially as run-of-the-river operations. This means that the water used to spin the turbines is typically returned virtually instantaneously to the riverbed downstream of the project and is not stored for later release. There are no large impoundments on the Souhegan River. Therefore, the opportunities for large amounts of storage do not exist. The impoundments are essentially full most of the time precluding the need for water to refill after drawdown. The only two dams with impoundments greater than ten acres are the Waterloom Pond Dam in New Ipswich and the Merrimack Village Dam in Merrimack. There are additional small impoundments throughout the watershed as well as several flood control structures near the headwaters of the Souhegan. Figure 3-3 shows the location dams on the Souhegan River. The Watershed Conditions Map B-1 also shows location of dams.

Figure 3-2: Location of Dams in the Watershed

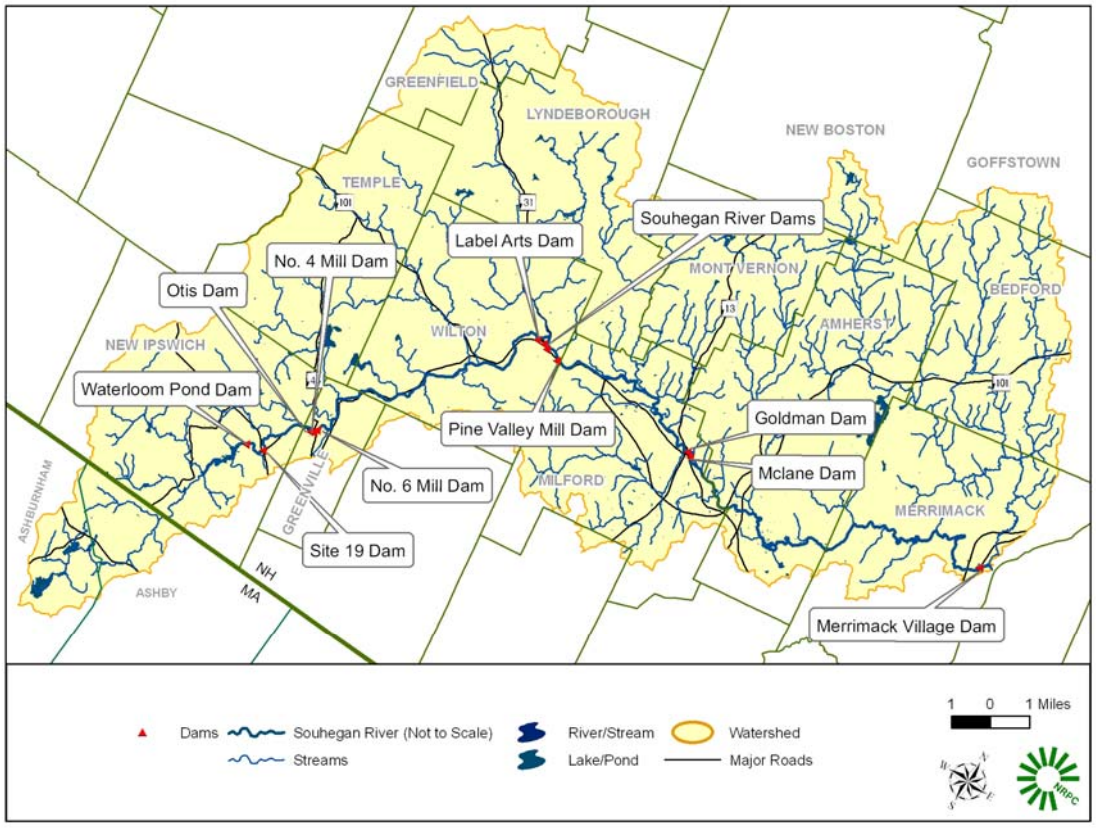


Souhegan River Dams
There are twelve dams listed in the NHDES dams' database on the Souhegan River (NHDES 2004):

Table 3-4: Listed Dams on the Souhegan River

Impoundment Name	Location
Souhegan River Dam. Aka Site 19	New Ipswich
Waterloom Pond Dam	New Ipswich
Otis Dam	Greenville
No. 4 Mill Dam	Greenville. Behind Elderly Housing
No. 6 Mill Dam	Greenville. Behind No. 6 Mill
Souhegan River Dam	Wilton
Souhegan River III Dam AKA Label Arts Dam	Wilton
Souhegan River Dam	Wilton
Pine Valley Mill Dam	Wilton. Near Milford Line.
Goldman Dam	Milford
McLane Dam	Milford
Merrimack Village Dam	Merrimack

Figure 3-3: Location of Dams on the Souhegan River



The river corridor currently contains five hydroelectric facilities that are listed in Table 3-5.

Table 3-5: Hydroelectric Facilities on the Souhegan River

Hydroelectric Facility	Location
Waterloom Pond Dam	New Ipswich
Otis Dam	Greenville
No. 4 Mill Dam	Greenville
No. 6 Mill Dam	Greenville
Pine Valley Mill Dam	Wilton

Source: Instream Protected Uses, Outstanding Characteristics, and Resources of the Souhegan River and Proposed Protective Flow Measures for Flow Dependent Resources, Final Report, NHDES, September. 2004.

2. *Water Withdrawals*

Facilities which use 20,000 or more gallons of surface water or groundwater per day (gpd) are required to register with the NHDES Water Management Bureau (WMB) and to provide information on average and daily water demand. Once registered, the facility must report its monthly water use to the WMB.

Currently, there are no surface water withdrawals for public water supplies from the Souhegan River. However, Pennichuck Water Works withdrew water from the river from 1965-1984 and maintains the right to withdraw water in the future. There are five municipal water supply wells in the watershed, one

in Amherst, two in Milford and two in Wilton. Monadnock Spring Water in Wilton is the only commercial well in the watershed that markets a regional product.

A major component of the withdrawals from the Souhegan River is for the Milford Fish Hatchery and is sustained primarily by induced infiltration from streamflow. The Savage Well in the western part of the aquifer captures 47 percent of its pumped water from surface-water infiltration *(Harte, P. T.; Mack, T. J. Geohydrology of and simulation of ground-water flow in, the Milford-Souhegan glacial-drift aquifer, Milford, New Hampshire." 1992 Report Number 91-4177)*.

Greenville is the only community in the watershed with a municipal surface water supply. The surface drinking water facility uses conventional treatment and receives its water supply from the Tobey Reservoir in Temple, New Hampshire. The consulting firm Woodard & Curran has been contracted to operate both the water and wastewater treatment facilities for the town of Greenville, New Hampshire, since 2001.

Table 3-6 lists the NHDES registered public water supplies in the Souhegan Watershed. The town of Greenville is included on the list as the only public surface water supply.

Table 3-6: Public Water Supplies Near the Souhegan River

USERNAME	FACILITY	Source Type	Description
AMHERST COUNTRY CLUB	AMHERST COUNTRY CLUB	GROUNDWATER	GPW /220' SW of Club House
MILFORD WATER WORKS and WWTF	MILFORD WATER WORKS	GROUNDWATER	GPW Curtis 2/West
MILFORD WATER WORKS and WWTF	MILFORD WATER WORKS	GROUNDWATER	GPW Curtis 1/ East
MONADNOCK MOUNTAIN SPRING	MONADNOCK MOUNTAIN WATER	GROUNDWATER	SPR 1 / 250' S of Plant
MONADNOCK MOUNTAIN SPRING	MONADNOCK MOUNTAIN WATER	GROUNDWATER	SPR 2 / 2/10 Mile NNW of Plant across Rt. 101
PENNICHUCK WATER WORKS	AMHERST VILLAGE DISTRICT	GROUNDWATER	GPW /IN PS
PENNICHUCK WATER WORKS	SOUHEGAN WOODS	GROUNDWATER	GPW 4/1010' SW of Pump House
PENNICHUCK WATER WORKS	SOUHEGAN WOODS	GROUNDWATER	GPW 1/920' SW of PH
PONEMAH GREEN GOLF COURSE	PONEMAH GREEN GOLF COURSE	GROUNDWATER	GPW /671' SW of Rear Cnr Clubhouse
WILTON WATER WORKS	WILTON WATER WORKS	GROUNDWATER	Everett GPW /In PH
WILTON WATER WORKS	WILTON WATER WORKS	GROUNDWATER	Abbott GPW /400' N of PH and 400' E of RTE 31
GREENVILLE TOWN	GREENVILLE WATER WORKS	SURFACE WATER	Tobey Reservoir

Source: NHDES Instream Flow Final Report

3. Wastewater Discharges

Point sources of pollution include discharges from one identifiable source such as a pipe. All point sources of pollution that discharge directly to surface waters are required to obtain a permit under the National Pollutant Discharge and Elimination System (NPDES). NPDES permits specify effluent limitations, compliance schedules, and monitoring and reporting requirements. Point source discharges include: Greenville WWTF (wastewater), Souhegan Wood Products (non-contact cooling waters), Hitchiner Manufacturing (non-contact cooling waters), Milford WWTF (wastewater), and Harcross Chemicals (non-contact cooling waters).[13] The location of the two wastewater treatment facilities is shown on Map A-1: Watershed Conditions.

The Greenville wastewater treatment system discharges to the Souhegan River. In 2000 the operator of the plant was charged with failing to properly test the facility's effluent between May of 1999 and February of 2000, resulting in the discharge and disposal of sewage and waste to the Souhegan River. Enforcement and corrective action has since occurred at the plant.

4. Superfund Sites

Four hazardous waste disposal sites are located in close proximity to the Souhegan River. The Savage Municipal Water Supply Site and Fletcher Paint EPA Superfund Site in Milford, and the N.H. Plating Company Superfund site in Merrimack. The Savage Municipal Water Supply Site was divided into two operable units. One is known as the O.K. Tool Source Area and the other as the Extended Plume Area.

In 1983, a State-wide drinking water sampling program revealed volatile organic compounds (VOCs) levels that exceeded drinking water standards in the Savage Municipal Well. Studies revealed that the groundwater is contaminated with VOCs including tetrachloroethylene (PCE), trichloroethylene (TCE), 111-trichloroethane, and vinyl chloride; and heavy metals including lead, chromium, and nickel. This soil was found to be contaminated as well with VOCs, as is the stream on site. A stream that receives discharge from Hitchiner Manufacturing and previously from Hendrix Wire and Cable flows through the site prior to entering the Souhegan River. Clean-up of the site and the extended groundwater plume is in progress.

The Fletcher's Paint Works and Storage Site was first investigated by EPA in 1988. This two acre site which borders the Souhegan River was found to contain sediments and surface waters containing VOCs, including benzene and toluene; heavy metals including nickel and lead; and PCB's. Soil contamination consists primarily of PCB's, PAHs and VOCs. Extensive clean-up efforts have been occurring since the EPA undertook an emergency removal effort at the site in 1988. Clean up is ongoing.

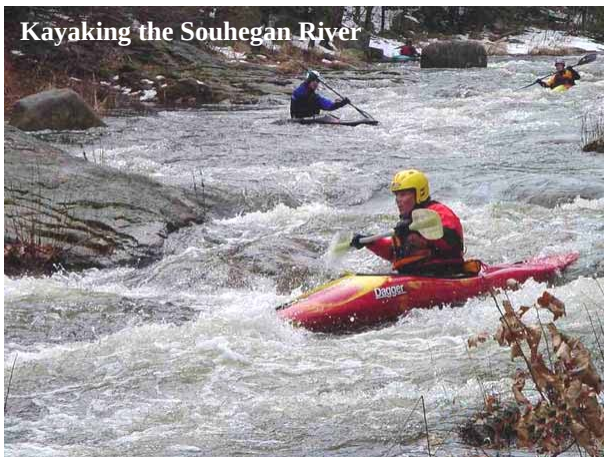
The third Superfund site in the watershed is the former New Hampshire Plating Company (NHPC) in Merrimack. Four lagoons located on the site were used for the disposal of wastes and wastewaters resulting from the company's electroplating operations. Various VOCs and heavy metals, including cadmium, are present in groundwater throughout the site. Treating the lagoon system, installing a cap, demolishing a contaminated building, removing contaminated debris and fencing the NHPC site have reduced the risk posed to health and safety on nearby residents and workers while final clean-up remedies are being implemented. The EPA has determined that this site does not pose and immediate threat to human health, and will continue to monitor this site for any changes that may trigger additional action.

[13] NRPC Watershed Study, 1995

D. RECREATION

1. Boating

Boating on the Souhegan River is limited to canoes and kayaks, since there are few spots where the River is deep enough to accommodate larger watercraft. Locations identified as suitable for recreational boating are shown on Map A-1, Watershed Conditions. The western sections of the River from Greenville to Wilton provide whitewater canoeing and kayaking during the spring and other periods of high water. These sections of the River are identified as good intermediate-level whitewater by both the Appalachian Mountain Club's (AMC) River Guide the New England Whitewater River Guide. The AMC Guide classifies the rapids in this section as Class II, III and IV. This stretch of the river is popular with canoes and kayakers because of early ice-out, good training runs and easy accessibility. The Boston and New Hampshire AMC chapters and the Merrimack Valley paddlers organize numerous trips on the Souhegan River every year.


Kayaking the Souhegan River

The stretch of the River between Wilton and Milford provides limited opportunities for canoeing and kayaking because the water level is generally very low and portages are required around the dams. Below the Route 122 Bridge in Amherst, the River is flat and provides excellent opportunities for family canoe outings. The water is shallow with a sandy bottom and there are numerous spots to picnic and wade. The Merrimack chapter of the Merrimack River Watershed Council sponsors annual canoe trips on this section of the River. Below the Seaverns Bridge in Merrimack, the River quickens as it flows through a series of ledges known as Indian Ledges. Passage for canoes and kayaks at this point is again limited to periods of high water. The stretch of the river below Turkey Hill Bridge is impassable to watercraft because of Wildcat Falls.

There are two canoe and kayak access ports in Merrimack: the Turkey Hill Bridge and the Seaverns Bridge. There are no formal ramps at either facility and access is over the riverbank. A minimum amount of off-street parking is available at each site adjacent to the bridges. Amherst also has two canoe or kayak access points maintained by the Amherst Conservation Commission. The first, at the Route 122 bridge, has off-street parking and a defined launch area. The second access point is near the bridge at Boston Post Road, and includes a set of stairs leading to the riverbank. Access at this site has been greatly improved as a result of an Eagle Scout project. There are now two parallel stairs leading to the river, wide enough to easily carry a boat up and down to the river. In Milford, river access is available at Keyes Field, the MCAA fields and near the Milford police station. Public access in Wilton is limited to the western section of town, adjacent to the bridge on Isaac Frye Highway and within the NH Department of Transportation scenic easement on Route 31 South.

2. Swimming

Swimming in the Souhegan River is limited to a few areas where the River is deep enough. Wading and rock jumping, however take place all along the River. Three areas are used by residents for swimming: the Horseshoe in Wilton, the confluence of Purgatory Brook in Milford, and the canoe launch on Boston Post Road in Amherst. These swim holes have been located on Map B-1, Watershed Conditions. The Horseshoe is used extensively throughout the summer; however, it is located on private property. The Town of Wilton at one time attempted to purchase the Horseshoe but was unsuccessful. The Milford site

is accessible through property owned by the State and is therefore protected from future development. The Amherst canoe launch is part of the Scott conservation lands, which were purchased by the Conservation Commission. One of the most popular wading and rock jumping locales is in Wilton along the Department of Transportation's scenic easement on Route 31 in Wilton. Picnic tables and limited parking are provided in two locations along the easement, and are popular with residents and travelers alike.

3. Golf

There are four golf courses along the Souhegan River in Amherst:

- Amherst Country Club, Route 122;
- Ponemah Green, Route 122;
- Buckmeadow Golf Course, Route 101A; and
- Souhegan Woods Golf Club, Thornton's Ferry Rd.


Swimming in the Souhegan

4. Hiking, Nature Study, Fishing Access, Picnicking within the Corridor

Popular fishing and other recreational spots are shown as an icon on Map B-1, Watershed Conditions. The land use categories shown on Map A-2, Watershed Assessment include parcels used for recreation. Passive recreation spots are located at:

- Riverside Park in Greenville;
- Taft Land owned by New Hampshire Fish and Game (NHF&G) in Greenville;
- Town Forest owned by the Town of Wilton;
- Society for Protection of New Hampshire Forests (SPNHF) land in Wilton;
- The Souhegan River Scenic Easement owned by New Hampshire Department of Transportation (NHDOT) in Greenville/Wilton;
- The Horseshoe, a privately owned parcel in Wilton;
- The Milford Fish Hatchery, owned by NHF&G;
- Milford town land;
- Bicentennial Park, owned by the Town of Milford;
- Keyes field, owned by the Town of Milford;
- Emerson Park, owned by the Town of Milford;
- Kaley Park owned by the Town of Milford;
- Cemetery Fields on Merrimack Road near Beaver Brook (that feeds the Souhegan), in Amherst;
- Amherst canoe port, owned by the Town of Amherst;
- Route 122 access, owned by the Town of Amherst;
- The Sherburne Site, owned by the Town of Amherst;
- Eighty Acres, owned by the Town of Merrimack;
- The Turkey Hill Bridge Site, Weston Park, owned by the Town of Merrimack; and
- Recently donated Watson parcel-planned for future park development.

There is also informal, publicly owned access for fishing and canoeing at various bridge crossings along the river including the Captain Clark Bridge in Wilton, Green Bridge in Milford, Route 122 Bridge in Amherst, and the Turkey Hill and Seaverns Bridges in Merrimack.

Public and semi-public land in Wilton include the recycling center property, the Society for the Protection of New Hampshire Forests (SPNHF) property, the Town Forest and the NH DOT scenic easement along Route 31. The Wilton Conservation Commission publishes a Town of Wilton Recreational Trails Map which includes trail descriptions of the SPNHF owned Heald Tract, which contains trails that cross the Souhegan River at the intersection of Route 31.

Milford access is provided by the wastewater treatment plant property, the town owned land east of the Swing Bridge, Keyes Field, two cemeteries, North River Road Fields and the State Fish Hatchery land.

In Amherst there is access to the river from the Scott land, the canoe launch and the two public golf courses along the River.

In Merrimack, areas specifically suitable for hiking include the State-owned Eighty Acres land just west of the FEE Everett Turnpike, the Whipporwill Boy Scout Camp and the town-owned conservation land further west on the Souhegan River.

5. Conservation/Open Space

Permanent open space parcels are shown on Map A-2. Watershed Assessment Open Space parcels located in or near the River Corridor include the following:

New Ipswich:

- There are a few small parcels of land owned by the town along the River that are predominately forested.

Greenville:

- NH Fish and Game owns a large parcel that is predominately forested and includes the gorge. Riverside Park is a small undeveloped park.

Wilton:

- The Town Forest, SPNHF owns a parcel along the River- forested; and
- NHDOT owns a 3.2-mile scenic easement on Rt. 31 in Wilton and Greenville

Merrimack:

- Eighty Acres site-predominately forested includes Wildcat Falls;
- Turkey Hill Bridge site-open and forested, provides car top access to the River;
- Davidson Avenue green space-predominately forested; and
- Whippoorwill Boy Scout Camp.

Milford:

- An unnamed piece east of downtown- floodplain, forest, fields the site east of the swinging bridge-open area and woods;
- Emerson Park- a small developed park;
- Keyes Memorial Park- floodplain, open recreational area;
- NH Fish and Game fish hatchery;
- North River Road, open space subdivision. 9 acres set aside for open space. Includes 250-foot buffer to the Souhegan River;
- Conservation easement adjacent to Souhegan River at bills Fergason's Maple farm east of the Fish Hatchery; and

- 50 foot Town easement along the Souhegan River from North River Road to the Fish Hatchery.

Amherst:

- Scott and Sherburne sites - These two adjacent parcels, 39 acres and 10 acres respectively are predominately floodplain. The Scott land is located on both sides of the Souhegan River, bordering Boston Post Road and Thorntons Ferry II. The Sherburne land, opposite the Souhegan High School has the Souhegan River as its rear boundary and Simeon Wilson Road as the front boundary; and
- The Currier Land - predominately floodplain, and The Curtis Well Site- public drinking water, mixed woods and fields.

E. HISTORIC AND ARCHAEOLOGICAL RESOURCES

The Souhegan River has played a pivotal role in the history of the towns within the watershed. For the purposes of this management plan the focus will be on water dependent historic structures within the corridor, specifically mills, bridges and dams. Of note are two non-water dependent structures within the corridor listed on the National Register of Historic Places; the Milford Town Hall and the Wilton Public Library. The location of Historic Mills, Bridges and Dams is shown on Map A-1, Watershed Conditions.


Stone Bridge, Milford

1. *Historic Mills*

- New Ipswich: High Bridge Mill, Columbian Manufacturing Company, Routes 123 and 124;
- Greenville: Columbian Manufacturing Company Tenement, Main St., Mill No. 4, Main and Mill Streets;
- Milford: Milford Cotton and Woolen Manufacturing Company. 2 Bridge Street. Listed on the National Register of Historic Places; and
- Merrimack: remains of Grist Mill located on private property at Indian Ledge Falls. Remains of canal to power mills at Merrimack Village Dam site.

2. *Historic Bridges:*


Otis Dam, Greenville

- New Ipswich: **High Bridge** - This bridge is claimed to be the highest stone bridge in the state, although the arch itself, spanning the Souhegan River, is comparatively small. The bridge presents a stone wall to the viewer and is 156 feet long and has been dated to 1817;
- Greenville: **Railroad Bridge, Green Bridge, Mill Street Bridge** - A stone arch bridge built circa 1858;
- Wilton: **Railroad Bridge** - Located downtown, old town pictures show that this was previously a covered bridge. **Whiting Bridge** - This bridge crosses Stony Brook at Route 31;

- Milford: **Swing Bridge, Green Bridge, and Stone Bridge;**
- Amherst: Granite structure abutments remain at the following sites: Behind Shaw's supermarket on route 101A and at the Amherst Country Club on route 122. **Old Boston Post Road Bridge** - A stone bridge visible from the new Boston Post Road Bridge; and
- Merrimack: **Chamberlain Bridge** on Route 3;

3. Historic Dams:

- New Ipswich: Waterloom Falls;
- Greenville: Otis Mill, No. 4 Mil, No. 6 Mill (Chamberlain);
- Wilton: Pine Valley;
- Milford: McClane Dam, Goldman Dam; and
- Merrimack: Merrimack Village Dam.

4. Archaeological Resources

Native American settlements were once common along the banks of the Souhegan River. Native Americans are known to have used the Souhegan River Valley as an important link between the Merrimack River Valley and the upper Contoocook River Valley. The River and its banks provided the native population with many readily exploitable resources including fish, migratory birds, flora, and fauna. Prehistoric and historic archaeological sites, such as Native American sites and cellar holes, contribute to the understanding of a community's past in a way which no written record can do.

According to the New Hampshire Division of Historical Resources, New Hampshire Archaeological inventory, there are four sites of historical significance within 100 meters of the Souhegan River. Three of these sites are located in Milford and one in Merrimack. Historical and archaeological information is sensitive in nature therefore specific site locations are not identified in public documents.

F. LAND USE

Map A-2, Watershed Assessment, is a generalized land use map depicting the forested, wetlands, developed, and other land uses within the River corridor and watershed. Land use data has been shown for the River corridor and the towns within the NRPC region. As the map shows, the upper portions of the watershed in New Ipswich, Greenville, and Wilton are relatively undeveloped and have considerable wetland areas. Urbanization increases through the corridor communities of Milford, Amherst, and Merrimack where business centers are located Bedford is the most urbanized of the watershed communities.

The Souhegan River flows through a populated area of the state; there is considerable variation in land use within the river corridor from one community to the next. Much of the land is undeveloped, especially in the upper reaches of the watershed. However, there are pockets of more intensive development, especially in and near the village centers. In New Ipswich, land use in the river corridor is primarily forested with scattered housing. Land use in Greenville is mostly undeveloped with the exception of the village center.

In Wilton, land use is sparse along the Route 31 scenic corridor but gradually intensifies toward the village center where there is a mix of residential and commercial/industrial use. Land use in Milford is quite diverse. The river corridor in the western part of Milford especially to the north of the River is lightly developed with a mix of open space, agriculture, commercial and residential uses. Downstream and to the east of the Milford downtown, land use is predominantly commercial. Much of the land in Amherst is floodplain and undeveloped but there are four golf courses in the western part of the river

corridor. In Merrimack, land use to the west of the Everett Turnpike is very low density residential and undeveloped. East of the highway, land use is highly developed for commercial and industrial use.

1. River Corridor Land Use

Table 3-7 provides a summary of parcel based land use types from the NRPC GIS database within the River Corridor. The corridor represents a quarter of a mile from each side of the river and is located in the towns of New Ipswich, Greenville, Wilton, Milford, Amherst, and Merrimack.

This examination of parcel based land use within the River corridor is based on the specific land use of individual parcels. The majority of the land, approximately thirty seven percent, in the River Corridor, is residential. The approximately twenty one percent that is listed as vacant is primarily located in the western section of the corridor. High-density residential development, parcels less than or equal to one acre are primarily located in the historic Town centers and are areas currently served by public water and sewer systems. Milford, Wilton, and Greenville are the only communities with public water and sewer service areas covering significant portions of the watershed. The densely developed areas in Milford, Wilton, and Greenville are in close proximity to the Souhegan River.

Commercial and Industrial land uses represent approximately six percent of the total River corridor. The bulk of the commercial/industrial uses are located along NH route 101A in Amherst and Milford, NH Route 101 in Milford, and Wilton, along Main Street in downtown Wilton, downtown Greenville, and along NH Route 124 in New Ipswich. The Souhegan aquifer underlies the majority of the commercial and industrial land uses.

Permanent open space represents approximately eleven percent of the 9,825 acres of the River corridor. Typical permanent open space is land that is categorized as conservation land and may have a conservation easement placed on it restricting certain uses. Recreation land, which includes both passive and active recreational use, is approximately three percent of the corridor representing 329 acres.

Table 3-7: Parcel Based Land Use from NRPC GIS Database for River Corridor

Corridor Total Area	**9825 acres**		
Corridor Land Use	**# of Properties**	**Total Acres**	**% of land use**
Agricultural	21	964	9.8%
Commercial/Industrial	329	573	5.8%
Institutional	20	23	0.2%
Mixed Use	6	6	0.07%
Municipal Facility	47	164	1.6%
Other Government	4	39	0.4%
Permanent Open Space	64	1082	11.0%
Right of Way	20	64	0.6%
Recreation	25	329	3.3%
Residential	2873	3629	36.9%
Road	11	550	5.5%
School	14	99	1.0%
Vacant	324	2050	20.8%
Water	24	253	2.5%
		9,825	100.00%

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CHAPTER 4 WATERSHED ASSESSMENT

The Souhegan Watershed and its river corridor represent a diverse natural and man-made landscape. This chapter will focus on providing information on threats and opportunities concerning the Souhegan Watershed.

A. SHORELINE SURVEYS

Two shoreline surveys have been conducted on the Souhegan River. In 1999, the Souhegan Watershed Association (SWA) working with local Conservation Commissions and the Nashua Regional Planning Commission (NRPC) and the Merrimack River Watershed Council (MRWC) conducted a survey to provide a snapshot of the river's vitality. A primary goal was to use the findings as baseline data to identify areas that may need future attention and monitoring as well as to prepare for future surveys. Included in the Survey report is a map of outfall pipe locations that were visible from the shoreline. Each pipe is described in the report (1999 Souhegan River Shoreline Survey).

A more recent survey was conducted as part of the NHDES Instream Public Uses, Outstanding Characteristics, and Resources (IPUOCR) study of the Souhegan River. An on-stream survey was conducted June 28-30, 2004. More detailed information on the NHDES survey can be found at http://des.nh.gov/rivers/instream/souhegan.asp. Findings of these two surveys provide a good generalized assessment of observed physical factors affecting the river and adjacent areas.

The first six miles of the river flow through forested areas with the river canopied and shaded. Erosion and removal of vegetation for residential development in the vicinity of Waterloom Pond was observed during the 1999 survey as well as erosion from Route 123.

Downstream steep riverbanks were observed but covered with an overhanging canopy that provides shading and a source of woody debris for habitat. The Route 31 bridge to the Route 101 bridge is classified as a Class 2 canoeing stretch and is heavily used in the spring. Severe clear-cutting was observed in 1999 across from the Wilton Town Forest. Trash, stormwater runoff, parking lots in close proximity to the river, residential lawns extending to the river, and a pipe extending from a residence to the river were also observed.

The segment from the Route 101 Bridge to the Label Arts Dam is Whitewater Class 3 and has the largest rapid on the river at the Horseshoe, a gorge with 30 foot cliffs on both sides. The Horseshoe while providing swimming and picnicking is not publicly owned and has issues with erosion of trails, trash, and a lack of parking. A change in the status of this popular area would have a huge affect on public access to the Souhegan River for recreation.

Directly above the confluence with Stony Brook, the Souhegan River enters urbanized areas with heavily stabilized banks. The confluence itself is created and enforced by old mill buildings and bridge crossings. Almost immediately after the confluence, two dams impound the river. Below the dams, the Souhegan River has been obviously realigned as a part of highway construction. Twenty-five percent of the three mile length stretch of river in this urbanized area is impounded. There are parking lots located at the top of the river bank, which has riprap for erosion control but an absence of any vegetation. Other potential threats noted in the 1999 survey were an observation of sudsy foam discharging from behind a business in Wilton and household trash discarded from a residence. In addition, erosion on the dirt road by the Hydro plant was noted.

The stretch of river from Milford to Merrimack consists of a wide variety of land uses including commercial, agricultural, residential, golf course and a wastewater treatment plant. Approximately three miles of the River in Amherst is accompanied by a golf course that reduces canopy shading and woody debris. The NHDES 2004 survey observed heavy bank stabilization with riprap at the road bridges in this area. The 1999 survey noted turbid water described as tea colored. Several irrigation pipes were noted protruding from the river and residential lawns were observed right up to the edge of the river above Boston Post road and behind Souhegan High School. A lack of vegetated buffers was observed in some areas along the Amherst Country club. The 1999 survey noted that during the summer, algal blooms were noted by the Souhegan Woods Golf Course.


View of Souhegan River

At Seaverns Bridge the 1999 survey noted that a drainage pipe runs almost directly into the river below the bridge. Erosion and dumping of lawn clippings were also found on the west bank. The Indian ledges are two series of ledges that are often used for recreation. Historically this area has experienced problems with trash, graffiti and campfires from night activities. Encroachment of riprap on the banks from residential development was observed. The 1999 survey noted that the Turkey Hill Bridge exhibits some signs of erosion from its road footings, and as with the Seaverns Bridge, does has at least two road drainage pipes discharging almost directly into the river. Also noted were visible signs of logging, purple loosestrife and trash. An inactive dam, the Merrimack Village Dam impounds a portion of this segment. These impoundments create substantial wetlands.

Downstream of Wildcat Falls the river flows though the residential and urbanized town of Merrimack. The Wildcat Falls area is used for kayaking and canoeing and has trails along the bank. For most of the length of this section there are steep eroding banks that go up at least six feet to a flat terrace. In a number of sections the bank goes up 50-60 feet. According to the 1999 survey there are several houses that have lawns that extend to the edge of the bank and have steps or access to the river. Homeowners have attempted to control erosion, one with sandbags. The 1999 survey noted that just above Wildcat Falls there are many converted cottages on tiny lots and several have dumped fill over the bank to increase or flatten their property. A deck was noted to encroach into the river edge. A majority of the banks are very steep and not easily accessible.

The stretch of river from the Everett Turnpike to the Merrimack River is in a very populated area, the demographic center of Merrimack. Commercial and Industrial uses are also present in this stretch with several pipes (thought to be drainage pipes in the 1999 survey) coming from the facility owned by Harcross Chemical. Piles of debris in an adjacent wetland on Jones Chemical property were observed in the 1999 survey. There are numerous trails along this segment of the river. The Harcross Chemical buildings have been demolished and the land has been donated to the Town of Merrimack for recreation or civic purposes.

B. FLOODING

The Amherst Master Plan Environmental Resources Chapter reports that the 1979 Flood Insurance Study identified principal flood problems to be major floods on the Souhegan River during the spring, fall and winter seasons. Some of the most severe flooding occurs in the spring as a result of snowmelt and heavy rains in conjunction with ice jams. Autumn is another critical season for flood damage because of heavy rainfall and the possibility of storms of tropical origin. Minor flooding in Amherst can occur any time of the year, as even heavy thunderstorms can result in rapid runoff and flooding in the down stream portions of the smaller streams. The same general conditions exist in Merrimack.

C. WATER QUALITY

The Souhegan River and all of its tributaries have a legislative classification of Class B except for the Mill Brook system in Wilton, which is identified as a Class A water. Class B waters are considered acceptable for primary contact recreation (swimming), fishing and municipal water supplies after adequate treatment. Class A waters are of the highest quality and are acceptable for water supplies after adequate treatment. For example, Mill Brook in Wilton flows into the Wilton reservoir, which historically served as the Town's water supply.[14]

The Souhegan River Local Advisory Committee (SoRLAC) surveyed public officials in 2005. All of the respondents stated that water quality was either very important or somewhat important to be protected within the river corridor.[15]

Water quality monitoring on the Souhegan River, tributaries and significant water bodies in the watershed has been conducted by both NHDES and the Souhegan River Watershed Association (SWA). The SWA has been monitoring the Souhegan River regularly since 1997. During the months of June, July, August, and September of 2004, more than thirty trained volunteers inspected designated sites and collected water samples on the entire Souhegan River. For 2004 the SWA monitored the following information at each collection site: air temperature, water temperature, dissolved oxygen concentrations, E. coli, and total phosphorous concentrations. Total phosphorous (tP) was tested four times in 2004 at approximately ten different sites. In addition, all volunteer monitors recorded water clarity, color, and odor and any notable human or animal activity. Locations of SWA monitoring sites are shown on Map A-2, Watershed Assessment.


Water Monitoring Wells

[14] The legislative water quality classification is essentially a goal; this does not mean that a particular surface water meets the water quality standards for its legislative classification. All surface water in New Hampshire are either Class A or Class B.

[15] A copy of the SoRLAC survey and results can be obtained from SoRLAC or NRPC.

In addition to the regular water quality monitoring, the SWA was chosen in 2004 to assist in a study to investigate the genetic fingerprint of the E. coli. The goal of that investigation is to reveal the different strains of E. coli present in the rivers, gain perspective on the origin and migration of the E. coli contamination in the river, and ultimately attempt to learn the sources of this contamination.[16]

Water quality monitoring in the Souhegan Watershed has also been conducted by the NHDES. The Federal Water Pollution Control Act PL92-500, commonly called the Clean Water Act (CWA), as last reauthorized by the Water Quality Act of 1987, requires each state to submit two surface water quality documents to the U.S. Environmental Protection Agency (USEPA) every two years. Section 305(b) of the CWA requires submittal of a report (commonly called the "305(b) Report"), that describes the quality of its surface waters and an analysis of the extent to which all such waters provide for the protection and propagation of a balanced population of shellfish, fish, wildlife, and allow recreational activities in and on the water.

The second document is typically called the "303(d) List," which is so named because it is a requirement of Section 303(d) of the CWA. The 303(d) List includes surface waters that are:

1. Impaired or threatened by a pollutant or pollutant(s).
2. Not expected to meet water quality standards within a reasonable time even after application of best available technology standards for point sources or best management practices for non-point sources.
3. Require development and implementation of a comprehensive water quality study (a Total Maximum Daily Load (TMDL) study) which is designed to meet water quality standards.[17]

The 303(d) List, represents a subset of all impaired waters as some impaired waters do not require a TMDL study.[18]

NHDES has classified the Souhegan River as threatened and in need of restoration.[19] Threatened watersheds are those whose aquatic systems are unlikely to maintain chemical, physical, and biological integrity due to anthropogenic influences. Watersheds in need of restoration require the manipulation of physical, chemical, or biological characteristics with the goal of returning natural or historic functions of its waterbodies.

1. Water Quality Indicators

The Souhegan Watershed Association (SWA) provides a description of the chemical, physical and biological indicators that they measure and their significance to water quality.

Temperature - Temperature is an important indicator of water quality as it affects the rate of many chemical and biological processes as well as the amount of oxygen that remains in solution to be readily available to aquatic organism. Seasonal and daily fluctuations are normal in a river system. Cold-water

[16] Additional information on the Souhegan Watershed Association Water Monitoring Project can be found at www.souhegan.org.
[17] A TMDL (Total Maximum Daily Load) establishes the maximum amount of an impairing substance or stressor that a waterbody can assimilate and still meet water quality standards and allocates that load among pollution contributors.
[18] Additional information on the NHDES water quality monitoring program can be found at http://www.des.nh.gov/wmb/swqa/
[19] NHDES Watershed Approach. Top 20 Watersheds from each Management Category.

fish species such as trout and Atlantic salmon that are of primary significance on the Souhegan require a temperature not exceeding 23-24 degrees Celsius for optimal growth.

Dissolved Oxygen - Dissolved oxygen (DO) is a measure of the oxygen dissolved in water. Sufficient oxygen levels in the water are very important since it is required for fish and plant respiration. When sewage or excessive animal waste enters a stream, oxygen consuming microorganisms begin decomposition, lowering DO levels. Due to the detection method used, DO in the SWA study is measured in milligrams per liter (mg/l). The NH water quality standard for DO calls for a daily average of 75% saturation (about 7 mg/ml) and for instantaneous values to exceed 4.5 to 5 mg/l for Class B waters.

Total Phosphorous - Phosphorous is a nutrient essential to a river's food web, however excess levels can cause algal blooms and can negatively affect fish. One reason is that decaying plant matter consumes oxygen and can reduce the DO concentrations. There are a number of sources of phosphorous including fertilizers, disturbed land, animal and human waste, and phosphorus containing detergents. NHDES recommends that levels should not exceed 0.05 mg/l for the mid-reach of a river or 1.0 mg/l overall.

Escherichia coli - E. coli bacteria counts are used as an indicator of contamination by human and animal waste. E. coli is found exclusively in the intestines of humans and warm-blooded animals and therefore is a very specific indicator for fecal contamination. A few strains can cause acute diarrhea. Due to the organism's very specific habitat, the presence of E. coli bacteria may also be an indicator of other waterborne pathogens including viruses, other bacteria and parasitic protozoan that take up residence in the intestinal tract and pose a health hazard to humans upon exposure. The NH water quality standards established by NHDES are the following:

- Designated swimming beaches should not exceed 88 colonies/100ml in any one sample or exceed 47/100 in a 60-day, three-sample average; and
- Non-designated areas should not have more than 406 colonies/100 ml in any one sample or more than 126 colonies/100ml in a 60-day, three sample average.

Information presented at a NHDES 2005 Drinking Water Source Protection Workshop by Steve Jones, Department of Natural Resources Center for Marine Biology/Jackson Estuarine Lab reported that E. coli bacteria have the capacity to persist and even re-grow in aquatic environments. Possible sources of bacteria from human sources include sanitary sewer overflows, illegal sanitary connections to storm drains, illegal disposal to storm drains, failing septic systems, landfills, marinas and pumpout facilities. Non-human sources include domestic animals, wildlife, livestock and urban and rural wildlife. Potential pathways of bacteria to surface water include:

- Downstream flow;
- Overland runoff;
- Direct deposition from non human sources;
- Illegal discharges; and
- Groundwater discharge.

2. NHDES Souhegan River Watershed Report

The NHDES finalized the Souhegan River Watershed Report in 1997. Nine monitoring stations were selected for this study with stations placed throughout the main stem of the river for observing transitions in the aquatic and riparian ecosystems from the headwaters to the mouth of the river. This report concluded that most stations throughout the watershed showed some signs of nutrient enrichment

stemming from human sources such as road and street runoff, poor vegetative buffers, impoundments and general urbanization. Regarding the assessment of the fish species present the report states, "The limited number of individuals and species, consisting predominantly of pollutant tolerant white sucker and the moderately tolerant yellow perch were also indicative that the river segment was undergoing some form of impairment."

Based on the NHDES sampling results enforcement action was taken to require bringing the Greenville wastewater treatment plant into compliance with its discharge permit requirements. The 1997 report states that a water quality signal was also picked up from the Milford wastewater treatment plant for pH, total dissolved solids, and specific conductance. Review of the monitoring reports from the plant revealed that the plant exceeded its effluent discharge limits for several parameters during the survey months. From the discharge location downstream the Souhegan River was heavily influenced by the treatment plant during the low flow dry weather period. It is important to note that this report reflects conditions monitored in 1997 and no additional information has been collected on discharge violations at the plant.

Seven sites were selected for the wet weather monitoring survey. These stations were selected based on previous monitoring efforts which had indicated potential problems from elevated bacteria, and also from those areas deemed most likely to be contributing non-point source loads to the waterbody.

Zinc and lead levels were reported to be elevated from storm drain discharges. A sample taken from the Milford footbridge significantly exceeded levels for copper, lead and zinc. These contributing sources and concentrations were stated to be typical for urbanized areas.

Total suspended solids (TSS) were highest at the Stony Brook confluence in Wilton and the Bridge on Route 31, just upstream of Wilton. These two stations demonstrate the influx of suspended solids into the river via storm drainage from runoff. Both stations have secondary roads running directly adjacent to the water bodies and have storm drain outlets into the river.

Samples taken during each of the storm periods showed bacterial counts above the state standard. The highest counts for wet weather were collected from the bridge off Route 101 heading into Wilton Center, which also showed the highest counts during dry weather. All stations showing high levels of bacteria were located in areas subject to direct urban runoff, or where a major transportation route is located directly adjacent to the river. With the exception of the Milford Bridge site station, being slightly less than the state standard, all stations exceeded the 406 counts/100 ml during the post storm sampling period. This could be expected based on the significant in-stream flows resulting from the storm and the extended period of over-bankfull flooding which occurred (Souhegan River Watershed Study, NHDES).

Results of the bacterial analysis demonstrate that urban runoff is a key contributor to the exceeding of bacterial standards, and can be expected to occur during wet weather conditions which cause moderate overland flow and are preceded by several days of dry weather conditions. Urban areas often hold bacterial concentrations in storm water runoff equal to that of dilute sewage, making the elevated counts in these areas predictable. The evidence of resident bank beaver (i.e.,) cuttings, in-bank lodges are also thought to be contributors to dry and wet weather bacterial inputs.

The NHDES study found the total organic carbon (TOC) to be below 10/mg/l for all of the wet weather stations. TOC is directly associated with oxygen demand placed on the waterbody and is a principal source for many aquatic organisms. While certain levels are beneficial to the natural system, elevated concentrations can result in undue stresses and impairment to the health of the water body. Higher TOC levels in the Souhegan River would likely be found during the warmer summer months due to increased

aquatic plant activity. In addition, control structures along the Souhegan River retain much of the upstream organic material such as leaf litter and limit its export father downstream through the river system to be utilized by aquatic organisms.

Nitrate/Nitrogen levels were within acceptable limits with concentrations slightly higher downstream of the Milford wastewater treatment plant. Total Phosphorous concentrations were also within the acceptable range with possible contributions from the Milford wastewater treatment plant which are diluted as the water moves downstream. Phosphorous contributions from the storm drains in Milford showed a high influx to the river compared to background conditions.

Research has shown that the benthic[20] dwelling communities are excellent instream indicators of the overall health of a habitat because of their important link in the food chain, and their ability to leave an impacted area. The instream biota reflect the combined effects of pollutants that may have no toxic effect before discharge, but may react synergistically with other substances once mixing has occurred within the stream. Macroinvertabrates commonly used in water quality surveys include: crayfish, snails, clams, worms, leeches, and aquatic insects such as stoneflies, mayflies, dragonflies and caddisflies, etc. Many of these organisms are very sensitive to changes in their habitat, both physically and chemically, and are excellent water quality indictors.

While only one station was rated non-impacted in the NHDES study, most stations maintained healthy macro-invertebrate communities and fell into the slightly impacted range. Individual evaluations revealed that almost all of the stations throughout the watershed showed some signs of nutrient enrichment stemming from human sources such as road and street runoff, poor vegetative buffer, impoundments and general urbanization.


Stone Landing, New Ipswich

The sampling of fish communities provides another sensitive indicator for determining the relative health of the aquatic ecosystem within the watershed. The limited number of individual species, consisting predominately of pollutant tolerant white sucker and the moderately pollutant tolerant white perch were also indicative that the river segments were undergoing some form of impairment. Streambed sedimentation from urban runoff, were also observed. The station located in the lower perennial portion of the river system demonstrated the highest number of species present in the Souhegan River. Brook, rainbow, and brown trout were almost non-existent in the Souhegan River during the September sampling period. The river is heavily fished during the summer months. No native brook trout or other salmon were found at any of the sampling sites.

The NHDES study included an assessment of the dry weather conditions of the river which represent the more stressed periods for aquatic life. In general the period of highest biological stress occurs during the lowest months of river flow; July, August and September, when fluctuations in dissolved oxygen concentrations are greatest, instream temperatures are highest, and man-made inputs have some of their largest impact. Monitoring of the Souhegan River revealed elevated total dissolved solid (TDS) concentrations just downstream from the two-wastewater treatment plants. Lower TDS concentrations

[20] Benthic refers to aquatic life occurring at the bottom of a body of water.

were observed as the river transcends the rural upper perennial, higher gradient, and ledge dominated headwaters. As the Souhegan River transitions from the headwaters into the lower perennial, lower gradient regions of the watershed, the TDS concentration increase.

Elevated total suspended solids and specific conductance were observed just below the Milford WWTP and is a result of the proportionally large discharge volume (2.15 MGD or 25 cfs) entering the stream. Instream flows during the monitoring period were quite low, and the Souhegan River was effluent dominated from this point downstream to the Souhegan River's confluence with the Merrimack River.

Total suspended solids for all dry weather stations were at or below one milligram per liter, demonstrating extremely good water clarity in the Souhegan River. Dissolved oxygen levels were within the acceptable range for Class B waters.

Temperature demonstrated the least amount of variability in the higher gradient, upper perennial segments of the river system. Water temperature was more constant in these regions because of higher stream gradients, groundwater contributions to streamflow, and a higher degree of canopy cover providing shade. Factors contributing to higher temperatures downstream were the wastewater treatment plant, a decrease in canopy cover, wide stream width, a decrease in stream depth and the presence of several impoundments.

Most of the pH values for the Souhegan River were reported to be within the normal range of supporting aquatic life. Trends in pH levels require further monitoring to determine possible sources. Total phosphorous levels were within acceptable levels with the exception of the station just below the Milford wastewater treatment plant which has no phosphorous removal controls in place.

3. Souhegan Watershed Association (SWA) Monitoring Results

The Souhegan Watershed Association (SWA) has been monitoring the Souhegan River regularly since 1997.[21] Nineteen sites along the entire length of the Souhegan are being monitored by the SWA. Refer to Map A-2, Watershed Assessment for locations of monitoring sites. In 2005 testing on Purgatory Brook, an important tributary of the Souhegan, was also added. Monitoring results for 2004 which have been compiled into an annual report that includes yearly comparison data are discussed below. Limited data reported in 2005 has also been included.

Temperature

The average surface water temperature during the summer of 2004 was 18.8 Celsius or 65.8 degrees Fahrenheit. The historical average is 19.0 degrees Celsius or 66.2 degrees Fahrenheit. The cold water fishery desired limits of 24 degrees Celsius or 75.2 degrees Fahrenheit was exceeded on the Souhegan River in two out of the eight collection days in 2004, both in August.

Summer River Flows

The Souhegan River showed low or average flow in June 2004 but then heavier than average flows throughout August and especially the end of September.[22] According to the 2004 SWA annual report the most important goals for the Souhegan River are the protection of the river flow and reduction of direct urban runoff. SWA states that the effect of local rainfall events is short-lived, on the order of hours. The main impact of local rain is the effect of flushing terrestrial wastes into the rivers.

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[21] Results of the monitoring can be reviewed on their web site www.souhegan.org.

[22] The SWA Summer 2004 Report at www.souhegan.org provides detailed data on river flow rates, air temperature and precipitation relevant to the region.

Bacteria Counts
The SWA has calculated the seasonal geomean for *E. coli* which is similar to an "average" but effectively weights the lower counts much more than the higher counts as compared to a straight average. The *E. coli* counts for 2004 are shown in Table 4-1: Summer *E. coli* Counts

Moderately high high *E. coli* was observed in 2004 on the lower half of the river, which is typical. The threshold for designated class B waters was exceeded on five out of the eight collection days. Table 4-2 contains the yearly comparisons for *E. coli.*

According to the SWA monitoring results testing on August 9th 2005 indicated that the water levels were low and the temperature was warm. The August 9, 2005 results of the Turkey Hill Bridge area in Merrimack had less than 88 colonies of E. coli per 100 ML of water, but that was the only one of the three popular swimming holes to not have elevated bacteria counts. The Horseshoe in Wilton tested at 260 colonies per 100 Ml, the highest seen at this popular swimming hole. The Boston Post Road Canoe port in Amherst tested at 164, well above the 88-target level but better than often seen at this swimming hole. The highest reading on the Souhegan was 436 colonies per 100Ml, a high number, at the Pine Valley Mill in West Milford. The water level at this site was extremely low below the dam on the Wilton/Milford town line. Typically the E. coli readings on the Souhegan River are very good in the headwaters in New Ipswich and Greenville; the levels pick up through downtown Wilton and Milford; and then the readings drop to satisfactory levels again in Merrimack.

Historically the Souhegan Swing Bridge site (SoR146- refer to map A-2, Watershed Assessment) has displayed among the highest levels of E. coli on the river over the past seven years of monitoring. Of note are the unusually high counts at site SoR210.

Table 4-1: Summer 2004 E. Coli Counts

Souhegan River E.coli Geo Mean of 3 counts (colonies/100 ml)									
Site #	**8-Jun**	**22-Jun**	**6-Jul**	**20-Jul**	**3-Aug**	**17-Aug**	**31-Aug**	**14-Sep**	**Seasonal G.M.**
	na	na	na	na	na	na	na	na	na
SOR333	1	66	1	96	72	120	30	20	21
SOR320	1	19	1	na	1	80	na	25	6
SOR309	1	16	1	64	38	78	40	30	16
SOR296	na	20	1	148	1	na	36	15	11
SOR291	1	31	1	112	74	na	23	20	14
SOR218	24	94	14	56	10	240	na	85	45
SOR210	125	**460**	na	400	208	**542**	**490**	na	**329**
SOR201	70	195	125	**550**	28	369	**640**	120	**171**
SOR170	133	130	na	360	23	398	180	35	**120**
SOR155	31	170	116	**410**	52	245	300	160	**141**
SOR150	na	na	na	na	na	na	na	na	na
SOR146	39	160	126	**780**	124	**447**	**415**	204	**203**
SOR133	100	125	225	**620**	86	400	280	220	**209**
SOR130	170	150	400	**800**	121	**738**	120	176	**250**
SOR122	60	162	325	**650**	71	**407**	**600**	230	**231**
SOR116	**500**	405	220	na	80	**453**	168	na	**254**
SOR095	100	156	220	**480**	90	245	215	145	**181**
SOR057	80	90	85	120	40	100	340	65	**95**
SOR034	31	14	30	170	15	230	344	na	59
SOR004	na	na	6	87	15	250	na	na	37
S G.M.	28	87	25	244	33	261	172	70	

Souhegan River Season GMGM (co	
74	c/100ml

Souhegan River Season geomean	
78	c/100ml

Table 4-2: Yearly Comparisons of E. Coli. Counts

Souhegan River Summer *E. coli* Count Comparisons (geomean of three samples colonies/100 ml)													Site Historical GM Average
92-'95 Site#	97 Site#	98- Site#	1994	1995	1997	1998	1999	2000	2001	2002	2003	2004	
		SoR333				53	48	na	19	30	36	21	35
		SoR320							65	26	46	6	36
SoR110	SoR1	SoR309	**102**	na	50	34	**163**	na	62	13	30	16	59
		SoR296					88	na	**122**	16	34	11	54
SoR100	SoR3	SoR291	46	28	26	**114**	**109**	na	76	21	65	14	56
	SoR4	SoR241			16	39							27
SoR90			37	33									35
SoR80	SoR5	SoR218	43	32	34	35	40	50	**120**	53	21	45	47
	SoR6	StB001			55	63	36						51
		SoR210							194	23	**105**	**329**	**163**
	SoR8	SoR201			51	**136**	**133**	**111**	**159**	**107**	**253**	**171**	**140**
SoR70			**106**	**177**									**141**
		SoR170							**121**	**100**	**74**	**120**	**104**
		SoR150				**119**	**217**	**162**					**166**
		SoR155							**140**	**174**	**518**	**141**	**243**
SoR60	SoR9	SoR146	**277**	**234**	**204**	**188**	**305**	**294**	**248**	**195**	**493**	**203**	**264**
		SoR133				**142**	**202**	**274**	**228**	**162**	**321**	**209**	**220**
		SoR130				**170**	**187**	**256**	**153**	**183**	**367**	**250**	**224**
		SoR122							**64**	73	**292**	**231**	**165**
		SoR116				**211**	**214**	**233**	**159**	**194**	**313**	**254**	**226**
SoR50	SoR10		**183**	**206**	**172**								**187**
SoR40	SoR11	SoR095	**161**	91	**125**	**167**	**202**	**127**	**73**	**177**	**335**	**181**	**164**
		SoR057				85	22	34	11	2	23	**95**	39
SoR30	SoR12	SoR034	50	25	59	83	40	24	22	3	17	59	38
SoR20	SoR13		53	34	35								41
		SoR004					20	23	na	na	na	37	27
SoR10			na	51									51
River Seasonal Geomean:			na	na	72	95	102	75	89	46	110	78	--->

For the 2005 season testing on Purgatory Brook in Lyndeborough/Mont Vernon came in at only 2 colonies of bacteria per 100 milliliters of water. This is the first year that regular testing was done on this important Souhegan tributary. Readings on the various tributaries are tested on an occasional basis. Regular testing on Stony Brook in Wilton, the largest Souhegan tributary, was stopped several years ago after not finding any unusual sources of bacteria. Purgatory Brook looks to be headed in that same direction according to Ken Butenhof, coordinator of the Souhegan Watershed Association testing program.

The SWA is currently participating in a study in collaboration with the University of Massachusetts and the consulting firm ENSR International in an investigation of strains of *E coli* as a means to pinpoint the origin and location of contamination sources. The Souhegan River was chosen for this study because of the years of data of *E coli* counts available and the diversity of habitat surrounding the river. For the study a stretch of the river was identified that contained sites in which levels of *E. coli* were elevated and contamination sources unknown. The stretch chosen is between SoR57 and SoR210 (refer to Map A-2 Watershed Assessment) and encompasses all of the perennially high *E. coli* count sites. This study is ongoing in 2005. Preliminary results included in the SWA 2004 Monitoring Report do not cite any specific sources of contamination but does conclude that there is a significant difference in the *E. coli* distributions under "dry weather" versus "wet weather" conditions. As is to be expected, *E. coli* counts increase when it rains as bacteria is washed from the land into the river.[23]

Dissolved Oxygen Concentrations

The dissolved oxygen levels (DO) levels measured in 2004 by the SWA were found to be mostly in the acceptable range. Only one site SoR 333 (refer to Map A-2 Watershed Assessment for location) had a

[23] Additional information on this ongoing study can be found on the Souhegan River Watershed Associations web site.

season average value below the level of 4.5 mg/l. This site is located near Water Loom Pond in New Ipswich. According to SWA monitors the trend over the last four years has been for steadily lower levels of DO at this site.

Nutrient Load
On the Souhegan River the suggested limit for Class B waters was reached somewhere on the river three out of four collection days for the 2004 season according to SWA. One site, SoR 095, exceeded the 0.1 mg/l recommended limit and another SoR 116, was at 0.099mg/l. In general levels tend to be higher downstream of the wastewater treatment facilities which are not regulated for phosphorus.

New Hampshire Department of Environmental Services (NHDES) Monitoring Results
As mentioned, NHDES conducted water quality monitoring for the Souhegan River as part of the NH 2004 305(b) and 303(d) Surface Water Quality Assessment. The NHDES report identifies a list of designated uses and waters that are threatened or not supporting each use. The six designated uses are Aquatic Life, Fish Consumption, Shellfish Consumption, Drinking Water Supply, Primary Contact (i.e., Swimming), Secondary Contact Recreation, and Wildlife. Each designated use was assigned one of the following four use support attainment options: Fully Supporting, Not Supporting, Insufficient Information and Not Assessed. If one or more Designated Use on an Assessment Unit (AU) was Not Supporting then that AU was determined to be Impaired. Each waterbody was divided into smaller segments referred to as Assessment Units (AU). In general, AUs are the basic unit of record for conducting and reporting water quality assessments. Any of the four mentioned support determinations could be flagged as Threatened. For this assessment a use was defined as threatened when there were no measured in-stream violations but other data [i.e. (predictive models), (NPDES permit effluent violations)] indicate the potential for water quality violations. Map A-2, Watershed Assessment shows all Threatened and/or Impaired waters in the Souhegan River Watershed.

In the Souhegan watershed there is only one AU (segment) of the Souhegan River that is located from approximately the Milford town line to the Merrimack River listed as Threatened. The Threatened Designated Use was assessed as insufficient information because the threat is from the wastewater treatment facility (WWTF). This facility is currently in "significant noncompliance" of its NPDES discharge permit[24] (as defined by EPA), or is on the "exceptions list" (i.e., facilities that are in significant non-compliance for two or more quarters or more of its permitted water quality based pollutant effluent limits). The cause of the threat is listed as copper. There have been no measured in river exceedances of the criteria.

Primary contact recreation (PCR) i.e. swimming is shown on Figure 4-1 with the associated use support categories attained in each river segment. Two segments of the Souhegan River and some of the tributary streams are not supporting for primary contact recreation.

Secondary Contact (SC) (uses that involve minor contact with the water) and its associated use support categories are shown in Figure 4-2. All segments of the Souhegan River are supporting for secondary recreation

Aquatic Life (AL) use support is shown in Figure 4-3. Segments of the Souhegan River from approximately the Milford town line to the Merrimack River are classified as non-supporting for aquatic life. This segment was flagged as threatened because the effluent discharge of the Milford wastewater

[24] The National Pollutant Discharge Elimination System (NPDES) is a permit to discharge treated wastewater into a body of water.

treatment plant exceeds its permit limitations. There was no measured in river exceedance of the criteria. Other segments of the River and tributaries are shown as not supporting for aquatic life.

Map A-2, Watershed Assessment, shows the surface waters within the watershed that are listed as threatened or impaired in the NHDES 2004 surface water quality assessment. Table 4-3 represents the 2004 NHDES water quality assessment list for waterbodies in the Souhegan watershed. This list includes information on which use is impaired, the pollutant identified and a suspected source if one was identified.

It should be noted that stretches of the river sampled were broken down into assessment units. An assessment unit is a smaller section of the river or pond. Table 4-3 provides information on the water bodies/assessment units within the watershed that are threatened or not fully supporting each use. Abbreviations of Aquatic Life (AL), Primary Contact Recreation (PCR) for use have been used.

Figure 4-1: Primary Recreation Use Support

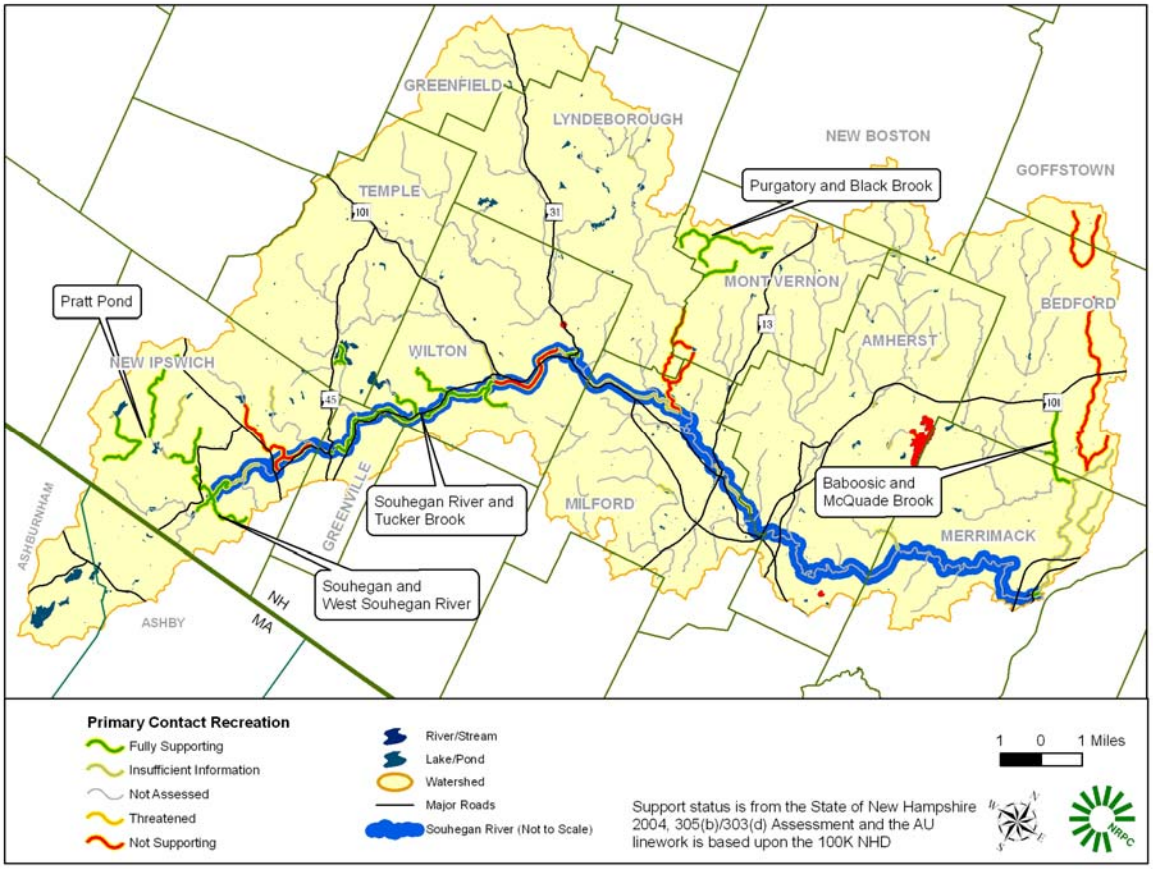


Figure 4-2: Secondary Contact Use Support

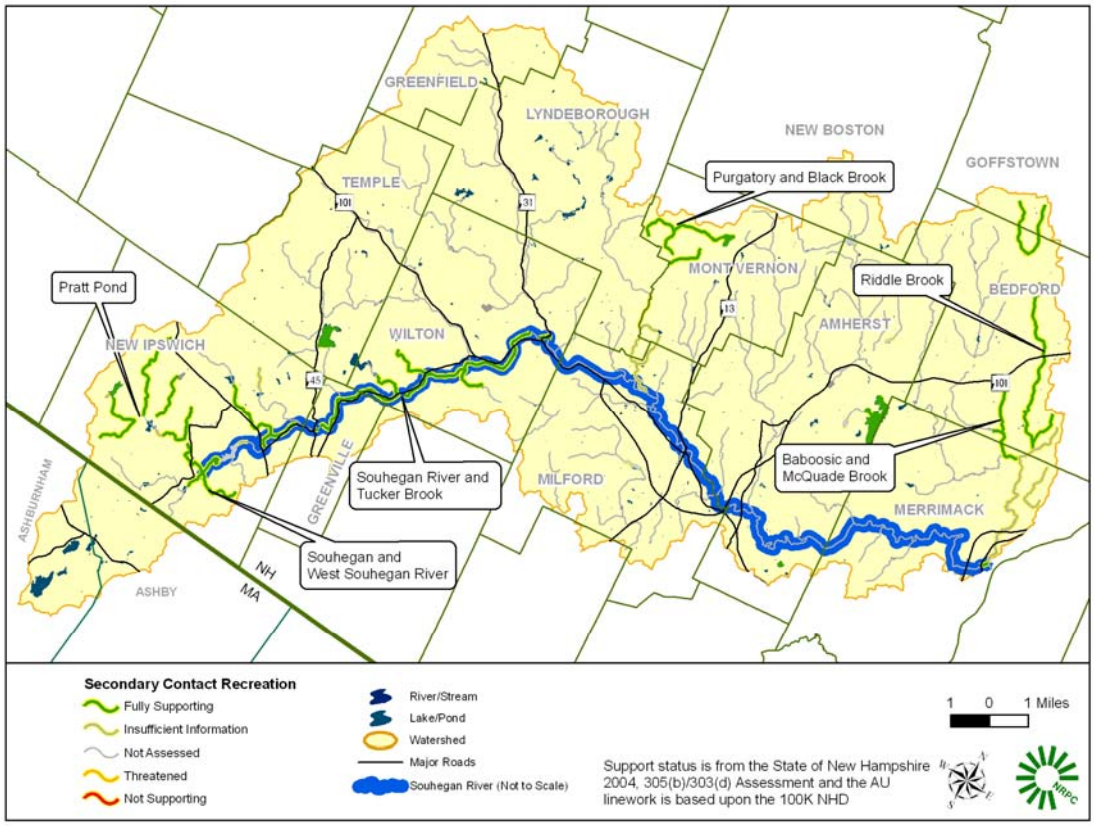


Figure 4-3: Aquatic Life Use Support

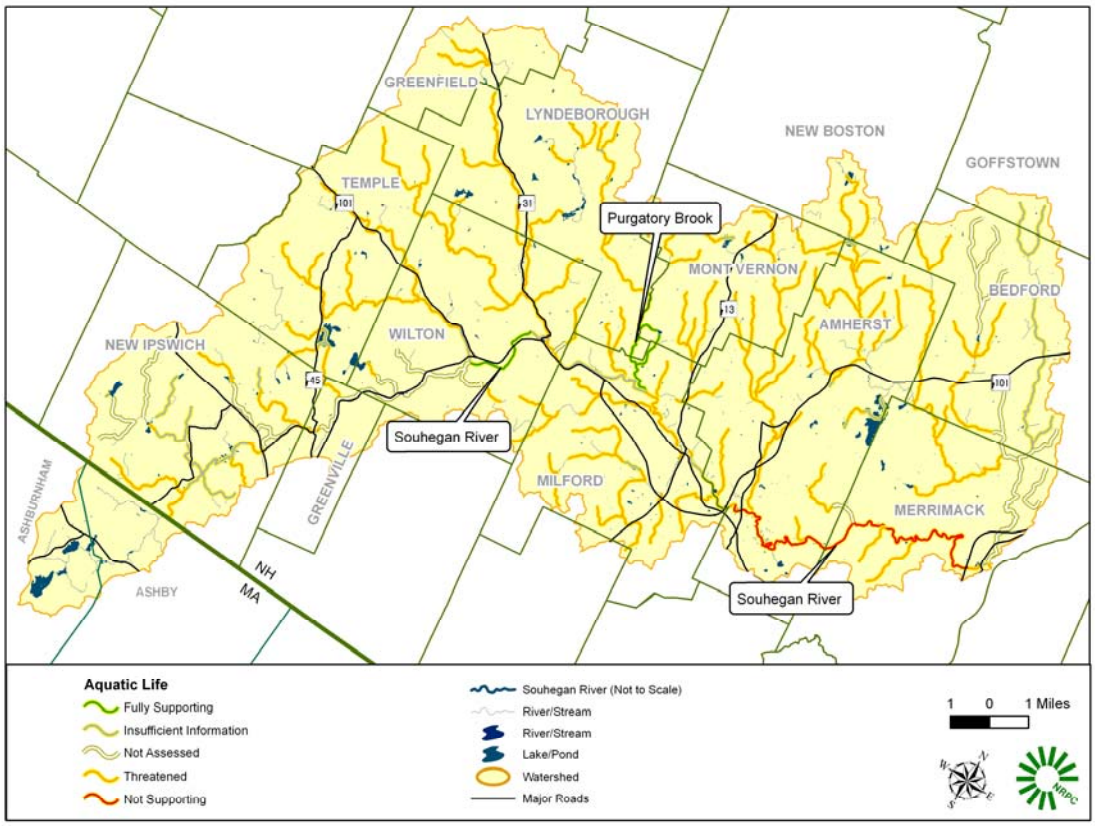


Table 4-3: NHDES 2004 Surface Water Quality Assessment

Waterbody/Assessment Unit	Use	Cause	Suspected Source
Souhegan River-Furnace Brook	PCR A	E. coli pH	Source Unknown
Souhegan River-Tucker Brook	A	Aluminum Benthic-Macroinvertebrate Bioassessemnts, pH	Source Unknown
Tucker Brook	A	pH	Source Unknown
Souhegan River	PCR	E. coli	Source Unknown
Souhegan River- Goldman dam	A	Dissolved Oxygen	Source Unknown
Souhegan River	A	Copper	Municipal Point Source Discharges
Pratt Pond	A	pH	
Pratt Pond Brook	A	pH	Source Unknown
Stony Brook-Town Beach(Goss Park)	PCR	E. Coli	Source Unknown
Purgatory Brook	PCR	E. Coli	Source Unknown
Unnamed Brook-from unnamed Pond to Souhegan River	A	Chloride	Source unknown
Honey Pot Pond	PCR	Chlorophyll-a	Source Unknown
McQuade Brook	A	Chloride	Source Unknown
Baboosic Brook-McQuade Brook	A	Benthic-macroinvertebrate Bioassessments, dissolved oxygen, pH	Source Unknown
Baboosic Lake	PCR	E. Coli	On- site Treatment Systems (Septic systems and Similar Decentralized Systems) Source Unknown.
Baboosic Lake- Town Beach	PCR	E. Coli	Source Unknown
Riddle Brook	PCR	E. Coli	Source Unknown
Baboosic Brook- Riddle Brook	A	Dissolved Oxygen	Source Unknown
Unnamed Brook from York Pond to Souhegan river	A	pH	Source Unknown

Of note is that two of the sites, at Tucker and McQuade Brook have reported bioassessment data as part of the NHDES Biomonitoring program. Since its inception in 1995, the NHDES Biomonitoring Program has continually expanded its assessment capabilities. The primary focus so far has been on wadeable streams, with numerous special projects in other habitats. Monitoring activities taking place at most sites include:

- Collection and identification of aquatic macroinvertebrates;
- Collection and identification of the resident fish community;
- Assessment of riparian habitat and land uses; and
- Physical and chemical measurements for assessing water quality.

Biological monitoring, the use of living organisms as indicators of the quality of the surrounding environment has great potential to be used as an assessment tool in the Souhegan Watershed. Biological monitoring incorporates cumulative impacts of multiple stressors. Limitations of traditional chemical monitoring include not determining long term or cumulative impacts. Chemical monitoring is only useful if impact occurs at the time of sampling.

D. REVIEW OF NON-POINT POLLUTION SOURCES

Seven general categories of non-point source pollution were identified in the watershed. These sources include:

- Site Development and Lot Conversion;
- Agricultural Land Use;
- Recreation Activities;
- Residential Land Use;
- Transportation Corridors;
- Stormwater Management; and
- Utility Right-of Ways.

1. Site Development and Lot Conversion

Site development and lot conversion occur or have the potential to occur throughout the watershed. Southern New Hampshire is one of the fastest growing regions in New Hampshire. During site development and lot conversion the ground is typically disturbed altering vegetation and hydrological processes. Site development and lot conversion can be sources of sediment if drainage, grading, and re-vegetation are not well-planned and controlled. The sediment that is washed into surface waters from construction sites is considered to be the greatest single non-point source pollutant (Jeer et al. 1997). Impacts of sedimentation on fisheries include reduction in water clarity, increases in water temperature which decrease dissolved oxygen levels, and filling in of spawning habitat. Impacts of sedimentation on wetlands include reduction in flood storage capacity. Sedimentation can also have negative impacts on drinking water supplies by damaging water treatment pumps, increasing treatment costs, and increasing the production of unhealthful disinfection byproducts.

2. Agricultural Land Use

Golf courses and timbering are included under agricultural land use. Farming depends on maintaining the productivity of the land, yet its activities can also contribute non-point source pollution. Golf Courses may use intensive turf management, which involves chemical applications. The three primary non-point source concerns from agricultural and golf course land use activities are soil loss or sedimentation, nutrients and pesticides.

Farmland in Greenville

3. Recreation Activities

Recreation activities occur on the waterbodies and surrounding land base. Water contact activities include in the watershed include motor-boating, swimming, fishing, sailing, kayaking, canoeing, and other non-motorized boating. During the winter snowmobiling and ice fishing occur. Recreational activities on the land include hunting, use of all terrain vehicles, horseback riding, and mountain biking.

4. Residential Land Use

Residential land use poses threats to water resources from several sources. For example, potential contamination sources include residential fuel storage, septic systems, landscape care, and household hazardous waste.

5. Residential Heating Fuel Storage

Residential heating fuel tanks are potential sources of contamination because they are prone to leaks due to line breakage, corrosion, and fitting and filter leaks (Freill, 2004). Over-filling of tanks is also a concern. The primary pollutants associated with residential heating fuel are volatile organic chemicals which can have negative impacts on fisheries and human health. The location of residential heating fuel tanks is significant. For example, residential heating fuel tanks consist of aboveground storage tanks which are located outside and inside tank installations which are usually located in a basement. There are two common concerns associated with outside tanks. Aboveground storage tanks should be located on an impermeable surface to prevent leaching of fuel spills into the groundwater and the tank themselves should be protected from harsh weather conditions. Tanks may tip over or become damaged due to ice and snow. Often tanks are not located on an impermeable surface and do not have weather protective structures. Inside tanks are typically located in finished or unfinished basements. Finished basements provide some spill or leak containment. In contrast, unfinished basements do not have a physical barrier which helps to contain spills. Finished basements may also have sump pumps to alleviate wet conditions. Although useful for removing water, sump pumps can accidentally pump fuel or fuel-contaminated water into groundwater resources or directly into surface water.

6. Wastewater Disposal

Everything that goes down the drain, into the toilet, dishwasher, and clothes washing machine goes to some type of waste water disposal system. In the watershed there are two general categories of wastewater disposal systems: a system associated with an individual home and a municipal sewer system. The majority of households in the watershed dispose of their waste water using individual systems which include septic systems, cesspools, and holding tanks. Of these three types of disposal systems, septic systems are the most common.

When wastewater disposal systems fail they can be sources of bacteria, viruses, and protozoa which can cause gastrointestinal illness. They can also be sources of pollutants from improper disposal of household hazardous waste. Both types of systems, sewers and individual wastewater disposal systems are capable of failure. Municipal sewer systems are typically managed by professional staff. Individual systems, on the other hand, often receive less attention after they have been installed. Typically the homeowner is responsible for ensuring proper system operation and maintenance. Septic systems should be maintained by pumping out wastes approximately every 3-5 years.

When septic systems function properly they can process household organic waste and destroy disease-producing bacteria. The most commonly approved system consists of a septic tank connected to a leach field. Wastewater first flows to the septic tank where heavy solids sink to the bottom. Grease, oils, and lighter solids rise to the top where they form a layer of scum. Beneficial bacteria which are naturally present in materials that are flushed into the system decompose the biodegradable waste. Liquids flow from the tank to the leach field where unhealthful bacteria, viruses, and some phosphorus are removed. Eventually the filtered water flows to the water table (CRJC, 1994). A failed system jeopardizes public health, is a neighborhood nuisance, and negatively impacts water quality in the watershed.

7. Lawn Care

Nutrients and pesticides are common pollutants associated with lawn care and gardening activities. Pesticides are sources of synthetic organic chemicals. These chemicals can be washed from lawns during a rain event, transported to surface water where they can bioaccumulate in fish tissue. Once these chemicals enter the drinking water supply they can pose potential health risks. Fertilizers are a source of nutrients such as Nitrogen and Phosphorus. Excess additions of these nutrients to waterbodies can result in increased frequency and mass of algal blooms. Algal blooms tend to increase water treatment costs, cause odors and poor taste and in some cases the blooms can be toxic.

Some of the natural shoreline of the Souhegan River and other water bodies within the watershed has been removed and replaced with lawns. The Shoreland Protect Act requires that limestone be used to fertilize lawns within 25 feet of the reference line of a great pond. Further from the shore, beyond 25 feet of the reference line only low Phosphate, slow release Nitrogen fertilizer or lime can be used.

8. Transportation Corridors

Transportation corridors include roads, highways, and railroad right-of ways. Roadways serve as potential sources of contamination because these impervious surfaces accumulate de-icing materials and chemicals from automobiles. Stormwater runoff carries these pollutants to nearby waterways and groundwater. In addition, where roadways cross streams the potential for stormwater runoff to enter surface water without adequate treatment increases.

Conductivity is generally found to be a good measure of the concentration of total dissolved solids (TDS) and salinity in a waterbody. Road salt, non-point source pollution (for example, agricultural run-off) and industrial inputs tend to increase conductivity levels as their intensity and frequency increase. Data on conductivity in the Souhegan River and other waterbodies is not available, however, because of the number of road and stream crossings contaminants from roadways is one of the primary suspected sources.

9. Stormwater Management

Stormwater runoff occurs when the capacity of soils and vegetation to absorb water from precipitation is exceeded and water flows across the land's surface. In developed areas, natural vegetation and permeable soils are replaced by tracts of impervious surfaces such as roads, parking lots, rooftops, driveways, sidewalks, and compacted fill. Because water cannot penetrate the impervious surfaces, it runs off into gutters and storm drains picking up toxins and suspended solids along the way. In undeveloped areas, water infiltrates the soil where some pollutants can be treated by natural processes. In contrast, in developed areas, the rate of stormwater runoff increases allowing for less time for natural pollutant treatment and increasing the volume of water flow.

According to the Environmental Protection Agency, contaminated stormwater discharges are responsible for the impairment of one-third of all assessed waters in the United States. Common stormwater pollutants include sediments, toxic chemicals (e.g. cyanide, phenolics, and trichloroethylene), metals, oxygen depleting chemicals, fecal coliform, oil, grease, pesticides, fertilizers, and trash (Ballestero et al., 2005). Little is known about the quality and location of stormwater runoff in the watershed. No water quality monitoring of stormwater has occurred. Also important for determining the potential volume of stormwater runoff is the percent impervious cover present in the watershed. Percent impervious cover has yet to be determined for the Souhegan Watershed. Research has shown that percent of imperviousness cover in a watershed can be used to estimate current and future water quality of sub-watersheds (Zielinski, 2002).

10. Utilities

There are two potential sources of contamination associated with utilities in the watershed: power-line right-of-ways and a sewer system. Pesticides are commonly sprayed to manage vegetation growth on the right-of-ways. Pesticides are sources of synthetic organic chemicals. Prior to spraying, utilities are required to give notice to municipalities.

The sewer system in the urbanized areas of the watershed communities is another potential source of contamination. When sewer systems malfunction or sewer lines rupture, they can be sources of bacteria, viruses, and nutrients.

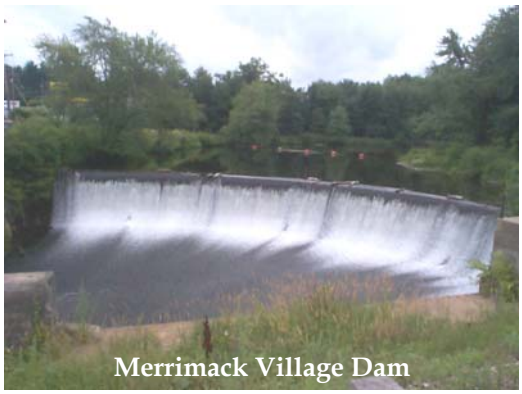
E. WATER USE

NH RSA 483:9-c, enacted in 1988, requires the NHDES to adopt rules for protected instream flows on designated rivers. Since 1990, NHDES has been working on concepts for instream flow protection. Chapter 278, laws of 2002(HB1449) created a pilot program for instream flow protection on the Lamprey and Souhegan Rivers. This program which enacted a significant compromise among water using interests and conservation interests, is based on the idea of first conducting studies to develop protected flows for the Instream Public Uses, Outstanding Characteristics, and Resources (IPUOCR) entities identified for the river segment, and then developing a management plan for the upstream watershed that will maintain the protected flows.

Instream public uses are defined as including the flow-dependent components of navigation, recreation, fishing, conservation, maintenance and enhancement of aquatic life, fish and wildlife habitat, protection of water quality and public health, pollution abatement, aesthetic beauty, public water supply, and hydropower production. A management plan for Souhegan River instream flow protection is currently being developed by NHDES.[25]

1. Merrimack Village Dam Study

The Merrimack Village Dam (MVD), located in Merrimack, NH, is the first dam on the Souhegan River. The dam is owned by Pennichuck Water Works (PWW), a public water supplier in Merrimack, NH.


Merrimack Village Dam

PWW purchased the dam in November 1964 to serve as a supplementary water storage site, but the dam and impoundment were never used for that purpose. The company is now interested in either removing the dam or transferring its ownership to another entity, which will then be responsible for dam maintenance, operations and any future fish passage requirements. In January 2004, the NH Dam Safety Department issued PWW a Letter of Deficiency (LOD), meaning that the MVD does not meet certain dam safety criterion. Dam repair and other issues were identified by NH Dam Safety as issues that must be addressed. A combination of the LOD, the fact that PWW does not utilize the dam for water supply, and the long-term liability and maintenance cost associated with the MVD prompted PWW to consider dam removal.

[25] The NHDES Instream Flow study for the Souhegan River is ongoing at this time. Future plans are for additional data collection, analysis and the development of a management plan.

Removal of the Merrimack Village Dam (MVD) would open approximately 14 miles of free-flowing main stem of the Souhegan River. The USFWS estimates that dam removal would restore about 100 surface acres of habitat for migratory fish. The USFWS also estimates that it would be feasible to attain 50 shad per acre of habitat, or 5,000 returning shad to the restored habitats in the Souhegan River if the MVD were removed (Ken Sprankle, USFWS, June 2003 Presentation). According to the USFWS American shad, Atlantic salmon, Sea lamprey, Blueback herring, Alewife, and American eel are believed to have historically utilized the Souhegan River basin.

In 2003 a study plan was jointly developed to identify studies needed to evaluate the impacts dam removal could have on infrastructure, sediment, pollutants (if any), fisheries, wetlands, and property. The study plan was developed in consultation with the NHDES, Merrimack Planning Board (MPB), Merrimack Conservation Commission (MCC), Merrimack Community Development Department (MCDD) and PWW. The studies and background research were designed to answer many of the questions raised and to generally understand the impacts of removal. A Phase II study may be conducted, depending on the outcome of this initial study, need for additional information, and feedback from various interested parties. Pennichuck Water Works has applied for funding to conduct a Phase II study.

A final report of the Merrimack Village Dam Removal Feasibility Study conducted by the consulting firm Gomez and Sullivan Engineers, P.C., January 2005 provides a detailed description of the project and its associated impacts.[26] A summary of the findings and conclusions of the study follows.

Hydraulic analyses and visual observations indicate sedimentation is occurring as a result of the backwater influence behind the Merrimack Village Dam. Sediment deposition of as much as eight feet has occurred in the impoundment. The total estimated volume of sediment behind the dam is 81,000 cubic yards. Above the Merrimack Village Impoundment, aquatic habitat appears able to support fish with quality riparian corridor habitat as buffer for in-stream habitat. Enough shade exists to maintain optimal water temperatures, and particle sizes large enough (coarse sands, gravel, cobble, and boulders) to create turbulence sufficient to maintain dissolved oxygen levels. Signs of eutrophication such as brown algae and excessive submerged aquatic vegetation are not evident in the upstream reaches from the dam.

In-stream habitat within Merrimack Village Dam impoundment suffers due to low water velocity, sedimentation, lack of shade, and a wide and shallow reach. The long residence time of water in the impoundment likely contributes to elevated water temperatures and low dissolved oxygen.

Sediment and associated pollutants that are carried by rivers generally settle directly behind dams where water velocities slow. Of concern with any dam removal project is the potentially harmful release of these accumulated sediments and pollutants to the downstream river channel and aquatic environment. Before dam removal occurs, it is common to conduct sediment testing to determine sediment size via grain-size analysis (to determine the potential for sediment mobility) as well as to test for pollutants.

The only Persistent, Bioaccumulative, and Toxic pollutant (PBT) found in the sediment above the screening criteria was benzo(a)pyrene, which exceeded the TEC criteria at site MVD-05. Note that samples from Site MVD-05 were collected from an area at the head of the impoundment, approximately 300 feet downstream of the Everett Turnpike Bridge. All of the exceeding incidents of the sediment

[26] Merrimack Village Dam. Dam Removal Feasibility Study. Final Report, January 2005. Gomez and Sullivan Engineers. PC

screening criteria were highest at the upstream site (MVD-05) and mostly related to polycyclic aromatic hydrocarbons (PAH's). This is most likely associated with its relative location to the Everett Turnpike Bridge (Gomez and Sullivan Final Report).

In summary, the report prepared by Gomez and Sullivan for PWW concluded that the sediment chemical analysis and subsequent toxicity testing indicates that contaminants are not likely to be readily bioavailable and pose no risk to downstream ecosystems.

The report also concluded that flow velocities in the stretch of the Souhegan River that is currently impounded by the MVD would increase upon removal of the dam. Under most flow conditions peak velocities occur at the ledge underlying the MVD. The increase in flow velocities will initiate sediment transport that had been blocked by the MVD.

Dam removal will result in a lower water surface profile in the area of the current impoundment. Water surface elevations will drop from as little as two feet near the Everett Turnpike to as much as eight feet near the dam site. The lowering of the water level will result in dewatering of the wetland adjacent to the dam by the fire station. However, large flow events beginning with the 2-year flood will result in inundation of the wetland. The 500-, 100-, and 50-year floods will result in overtopping of the embankment that separates the wetland from the main channel of the Souhegan River.

Presently, much of this wetland is classified as Palustrine Open Water (POW) with some Palustrine Scrub-Shrub (PSS) and Palustrine Forested (PFO) areas along the edges. Removing MVD would convert most of the open water wetland into more scrub-shrub and/or forested wetland. It is likely that some of the current scrub-shrub and forested wetland areas would gradually convert to upland.

Wildlife habitat within the open water wetland areas would also be altered if the dam were removed. Instead of an aquatic habitat supporting fish, waterfowl, amphibians, and reptile species, the converted wetland would be changed to a more terrestrial environment.

Scour in the channel below the dam is not a significant issue owing to the presence of natural bedrock formations and concrete retaining walls. This is particularly true for the Chamberlain Bridge, which has its foundations set upon bedrock. The Chamberlain Bridge would not be affected by abutment scour should the dam be removed. If the impoundment is unprotected, the channel upstream of the MVD will be subject to scour with increased flow velocities upon dam removal. The impoundment will experience a lower water surface elevation as the impoundment reverts to riverine conditions.

Nearly 81,000 cubic yards of sediment is currently impounded by the MVD, however, not all of this sediment would be naturally swept downstream. The report hypothesizes that the channel will not experience rapid lateral migration; rather it will scour until the current impoundment returns to an equilibrium state. The HEC-RAS Dam-out geometry (absent sediment) indicates that a backwater pool will remain in the same location as the MVD Impoundment, thereby protecting a significant portion of the impounded sediment from scour.

It is also important to note that no spawning grounds will be destroyed by letting natural sediment transport processes scour sand from the impoundment and deposit it at the mouth of the Souhegan River because the channel bed is already sand.

Before removal of the MVD is undertaken, the report states that it will be important to initiate several sediment protection-related activities. Investigation of the canal structure and outlet, dredging sediment

immediately upstream of the canal gate structure, dewatering of the impoundment, bank stabilization, and revegetation will all need to be initiated or completed before dam removal can begin.

It is important to initiate re-vegetation as soon as possible after the impounded soils are exposed. If the impoundment is dewatered during summer months, it is expected that revegetation will be rapid. Native grasses and shrubs that grow on currently exposed mid-channel bars will take root in newly exposed soils. As such, revegetation may occur through natural processes, or through active reseeding and planting of the exposed sediments with native grasses, shrubs, and trees. Active reseeding may be the best alternative to prevent the emergence of invasive species. Purple Loosestrife (Lythrum Salicaria L.) has been identified above and below the dam, so more extensive planting and protection may be required to limit invasive species spreading throughout the impoundment. Biodiversity in plantings will guarantee that some of the plantings thrive, ensuring that plantings are successful in protecting exposed soils.

Sensitive locations that may be subject to bank failure should receive further attention before dam removal. Stabilization of these areas may require live-staking, coir fascine, and erosion control matting in addition to seeding and planting to stabilize banks. Live staking provides immediate stability and reduces soil moisture while providing long-term stability with root development. Live-staking is most successful if instituted during the spring or fall because the stakes will be in a dormant growth-phase and will not be damaged while being placed. Coir fascine will protect the toe of the bank while accumulating sediment to stabilize the toe. Coir fascines, made from coconut husks, will biodegrade slowly over three to six years. Erosion control matting will provide immediate slope stabilization and protect soils while root structures are developing. Incorporation of large woody debris may also help to create habitat diversity and protect the right bank from failure by undercutting and scour.

Bioengineering methods are preferred to older methods of bank stabilization (e.g. Riprap revetment, or structural solutions) for several reasons. First, bioengineering methods are more adaptable and work to enhance natural processes rather than altering them. Second, bioengineered methods of bank stabilization are less costly than more established methods. Third, bioengineering methods do not require as much maintenance as structural methods (drop structures, dikes, etc.) because the design life is short with the expectation that the ecosystem will begin to establish a natural equilibrium during that time. Lastly, proper selection of materials will ensure that all materials are biodegradable such that no cleanup or removal cost is incurred in the future.

As noted at the June 2003 meeting, many members of the public feel the dam and flowing water is aesthetically appealing and provides scenic views throughout the changing seasons. One of the common concerns with dam removal projects is the aesthetic appeal of the site immediately following dam removal. Dam removal usually results in a temporary exposure of sediments (i.e., mud flats) due to the de-watering of the impoundment. This is generally unavoidable and tends to be visually unappealing immediately following a dam removal. However, firsthand experiences at dam removal projects in New Hampshire and nationwide have documented that these exposed sediments typically revegetate within a few weeks during the growing season and are soon "greened up." It is common for members of the public to be cautious at dam removal due to aesthetic concerns and if dam removal proceeds, it is recommended that "before" and "after" photographs of past dam removals be shared with the public. In addition, a combination of appropriate computer software and site-specific technical knowledge can be used to generate digitally enhanced "after" photographs of what the project could look like after dam removal.

In September 17, 2002 Kate White, a Research Hydraulic Engineer with the Army Corp of Engineers Colds Regions Research and Engineering Laboratory (CRREL) sent a letter to NHDES regarding icing

issues on various dams considered for removal. Kate White's summary of ice jamming on the Souhegan River is summarized below.

"A search of the CRREL Ice Jam Database revealed that five ice jams have been reported on the Souhegan River. Ice jams have also been reported on Baboosic Brook and the Merrimack River in Merrimack, indicating an active ice regime, so that it is highly likely that more jams have occurred than have been reported. Three of the ice jams on the Souhegan River were located in Merrimack, one upstream from the USGS gage (01094000), and two reported at the gage. The jam upstream from the gage was apparently formed at an oxbow in the river about 1.5 miles upstream from the Everett Turnpike, while the jams at the gage were reported as being due to ice jams at the gage. These ice jams formed somewhere in the reach between the Merrimack Village Dam and the gage, most likely at the upstream end of the impoundment. It is possible that removal of the dam could change the ice regime of the river so that ice that might have jammed at the upstream end of the impoundment is transported downstream, where it could jam in the backwater from the Merrimack River. Observation of the ice regime at the Merrimack Village Dam and the downstream reach, including the adjacent Merrimack River, is highly recommended before removal in order to assess the potential for increased downstream jamming".

2. *Merrimack River Anadromous Fish Restoration Program*

The MVD represents the first barrier to upstream fish passage on the Souhegan River. There are two dams on the Merrimack River located below the Souhegan River confluence. The Essex Dam in Lawrence, MA and the Pawtucket Dam in Lowell, MA are located approximately 33 and 21 river miles downstream of the confluence respectively. Approximately 11 river miles upstream of the Souhegan River confluence is Amoskeag Dam in Manchester, NH. All three dams are equipped with upstream and downstream fish passage structures, thus the diadromous and catadromous fish can migrate to the mouth of the Souhegan River.[27]

The Massachusetts Division of Fisheries and Wildlife (MDFW) monitors the number of returning diadromous fish and counts the number of American shad, Atlantic salmon, striped bass, Sea lamprey, gizzard shad, and river herring that utilize the upstream passage structures at Essex and Pawtucket Dams. The New Hampshire Fish and Game (NHF&G) is responsible for obtaining counts at Amoskeag Dam.

The Souhegan River is an important part of the Merrimack River Anadromous Fish Restoration Program and is considered one of the most productive rivers in the Merrimack Watershed. Restoration efforts of anadromous fish on the Merrimack River have been on-going for several years. The upper reaches of the Souhegan River and its tributaries provide the appropriate habitat- gravelly, sloping bottoms, water temperatures, oxygen levels and food sources - for excellent growth and survival of Atlantic salmon fry and juveniles. On average, 125,000 Atlantic salmon fry are stocked in the Souhegan River and tributaries including Stony Brook, Blood Brook, and King Brook annually. In addition to stocking fry, prespawn American shad and river herring have been transferred and/or stocked by the US Fish and Wildlife Service (USFWS) and NHF&G. In June 2003, 600 adult American shad were transported and released in the Souhegan River in Amherst.

[27] Diadromous fish spend part of their lives in freshwater and saltwater. These include anadromous fish. Anadromous fish (such as river herring, Atlantic salmon, American shad, Sea lamprey) spawn and develop in freshwater, before returning to the ocean. Once anadromous fish reach sexual maturity, they repeat the cycle and return to freshwater to spawn. Alternatively, catadromous fish (such as American eel) spawn and develop in saltwater, and move into freshwater to grow.

Adult salmon are stocked in the Merrimack River for anglers. A member of the Fire Department has seen salmon located in holding pools immediately below Chamberlain Bridge. In fact, they have observed salmon attempt to ascend the MVD, however, they have been unsuccessful due to the lack of a holding pool just below the dam. It is suspected that because the concrete apron extends well downstream (beneath a portion of Chamberlain Bridge), the salmon cannot sustain the swimming speed to negotiate both the apron and the dam.

The Merrimack River Basin Fish Passage Action Plan for Anadromous Fish, January 1988, calls for the construction of upstream passage at the MVD when 15,000 shad/year (on average), pass through the Amoskeag Dam fishway over a 5-year period. To date, upstream passage has not been required as the number of returning shad is well below the 15,000 trigger. It is assumed that once the number of shad passing the Pawtucket Dam increase, the intensity of monitoring of the Amoskeag fishway will increase to determine if the 15,000 shad/year threshold is achieved.

In addition, the Souhegan River is integral to the extremely successful USFWS Adopt-A-Salmon Family Program that uses a watershed approach for environmental education. Classrooms are given Atlantic salmon to raise during the year which are then released into the Souhegan River in the spring. At present, the Souhegan River is the main release site for the program that currently involves approximately 25 schools in Massachusetts and New Hampshire. The fry are stocked by state and federal natural resource personnel, volunteers, and school children.

F. RECREATION

The Souhegan River Local Advisory Committee conducted a survey of local officials to obtain their perceptions of important issues during the summer of 2005. Surveys were directed to the Planning Board, Zoning Board of Adjustment, Board of Selectmen, Conservation Commission, Department of Public Works, Town Clerk or Administrator and Citizens.


Recreation for Children

A majority of the respondents believed that open space, swimming, canoeing, picnicking, walking/bird watching and fishing contributed to the quality of life in their communities. A majority also rated open space, public access/recreational use as either very important or somewhat important to be protected within the Souhegan River corridor.

The Souhegan River provides numerous recreational opportunities to the residents of the communities along its banks, to the region and to the State as a whole. Activities such as canoeing, kayaking, fishing and swimming take place on the river itself, while its riparian areas are used for hiking, cross country skiing, picnicking, bird watching, nature study and the enjoyment of scenic views. The river corridor is situated such that the recreational opportunities it provides are available to a large and diverse population. While no recreational user counts exist for the river, it can be assumed that demand for recreation is increasing in the area as population increases.

1. Permanent Open Space/ Recreation Land and Trails

While access is provided to the river in each of the corridor communities, the creation of a river trail that links the various communities or stretches of land within each community is an ongoing endeavor. The potential for trail development along the Souhegan River is great; if developed a continuous river trail would serve the recreational needs of a large population and further increase awareness and enjoyment of the River. Such a trail could ultimately connect the existing public conservation and recreation areas. The importance of providing legal access for river users cannot be over emphasized. It is also important that sufficient parking be provided at put-ins and take-outs to alleviate problems with the surrounding neighborhoods.

As part of the Regional Environmental Planning Program Report of 2000, a Souhegan River corridor was outlined as a priority. Seven significant parcels were identified in the Towns of Wilton, Milford, and Merrimack that were high priorities to protect through acquisition or the placement of an easement for access.

Map A-1, Watershed Conditions shows the permanent open space and recreation land within the corridor. This map does not show trails or easements that may have been obtained by the corridor towns.

Each of the corridor towns Master Plans or Conservation Commissions have identified existing lands that have been protected along the river corridor. The Merrimack Master Plan includes a list of parcels identified as high priority possible future additions to a Souhegan River greenway.

The New Ipswich Master plan lists conservation land under Community Facilities that is within the corridor. The Milford Conservation Commission has information on hiking trails and picnic spots on the Souhegan on their web site. Wilton also lists recreation sites on the Souhegan River on its web site. The Wilton Conservation Commission produced a recreational trails map in March 2003 that contains descriptions of trails on land along the Souhegan River. The Amherst Master Plan lists conservation/recreation land. The Merrimack Master Plan lists significant conservation properties and lists three Souhegan Greenway parcels. The Merrimack Master Plan states that protection of these parcels would help to bring about a greenway, connecting protected land and trails along the Souhegan River with similar land along the Merrimack River.

In a recent development in the Town of Merrimack the option of the town acquiring the 10-acre former Harcross site for public use from a donation is being discussed. The site lies on the north side of the Souhegan River. Over the years, the land has been the location of a tannery and chemical plant. The current owner has been cleaning up the contamination on the property with the assistance of state and federal environmental officials. Based on the results of an environmental risk assessment the site is considered a very good candidate for a Brownfields development site. Brownfields remediation and redevelopment are components of federal and state programs to restore economically viable uses to land that is (or is perceived to be) contaminated with industrial waste. According to the environmental consultant report there is no risk to human health from direct exposure on the property. Cleanup of groundwater is continuing.

In an exciting step forward in the development of a trail corridor, Milford has obtained or is the process of obtaining thirteen easements along the Souhegan River connecting Emerson Park to the Town owned conservation land on the River. The types of easements obtained include conservation, trail, historic preservation and agricultural.

The acquisition of land or easements on land abutting the river has been an ongoing process for the corridor towns. NRPC is currently working with the towns through the Regional Open Space Study

(ROSS) to update the GIS database with the permanent open space parcels that have been acquired by the NRPC area towns. This update will include parcels that are part of the Souhegan corridor.

A slightly more complex process that would facilitate the development of a corridor trail plan is adding survey data from conservation easements to the NRPC GIS database. This would provide a visual picture of location of trails, existing connections and possible locations of future corridor connections.

The Regional Open Space Team (ROST) is a group of interested conservationists working on the goal of connecting trails in the region. The Towns of Milford, Wilton and Amherst have been participating in ROST. The main goal is to access open space from existing and future residential neighborhoods. The secondary goal is to identify routes to connect conservation lands, forests and existing or future trail corridors. In Milford the team is called Milford Open Space Team (MOST) and consists of Conservation Commission members and recreational enthusiast (hiking, mountain biking, snowmobiles, equestrian, cross-country, snowshoeing, etc.). All open space parcels and their level of protection have been identified. Continuation of the Souhegan River Trail is one of MOST's biggest projects.[28]

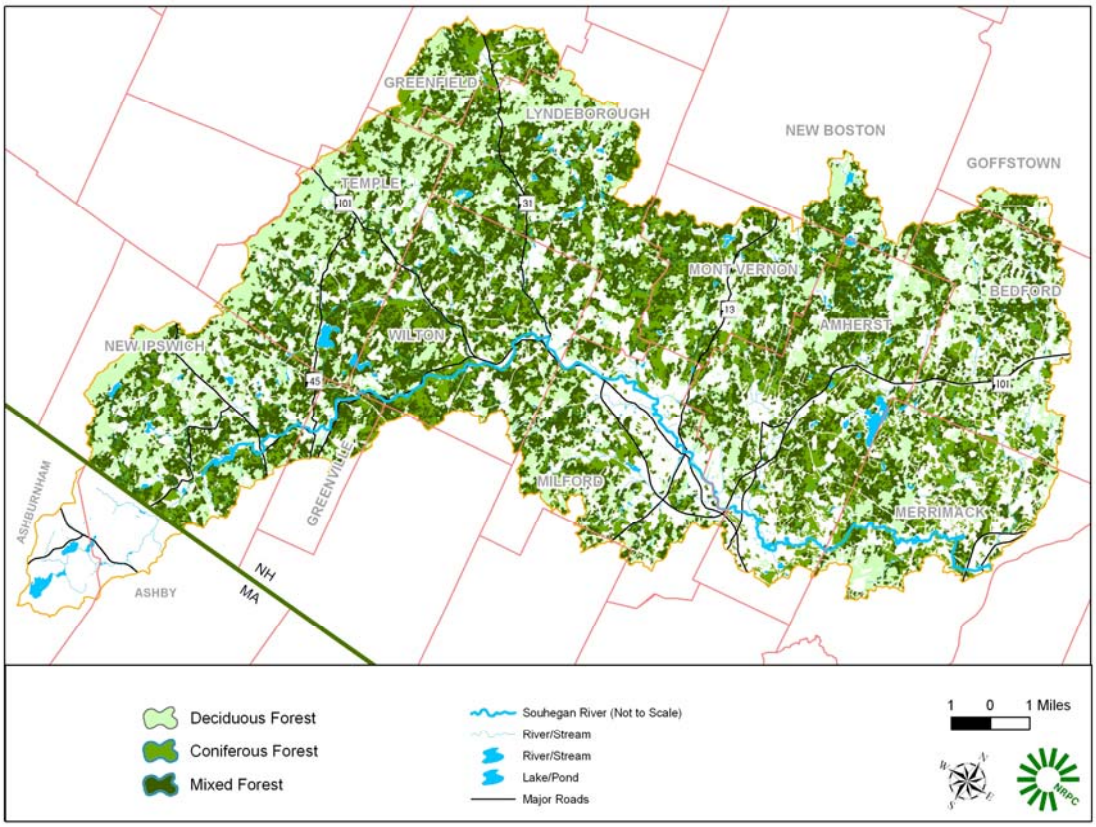
G. LAND COVER/LAND USE

1. Tree Cover

Figure 4-4 shows general tree cover in the watershed. Segments of the Souhegan River in the more urbanized areas can be seen in this map to lack a heavy tree cover. Lack of a tree canopy can increase water temperatures from lack of shading and have a detrimental affect on habitat conditions.

[28] The opportunities and obstacles for this project is described in the NRPC Bicycle and Pedestrian Plan.

Figure 4-4: Tree Cover in the Souhegan River Watershed



2. *Land Cover*

Land cover is shown on Map A-1, Watershed Conditions. Land cover was obtained from satellite imagery data taken between 1990 and 1999. Table 4-4 lists the land cover categories by acreage and percent in the Corridor and in the watershed.

Table 4-4: Land Cover in The Corridor and Watershed

Corridor Land Cover	Acres	
Residential/Commercial/Indust.	1038.7986	4.77%
Transportation	7095.7812	32.60%
Row Crops	180.6257	0.83%
Hay/Pasture	1610.5794	7.40%
Orchards	96.1330	0.44%
Beech/Oak	1698.6846	7.80%
Paper Birch/Aspen	21.6751	0.10%
Other Hardwoods	270.9386	1.24%
White/Red Pine	1920.6535	8.82%
Spruce/Fir	136.6735	0.63%
Hemlock	400.3870	1.84%
Mixed Forest	5073.3752	23.31%
Open Water	412.2280	1.89%
Forested Wetland	21.2737	0.10%
Open Wetland	262.7101	1.21%
Disturbed Land	43.1495	0.20%
Other Cleared	1480.5288	6.80%
Total	21764.1955	100.00%
Watershed Land Cover	**Acres**	
Residential/Commercial/Indust.	3585.8220	2.66%
Transportation	7585.8790	5.62%
Row Crops	301.2436	0.22%
Hay/Pasture	9475.8261	7.02%
Orchards	1110.4468	0.82%
Beech/Oak	28459.7902	21.08%
Paper Birch/Aspen	1033.3798	0.77%
Other Hardwoods	3775.8804	2.80%
White/Red Pine	16745.2086	12.40%
Spruce/Fir	1562.6132	1.16%
Hemlock	6157.5309	4.56%
Mixed Forest	41689.4202	30.88%
Open Water	1888.1409	1.40%
Forested Wetland	650.0519	0.48%
Open Wetland	2756.1478	2.04%
Disturbed Land	285.3886	0.21%
Bedrock/Vegetated	11.6403	0.01%
Other Cleared	7942.1130	5.88%
Total	135016.5233	100.00%

H. NRPC REGION WIDE BUILDOUT ESTIMATES

NRPC has conducted a study analyzing maximum buildout conditions and the impacts it will have on the region. The study was conducted for each community in the NRPC region and then aggregated to produce region-wide results. "Buildout" is a theoretical condition and exists when all available land suitable for residential and nonresidential construction has been developed. The time frame for when build out occurs is dependent on numerous factors and was not predicted by the NRPC model. Zoning regulations pertaining to allowable uses and allowable densities are an indication of the desired type and amount of growth that will occur in currently undeveloped areas. The corridor towns of Wilton, Milford, Merrimack and Amherst were included in this study. Results provide an idea of potential future growth in most of the corridor towns and corresponding impacts on resources. It is important to note that results are town wide and do not reflect development in the entire corridor or watershed.

The model estimated the current developable acres with the following results for corridor towns:

- Wilton- 1,770;
- Milford-3,168;
- Amherst- 2,545; and
- Merrimack-2,578.

Population growth at build-out was estimated to be:

- Wilton- 64%;
- Milford- 48%;
- Amherst- 28%; and
- Merrimack- 20%.

Non residential growth in number of lots is predicted to be the following:

- Wilton- 52;
- Milford-301;
- Amherst-57; and
- Merrimack-107.

Water demand was also predicted for when build-out may occur and is shown in Table 4-5 Water use was based on a combination of public/private wells and public/private water systems. Average per capita demand is based on Pennichuck Water Works yearly averages. These are general estimates based on build-out assumptions.

Table 4-5: Estimated Water Demand at Buildout

Town	Current /million/gallons/day	Use at build-out
Wilton	0.28	0.47
Milford	2.29	3.39
Amherst	.86	1.09
Merrimack	4.25	5.09

The conversion of rural land to urban land usually increases erosion and the discharge and volume of storm water runoff in a watershed. It also causes other problems that affect soil and water. Farmland

converted to suburban, commercial or industrial uses is likely to increase runoff. Compacted lawns and playing fields have more runoff than the undisturbed woods and erosion during construction continues to be major problem in many areas. Possible impacts associated with development include:

- Lower low flows in streams;
- Higher peak flows and flooding;
- Runoff of pesticides, fertilizers;
- Less clean recharge and dropping water levels;
- Pollution of drinking water; and
- Loss of wildlife habitat and damage to fisheries.[29]


Upper Garland Falls, Wilton

Concerns associated with highways and railroads include chronic runoff of pollutants, salt, sand and hazardous materials spills.

Percentage of impervious surfaces is widely recognized as an excellent indicator of urbanization and the impacts of urbanization on water resources. Those interested in preventing and/or mitigating the impacts of urbanization on water resources need to be aware of the effects of impervious surfaces, their relationship to the water cycle, their impacts on waterways, and the ways that this relationship can be used to inform better community planning and site design.

The quality of stream flow for fifteen streams in Connecticut was found to be significantly related to the percentage of impervious surface, the percentage of urban land cover, and the percentage of agriculture land cover. Practices are needed that can compensate for the direct impact of imperviousness (Non-point Education for Municipal Officials impervious surface research. Final Report. University of Connecticut Department of Natural Resource Management and Engineering).

Much attention has been devoted to the use of imperviousness thresholds in the literature. Research into the impact of urbanization on the biotic (Wang et al. 1997, Roy et al. 2003, Finkenbine et al. 2000; May et al., 1997), and physical (Wang et al. 1997, Booth and Reinelt 1993, Booth and Jackson 1997, Bledsoe and Watson 2001) integrity of streams has suggested that stream degradation occurs between 10%-20% imperviousness (Scheuler, 1994). However, a recent literature review concludes that a single threshold value is difficult to recommend (Brabec et al., 2002). Their summary suggests that degradation thresholds have ranged from 4 to 12 % for fish populations, 8-15 % for macroinvertebrates, and 4 to 50 % for abiotic measurements such as water quality and habitat.

The importance of the Souhegan River for recreation, fishing and to the Salmon Restoration Project means that managing imperviousness in the watershed needs to be an important consideration for restoring and protecting water quality.

I. REGULATORY FRAMEWORK

The land within the watershed and corridor is subject to both state and local regulatory controls. These controls are an important component in protecting the long-term health of the river.

[29] Comprehensive Environmental Inc. Spring 2005 newsletter on Low Impact Development.

1. Rivers Management and Protection Act

The Souhegan River is a Designated River under the Rivers Management and Protection Act of 1988 (RSA 483). Under the provisions of RSA 483, designation of the river provides for increased protection against the construction of new dams, damaging channel alterations, water quality impairment and the siting of solid and hazardous waste facilities in the river corridor. An important feature of this protection is that sludge and septage application is not allowed within 250 feet (with limited exceptions).

Designation also requires the establishment of a protected in stream flow to maintain water for public uses including water quality, fisheries, recreation, and scenic values. The NHDES designation allows the Souhegan River Local Advisory committee the opportunity to comment on all state permit applications for projects along the designated river corridor within a quarter mile buffer. Local river management advisory committees may apply for and accept, from any source, gifts, grants, and donations of money. The committees may expend these funds to carry out their duties pursuant to RSA 483:8-a. No state-owned property adjacent to or providing access to a river shall be disposed of by the state except upon the review and recommendation of the advisory committee.

The Souhegan River is classified as rural, rural-community and community. Segments of the Souhegan River have been classified as follows:

(a). As a rural-community river from the confluence of its south and west branches in New Ipswich to a point 0.5 miles above the Otis Dam in Greenville;
(b). As a community river from the point 0.5 miles above the Otis Dam in Greenville to a point 0.5 miles below the Otis Dam;
(c). As a rural river from the point 0.5 miles below the Otis Dam to the Label Arts Dam located approximately 0.3 miles above the confluence with Stony Brook in Wilton;
(d). As a community river from the Label Arts Dam to the Wilton Road bridge near the Pine Valley Mill in west Milford;
(e). As a rural-community river from the Wilton Road bridge to a point 0.5 miles above the route 13 bridge in Milford;
(f). As a community river from the point 0.5 miles above the route 13 bridge to a point 0.5 miles below the route 13 bridge;
(g). As a rural river from the point 0.5 miles below the route 13 bridge to the Everett Turnpike bridge in Merrimack; and
(h). As a community river from the Everett Turnpike Bridge to the confluence with the Merrimack River in Merrimack.

The Souhegan River as it flows through the forests, wetlands, scattered housing and open space of the upper river corridor, and the largely undeveloped broad floodplains of the lower river corridor typifies the definition of a rural river. The remaining segments of the Souhegan River are either "community river" classification or "rural-community river" classification. The segments that are community river or rural community river classification are those that are generally more developed or where existing hydropower facilities or village centers are located. The classifications reflect the river values and characteristics identified by the local towns and NHDES as important to protect and maintain.

Rural, rural community and community river classification requires that water quality shall be restored to or maintained at least to the Class B level. Significant adverse impacts on water quality or other instream public uses shall not be permitted. NHDES is required to review and consider adopted local river corridor management plans prior to issuing any permit under RSA 485-A:13, RSA 485-A:17, or RSA 482-A. The three classifications of the Souhegan River state that no interbasin transfers of water is allowed and no new channel alteration activities shall be permitted which interfere with or alter the natural flow

characteristics of the river or segment or which adversely affect the resources for which the river or segment is designated. However, the commissioner may approve such channel alterations as may be necessary for the construction, repair, or maintenance of a project including public water supply intake facilities in the river or river corridor. The NHDES shall encourage the use of native vegetation to stabilize stream banks.

2. *Shoreland Protection Act*

The NH Comprehensive Shoreland Protection Act (CSPA), RSA 483-B, became effective on July 1, 1994 and established the "protected shoreland." The protected shoreland is all the land located within 250 feet of the "reference line" of public waters. Within the protected shoreland, certain activities are restricted or prohibited, and others require a permit from the NHDES All activities that are regulated by the NHDES must comply with applicable local, state, and federal regulations.

All rivers determined to be fourth order or higher are under the jurisdiction of the CSPA. The Souhegan River is listed as a fourth order or higher stream from the juncture of the South and West branches in New Ipswich. Table 4-6 lists waterbodies in the watershed covered by the CPSA

The reference line for streams and rivers under the jurisdiction of the CSPA is the ordinary high water mark. The ordinary high water mark is defined as the line on the shore, running parallel to the main stem of the river, established by the fluctuations of water. It is indicated by physical characteristics such as a clear, natural line impressed on the immediate bank, shelving, changes in the character of soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas. Table 4-7 lists the minimum shoreland protection standards under the CPSA.


Pratt Pond, New Ipswich

Table 4-6: Major Tributaries and Other Waterbodies in the Watershed Covered by the CSPA

Waterbody	Location/Town
Pratt Pond	New Ipswich
Waterloom Pond	New Ipswich
Wheeler Pond	New Ipswich
Site 13	New Ipswich
Site 14(Furnace Brook Dam)	New Ipswich
Site 19(South Branch)	New Ipswich
Site 35	New Ipswich
Otis Dam	Greenville
Heald Pond/Site 15	Temple/ Wilton
Site 10-A	Wilton
Site 33	Wilton
New Wilton Reservoir	Wilton
Stony Brook	Juncture of Wilton Reservoir to the junction of the Souhegan River
Osgood Pond	Milford
Souhegan River Dam	Milford

Waterbody	Location/Town
Baboosic Lake	Amherst
Baboosic Brook	Juncture of Riddle Brook in Merrimack to juncture of Souhegan River
Stump Pond	Amherst/Merrimack
Honey Pot Pond	Amherst
Mont Vernon	Hortons Pond
Site 12-A	Temple
Site 25-B	Temple
Site 26 Dam	Temple
Hortons Pond	Mont Vernon
Badger Pond	Lyndeborough
Burton Pond	Lyndeborough
Site 8	Lyndeborough
Site 28	Lyndeborough
McQuade Brook II	Bedford

Table 4-7: Minimum Shoreland Protection Standards (RSA 483-B)

LIMITS WITHIN THE PROTECTED SHORELAND

PROHIBITED USES (*RSA 483-B:9, II*)

- Establishment/expansion of salt storage yards, auto junk yards, solid waste & hazardous waste facilities.
- Use low phosphate, slow release nitrogen fertilizer from 250 feet to 25 feet.

Uses Requiring State Permits

- Public water supply facilities (*RSA 483-B:9, III*).
- Public water & sewage treatment facilities (*RSA 483-B:9, IV*).
- Public utility lines (*RSA 483-B:9, IV-b*).
- Existing solid waste facilities (*RSA 483-B:9, IV-c*).
- All activities regulated by the DES Wetlands Bureau per RSA 482-A (*RSA 483-B:9, II(c)*).

Other Restricted Uses

- All new lots, including those in excess of 5 acres, are subject to subdivision approval by DES (RSA 483-B:9, V(b)(1)).
- Setback requirements for all new septic systems are determined by soil characteristics (RSA 483-B:9, V(b)(2)).
- Minimum lot size in areas dependent on septic systems determined by soil type (RSA 483-B:9, V(e)(1)).
- Alteration of Terrain Permit standards reduced from 100,000 square feet to 50,000 square feet (RSA 483-B:6, I(d)).
- Total number of residential units in areas dependent on on-site sewage & septic systems, not to exceed 1 unit per 150 feet of shoreland frontage (*RSA 483-B:9, V(e)(2)*).

NATURAL WOODLAND BUFFER RESTRICTIONS (*RSA 483-B:9, V(a)*)

- Where existing, a natural woodland buffer must be maintained.
- Tree cutting limited to 50% of the basal area of trees, and 50% of the total number of saplings in a 20 year period. A healthy, well-distributed stand of trees, saplings, shrubs, and ground covers must be maintained.
- Stumps and their root systems must remain intact in the ground within 50 feet of the reference line.
- The opening for building construction is limited to 25 feet outward from the building, septic system, and driveway.
- The opening for accessory structures is limited to 10 feet outward from the footprint.

NEW SEPTIC SYSTEM LEACHFIELD SETBACKS (*RSA 483-B:9, V(b)(2)*)

- 125 feet where soil down gradient of leachfield is porous sand & gravel.
- 100 feet where soil maps indicate presence of soils with restrictive layers within 18 inches of natural soil surface.
- 75 feet where soil map indicates presence of all other soil types.
- 75 feet minimum setback from rivers.

PRIMARY BUILDING LINE*

- Primary structure setback 50 feet from the reference line (*RSA 483-B:9, II(B))*.
- Fertilizer use is prohibited within 25 feet of reference line (*RSA 483-B:9, II(d)*).
- Accessory structure setback 20 feet from the reference line (*EnvWs 1405.04*).

REFERENCE LINE (*RSA 483-B:4, XVII*)

- For coastal waters = highest observable tide line.
- For rivers = ordinary high water mark.
- For natural fresh waterbodies = natural mean high water level.
- For artificially impounded fresh waterbodies = water line at full pond.

*If a municipality establishes a shoreland setback for primary buildings, whether greater or lesser than 50 feet, that defines the Primary Building Line for that municipality.

Structure "means anything built for the support, shelter or enclosure of persons, animals, goods, or property of any kind, as well as anything constructed or erected with a fixed location on or in the ground, exclusive of fences" (**RSA 483-B:4 XXII**). Some examples of structures:

- Patios, walkways, and parking areas;
- Underground storage tanks (USTs);
- Camping trailers and RVs;
- Stone walls;
- The fill extension of a septic system or a roadway is considered part of the structure; and
- Grading and contour changes are not considered structures, however, they are subject to the restrictions of the Natural Woodland Buffer (RSA 483-B:9(a). This means if trees must be cleared within the woodland buffer or stumps must be removed within 50 feet of public water, the grade must remain unchanged.

3. NHDES Alteration of Terrain Program

The Alteration of Terrain permit program is intended to protect New Hampshire surface waters by controlling soil erosion and managing storm water runoff from developed areas. A permit is required whenever a project proposes to disturb more than 100,000 square feet of terrain (50,000 sq. ft. if within the protected shoreland). The program applies to both earth moving operations, such as gravel pits, as well as industrial, commercial and residential developments. The Local Advisory Committee submits comments to NHDES on all Alteration of Terrain permits within a quarter mile of the Souhegan River.

4. EPA Stormwater Regulations

Storm water is regulated by the U.S. Environmental Protection Agency under the Clean Water Act. Since March 2003, municipalities and developers have been subject to new requirements dealing with storm water management. The new requirements are called Phase II Storm Water Regulations since they are the second round of storm water rules implemented by EPA. Phase I, passed in 1992, dealt with larger municipalities (none in New Hampshire), privately-owned industries, and construction sites of 5 acres or larger.

Phase II regulates Small Municipal Separate Sewer System ("Small MS4") EPA reissued the Construction General Permit (CGP) on July 1, 2003. The reissued CGP now covers both the Phase I large construction sites greater than five acres and "Storm water associated with small construction activity," which includes construction sites from one to five acres (or smaller than one acre if part of a larger "common plan of development or sale" that totals one acre). The permit contains conditions to protect endangered species and historic properties and requires the owner and operator of the construction site to, among other things:

- Develop and implement a storm water pollution prevention plan (SWPPP);
- Post a visible public notice at the main entrance of the construction site (or if infeasible, at a local public building) containing confirmation of permit coverage and details on where the SWPPP may be viewed;
- As part of the SWPPP, develop a site map showing surface waters, disturbed areas, best management practices (BMPs), etc.;
- Have "qualified personnel" inspect all erosion and sediment control BMPs, maintain BMPs after storm events and keep records in the SWPPP of all inspections and maintenance performed;
- Control wastes, such as discarded building materials, concrete truck washout, and sanitary wastes; and
- File a Notice of Termination (NOT) form when the construction site is stabilized/revegetated.

The Municipal Separate Storm Sewer System General Permit (MS4GP) was issued by EPA on May 1, 2003. Small MS4 owners and operators in urbanized areas (based on 2000 census) in the following Souhegan Watershed municipalities are required to apply for coverage under the MS4GP: Amherst, Bedford, Merrimack, and Milford.

The MS4GP requires MS4 operators to develop a storm water management program that controls pollutants from all of the MS4 discharge points to the "Maximum Extent Practicable". The MS4GP requires that the storm water program include the six minimum control measures listed below as well as an annual report to EPA summarizing progress toward achieving specific measurable goals:

- Public education and outreach on storm water impacts;
- Public involvement/participation during program development;
- Illicit discharge detection and elimination;

- Construction site storm water runoff control;
- Post-construction storm water management in new development and redevelopment; and
- Pollution prevention/good housekeeping for municipal operations.

J. WATERSHED PROTECTION AUDITS

Research conducted by a wide range of scientists has conclusively demonstrated the link between urbanization and receiving water body health. These impacts of urbanization come from many sources, including alterations to natural hydrology, influxes of pollutants during both wet and dry weather, modifications to natural vegetation, and increased impervious cover. Based on these causes and sources of impacts, watershed practitioners have recognized the need to apply a wide array of techniques to help maintain or restore water body health. These techniques are referenced as the "Eight Tools of Watershed Protection" shown in Table 4-8[30]

Table 4-8: The Eight Tools of Watershed Protection

Watershed Protection Tool	Description
1. Watershed Planning	The application of regulatory measures and/or planning techniques that are designed to maintain or limit future impervious cover, redirect development where appropriate, and protect sensitive areas
2. Land Conservation	Programs or efforts to conserve undeveloped, sensitive areas or areas of particular historical or cultural value
3. Aquatic Buffers	The protection, restoration, creation, or reforestation of stream, wetland, and urban lake buffers
4.Better Site Design	Local ordinances and codes incorporate techniques to reduce impervious cover and/or redirect runoff onto pervious surfaces in the design of new development and redevelopment projects
5. Erosion and Sediment Control	The use of erosion control, sediment control, and dewatering practices at all new developments and redevelopment sites.
6. Stormwater management	The incorporation of structural practices into new development, redevelopment, or the existing landscape to help mitigate the impacts of stormwater runoff in receiving waters.
7. Non-Stormwater Discharges	Locating, quantifying, and controlling non-stormwater pollutant sources in the watershed. Operation and maintenance practices that prevent or reduce pollutants emerging entering the municipal or natural drainage system.
8. Watershed Stewardship Programs	Stormwater and watershed education or outreach programs targeted towards fostering human behavior that prevents or reduces pollution over a range of land uses and activities.

[30] Center for Watershed Protection. Do-It-Yourself Watershed Planning Kit.

To gain a better understanding of the status of watershed protection in the Corridor towns, The NRPC requested the Planning Boards or Planning staff to provide information for a watershed audit. The audit was developed by the Center for Watershed Protection and is based on the eight tools listed in Table 4-8. The audit aims to establish a baseline of current strategies and practices within each primary watershed community and identify which tools can be used to maximize protection of the watershed. By understanding the current state of development strategies and practices, strengths and weaknesses can be assessed and future efforts planned. This review is not a critique of past management efforts in the watershed. Instead, it is intended to provide a basis for future efforts in protecting and managing the Souhegan Watershed. In addition to the responses from the audits a review of pertinent sections of each community's Master Plans was conducted. The following is an overview of the major findings of the audits and the Master Plan reviews.

1. Watershed Planning

Most of the Master Plans for towns within the Souhegan Corridor refer to the Souhegan River as a community asset. The communities vary regarding the cycle they are in to update their Master Plans with plan dates ranging from 1985-2002.

The New Ipswich Master Plan, adopted in 2004 contains a chapter on conservation and preservation analysis. Regarding rivers, ponds, streams, and wetlands, the plan states that the Souhegan River has been a major factor in shaping the topography of the area as well as the growth and development of New Ipswich. The river is a source of power with a hydroelectric plant at the dam on Water Loom pond. The Souhegan also supports a variety of wildlife and provides opportunities for fishing, boating, and other water activities. New Ipswich is also fortunate in the number of brooks, streams and ponds that are evident in almost every section of the town, all providing source for recreation and enhancing the scenic quality of the area. A significant portion of land in the town is in wetlands, supporting wildlife and protecting the aquifer. The Master Plan highlights that the density of residential development around Pratt pond places it in serious jeopardy. The density of housing and the existence of ancient septic systems make water in the Center village especially vulnerable to contamination. According to the Master Plan, there is an immediate need to determine the magnitude of the problem, and that can only be done by an extensive water testing program.

The Greenville Master Plan of 1985 recommends the following land use, open space and recreation policies and objectives:

- Preserve, protect, and improve (where appropriate) the recreational and scenic resources of Greenville;
- Provide for the recognition, management, and protection of agricultural, forest, and water resources as vital to the proper development of land in Greenville;
- Control development in environmentally sensitive areas;
- Provide recreation, open space, and buffer areas for future growth, wile preserving natural resources, assets and attractions;
- Provide a means for purchasing land, receiving land as gifts, and other means of maintaining, preserving, and improving open space;
- Establish a plan and provide for open space in developing areas; and
- Encourage the preservation of open space through such means as the purchase of development rights, conservation easements, and restrictive covenants.

The Wilton Master Plan recommends reviewing the Town's existing watershed protection zoning ordinance to incorporate surface water setback, lot frontage, and other applicable performance standards.

It also recommends creating a surface water shoreline protection overlay zoning district that protects the shoreline vegetation

The Milford Master Plan recommends that the Milford Planning Board, the Water Commissioners, and the Conservation Commission develop, adopt and begin measures of implementing a Water Resources Management and Protection Plan, based on a watershed approach. The plan will incorporate recommendations for regulatory and education action necessary for long range protection water resources. Milford adopted a one year Interim Growth Management Ordinance in December 2004.

The Amherst Master Plan notes that The Souhegan River is the most significant water course in Amherst providing recreational opportunities and water for irrigation. Appropriate balancing of the continuing multiple uses of the Souhegan River and corridor must be provided. In order to meet these goals, objectives were identified:

1. Restore and protect water quality.
2. Protect water quantity.
3. Raise public appreciation awareness of the Souhegan River and its natural, historic, scenic, and recreational resources.
4. Provide and increase public access for use of the River.
5. Develop a greenbelt along the River shoreline.
6. Maintain a variety of habitats to promote a diversity of wildlife within the corridor and greenbelt.

The Amherst Master Plan states that water quality is also important since the Souhegan River is the premiere nursery habitat for the Atlantic Salmon Restoration Program with over 100,000 Atlantic salmon frye stocked annually. Even minor changes in temperature and dissolved oxygen can have a severe impact on fisheries and other aquatic species. Therefore it is important that shoreline vegetation be maintained. Additional recommendations include:

- Inform all residents within the Shorelands Protection Zone of regulations that apply to them - fertilizer usage, tree cutting, etc. (Zoning Office);
- Implement the standards of the Comprehensive Shorelands Protection Act (RSA 483-B) which became fully effective on July 1 1994, to protect and conserve the following qualifying public water bodies; Baboosic Lake, Little Baboosic Lake, Damon Pond, Joe English Pond, Lincoln Pond, Honey Pot Pond, Stump Pond, and the Souhegan River (Planning Board);
- Replace the High Intensity Soil Survey (HISS) standards in the Subdivision and Site Plan Regulations to require the use of the Site Specific Soil Standards for future applications (Planning Board);
- Amend the zoning ordinance to exclude parking lots from the woodland buffer zone (Planning Board); and
- Continue the role of advocate of quality environmental education programs (Conservation Commission, Recreation Commission, School Districts).

The Amherst Master Plan states that non-point pollution sources (NPSs) represent the greatest threat to surface and groundwater resources in Amherst. NPSs include landfills, hazardous waste sites, urban runoff, subsurface waste disposal, road salt, nutrients and pesticides from commercial, agricultural and residential sources. The NH Department of Environmental Services Water Supply and Pollution Control Division maintains and distributes an "All Sites Listing" comprised of several sub-lists including: the Groundwater Hazard Inventory, the Hazardous Waste Site Inventory, the list of large underground storage tanks, the list of lined and unlined landfills and dump sites, and a list of junkyards. As the information on this list is updated regularly, the Town of Amherst should obtain a copy of the list on a

regular basis. In addition, the Town should undertake all measures within its control to decrease the impacts of NPSs on surface and ground water. The Town's commitment to maintaining quality water resources is illustrated in the no salt/limited salt roads policy. In addition, the Town should continue to encourage the NH Department of Transportation to investigate options to its current road salting policy.

The Town of Merrimack updated its Master Plan in 2002. The development of the Plan was coordinated and overseen by a Committee of Town residents, board members, and Town staff known as the Merrimack Master Plan Advisory Committee. Early on in its deliberations, the Committee worked with a private planning consultant to develop a list of Strengths, Weaknesses, Opportunities, and Threats (SWOT) facing Merrimack in the future. The Committee also developed a preliminary list of recommended actions that can be taken to improve the quality of life in Merrimack.

Several of the strengths, weaknesses, opportunities, and threats discussed by the Committee, as well as recommended actions, concern the state of Merrimack's natural environment and open spaces. During the SWOT exercise, the Committee was divided into several groups, each developing their own list of strengths, weaknesses, opportunities, and threats facing Merrimack, as well as a list of recommended actions. Each group picked their top three items in each category, and these were then compiled into a composite listing representing the Committee as a whole. The results of the SWOT exercise can be related to Natural Resources shown below.

Strengths:
1). Two rivers – Merrimack & Souhegan
2). Rural character

Weaknesses:
1). Pollution (surface water bacterial contamination & "EPA" issues)

Opportunities:
1). Development of river/lake access
2). Development/acquisition of public space
3). Available land
4). Expansion of Town parks, riverfront areas, and activities for all areas


View of the Souhegan River

Threats:
1). Lack of land for community development
2). Water supply
3). Water situation (wells in other towns)

The Town should:
1). Pursue land acquisition
2). Protect, acquire, develop and purchase river and lakefront land
3). Pursue State and Federal funding
4). Define growth areas and regulate (i.e. Residential, industrial, open space)

Based on the SWOT analyses described above and the results of the 1998 survey, the Master Plan Advisory Committee placed a priority on the protection of and access to surface waters, particularly the Merrimack and Souhegan Rivers; protecting the Town's (subsurface) water supply; and the retention of open space through land acquisition, particularly in relation to surface waters.

The Natural Resources chapter of the Master Plan briefly examines Merrimack's surface water resources, with an emphasis on water quality, threats to water quality, and what can be done to safeguard and enhance water quality. In this endeavor, it has been discovered that a comprehensive watershed-based approach is the most effective in safeguarding water quality. Perhaps the most significant finding is the reclassification of Baboosic Lake from mesotrophic in 1993 to eutrophic in 1998. This is indicative of accelerated eutrophication due to increased nutrient loading as a result of increasing development in the watershed. Excess phosphorus is the nutrient most likely responsible for the recent decline in the lake's water quality. The phosphorus originates from geologic materials, atmospheric deposition, waterfowl waste, fertilizer runoff, and domestic septic systems. Water clarity has decreased due to algal blooms feeding on the high concentrations of phosphorus. Comprehensive planning and site design requirements are needed to reduce impervious surfaces, erosion, and maximize stormwater systems. Best management practices such as proper septic maintenance, reduced fertilizer application, and improved buffers around the lake should be encouraged.

2. Land Conservation

Most of the Corridor Towns reported participating in the National Flood Insurance Program (NFIP) and incorporating the NFIP standards into local regulations. Floodplains were reported to be mapped in Milford and Amherst.

Preservation of cultural or historical areas is encouraged. Amherst has a Historic District and a Heritage Commission. Milford encourages preservation through the Open Space Conservation District.

Preservation of agricultural areas is informally encouraged.

Critical habitat areas were reported to exist and are generally encouraged to be preserved.

Each town with the exception of Greenville has regulations or requirements, other than what is required by state and federal laws governing the preservation of wetlands during development.

Development restrictions on steep slopes were reported in most communities with the exception of Greenville. Restrictions are included in Cluster, Planned Residential Development (PRD), Open Space Districts and Soils Based Zoning. While New Ipswich has adopted development restrictions on steep slopes that apply to the entire town, other towns may only apply restrictions to specific areas or districts.

Conservation of forested areas is reported to be encouraged in each community with the exception of Greenville. Data from the NRPC parcel based GIS database indicates that for the portion of the watershed located within the towns of Merrimack, Amherst, Milford, Wilton, Mont Vernon, and Lyndeborough, 374 parcels representing 10,296 acres of land are classified as permanent open space. Most of the communities have recently acquired open space either with town owned funds or with a combination of town and state funding such as the LCHIP program.

Through the course of the Master Plan process in Merrimack, an emphasis was also placed on the conservation of larger forest tracts, primarily for the purposes of retaining the rural character of portions of the Town, providing for open space, passive recreation and for wildlife habitat.

3. Aquatic Buffers

A review of aquatic buffers for the corridor towns is provided in Table 4-9.

Table 4-9: Aquatic Buffers in Corridor Towns						
Aquatic Buffers	**New Ipswich**	**Greenville**	**Wilton**	**Milford**	**Amherst**	**Merrimack**
Stream buffers required?	Yes	No	Yes	Yes	Yes	Yes
Widths requirements	25′ buffer, 50′structure setback,100′ stream set back		Same as wetlands	25′ and 50′ as specified in zoning. Souhegan, tributaries and major water bodies in Souhegan Watershed-50′	No structures 50′ from wetlands, 25′ natural vegetated buffer. 100′ buffer from Public Water Supply wetlands. Souhegan – 100 feet.	25′ no cut (exceptions) 40′ building set back
Wetland buffers required?	No, but setback for structures is 50′	No	Yes, 50′ from delineated wetland	Yes, same as for stream buffers	Yes, 25′ undisturbed, 50′ building setback, specifically identified wetlands have 100′ buffer.	Yes,25′ no-cut buffer

Based on this information the required undisturbed natural buffer requirement for the Souhegan River in the corridor towns varies from none to 100 feet.

The Amherst Master Plan envisions a riparian buffer on both sides of the Souhegan River. The Plan recommends that the buffer extend at least 150 feet back from each bank and be managed for stream bank protection and runoff filtration. A riparian buffer should support a mix of plant species from ground cover to shrubs and trees. The mix is important if the buffer is to do the job of removing suspended sediment in surface runoff and chemical fixation of dissolved ions. Lawn grass beside the water is better than pavement but a mix of species is necessary to be most effective.

The plan also recommends that Town planning and the zoning ordinance should incorporate the concepts and objectives of the greenways section of the Master Plan.

The Milford Master Plan recommends to further refine and modify, if appropriate, the Wetlands Conservation District regulations in the Zoning Ordinance.

Such sources as the Shoreland Protection Act (RSA 483-B), Buffers for Wetlands and Surface Waters, A Guidebook for New Hampshire Municipalities, and Riparian Forest Buffers provide the latest knowledge and research relative to the function of wetland buffer areas. Milford's wetland buffer requirements should be reviewed to incorporate appropriate community supported buffer requirements.

Aquatic buffers for the watershed towns were limited and are shown in Table 4-10.

Table 4-10: Aquatic Buffers in Watershed Towns				
Aquatic buffers	**Temple**	**Lyndeborough**	**Mont Vernon**	**Bedford**
Stream buffers required?	No	No	No	No.
Wetland buffers required?	No	No	Yes, 25 feet	Yes, structures setback 50 feet from Hydric A&B soils

4. Better Site Design

All of the watershed towns have districts or targeted areas or activities listed in their zoning ordinances. Examples include:

Village
Rural
Conservation Overlay
Groundwater Protection
Excavation of Natural Materials
Cluster Development
Floodplain
Wetland Conservation
Aquifer Protection
Watershed
Open Space
Water Pollution Control
Drainage
Historic
Shoreland Protection
Agricultural
Mountain
Planned Residential Development
Nonbuildable

The largest aquifer in Amherst is located along the Souhegan River, extending from Milford to Merrimack and southward to Witches Brook. The Souhegan aquifer is the most significant deposit of stratified drift in the region. Three large wells currently withdraw water from this aquifer, the two Curtis wells in Milford withdraw a combined total of approximately 1 million gallons per day and the same amount is withdrawn from the Bon Terrain well by Pennichuck Water Works. Amherst's Aquifer Conservation District prohibits outdoor storage of road salt and dumping of snow containing de-icing materials; solid waste disposal sites; septage disposal sites, automotive repair shops, junkyards, and salvage operations; on-site storage of hazardous waste or toxic materials except temporarily as necessary in the ordinary course of business; residential underground hazardous fuel storage tanks; and filling/gas stations. The District also places special conditions on all uses in the district relative to septic systems, temporary storage of solid and liquid wastes, installation of monitoring wells for facilities utilizing or storing hazardous wastes, subsurface storage of petroleum products, use of pesticides, herbicides, fertilizers and other potentially dangerous leachables. Maximum impervious coverage in the District is 70 percent and stormwater drainage must be collected in catch basins or settling basins before leaving the site.

The Amherst Water Resource Management Update, October 1990, includes information on the water quality concerns found in Baboosic Lake. The NHDES prepared a hydrological study which was completed in 1986 which confirmed signs of accelerated eutrophication. Eutrophication is "excessive fertilization of surface water which manifests itself in the form of noxious growth of floating and attached algae and aquatic macrophytes". In lay terms, excessive nutrients provide a fertile environment that produces an overabundance of algae, which "rob" the lake of oxygen and destroy the lake's delicate ecological balance. The study determined that the eutrophication resulted from increased nutrients draining into the lake from the watershed and identified two factors contributing to the nutrient level: 1)

increased development in the watershed and 2) recent conversions of seasonal cottages to year-round use. The study found the biggest concern to be the concentrations of the nutrient phosphorus in the lake.

The Amherst Master Plan states that the Wetland Conservation District permits the following activities in wetlands: forestry/tree farming, agriculture, wells and well lines, wildlife refuges, parks and recreation uses suitable in wetlands, conservation areas and nature trails, open space and minimal impact crossings for roads and driveways. In addition, wetland areas can not be used to satisfy minimum lot size requirements, septic tanks and leachfields must be set back 75 feet from the edge of the wetland and no structures can be erected within 50 feet of the edge of the wetland.

The Master Plan recommends that with regard to wetland regulations, the Conservation Commission and the Planning Board should work together to evaluate the existing regulations and make recommendations for changes. One change would be to require a natural vegetative buffer be maintained within the 50 foot structure setback. Vegetated buffers decrease non-point source pollution by stabilizing the soil and preventing erosion, decreasing the velocity of runoff and removing nutrients from the runoff.

The Town of Merrimack is the only watershed town to have a Shoreland Protection District included in their Zoning Ordinance and Building Code. The public waters within the Souhegan watershed that are covered in this district are Baboosic Lake, Baboosic Brook, and the Souhegan River. The ordinance mirrors the standards and wording of the NH Comprehensive Shoreland Protection Act (CSPA). The Office of Energy and Planning has not certified the local ordinance. The CSPA allows primary building set back requirements to be less than the 50 feet required if a town has a set back requirement that is less stringent. The primary building set back in Merrimack is 40 feet. The no-cut zone is 25 feet, with exemptions allowed.

Milford draws most of its water from the Curtis Wells, located along the Souhegan River in Amherst, to serve local needs. The town of Milford adopted a Wellhead Protection Program in 1999. Which serves as a protection area is within the Souhegan corridor and is comprised of a 4000-foot buffer from the wells. This program is a multi-stage strategy designed to protect the Curtis Well field, Milford's primary source of municipal water. In 1993 the Curtis Well Head Protection area (WHPA) was delineated and the Potential Contaminant Sources (PCS's) were identified. A total of 29 PCS's were identified in the study area.

A health ordinance was adopted giving the Health Officer the authority to enforce the Best Management Practices recommended by the State of NH in 1999. Three of the seven steps contained in the Wellhead Protection Program are to distribute educational materials to all PCS businesses in the protection area and inform the PCS's of the upcoming inspection program, perform inventory inspections of all PCS's in the protection area and continue to educate the public on the importance of groundwater protection and what they can do to help. The program recognizes both point and non-point source contaminants. In addition to the education component, the program includes recommendations for the Planning Board to adopt new or amend the Town's existing land use regulations to include provisions for groundwater protection. Members of the community, including the Souhegan Watershed Association have participated in stenciling storm drains throughout the Town.

Many of the towns provide flexible site design criteria that utilize open space or cluster development. Only some of the towns require a minimum percentage of open space in a subdivision to be managed in a natural condition. Some towns specify allowable and unallowable uses for open space in subdivisions.

Most of the Corridor towns responses to the audit indicated that they used conservation easements and land acquisition program techniques to manage land use and impervious cover. Additionally, Milford reported limiting infrastructure (public sewer, water, or roads) extension and encouraging infill/community redevelopment. This technique consists of encouraging new development and redevelopment within existing developed areas.

The Milford Master Plan recommends incorporating Site Specific Mapping Standards for New Hampshire and Vermont into Milford subdivision and site plan regulations.

Site Specific Mapping Standards for soil delineation have been officially approved and adopted by the Society of Soil Scientists of Northern New England, and are replacing the high intensity soil standards commonly utilized in the past fifteen years.

5. Erosion and Sediment Control

One of the most important factors in watershed protection is requiring and enforcing adequate erosion and sediment control during construction. While some of the towns refer to state guidance, both Wilton and Milford have developed their own guidance documents. Milford specifically requires the preservation and non-disturbance of natural vegetation as well as the preservation and non-disturbance of stream or wetland buffers.

Erosion and sediment control plans are required during the site plan review process for most of the towns. Audit responses regarding inspections for compliance vary from none to sometimes to yes. Inspections appear to be conducted informally primarily by municipal inspectors or third party inspectors. Frequency of inspections varies with Milford reporting daily/weekly inspections by persons with on-site field knowledge of proper erosion and sediment control installation and field inspection training. None of the communities reported sponsoring erosion/sediment control training for developers, contractors, engineers or inspectors. Mont Vernon requires that site development can not begin until the soil erosion and sedimentation control plan is certified and control measures and facilities are installed and functional.

6. Stormwater Management Practices

Milford, Amherst, and Merrimack report stormwater management practices being required on new sites however, site plan regulations regarding stormwater are fully waivable by the Planning Board in Amherst. Milford and Amherst report using the peak discharge rate for a 25 year storm (flood control) treating stormwater runoff for water quality and controlling or reducing the total volume of runoff by means of infiltration practices, etc as design criteria for stormwater practices.

New Ipswich, Wilton and Milford have developed guidance or set forth requirements on the types of stormwater practices that may be constructed. The other towns refer to state guidance documents. All the towns except Greenville require a stormwater plan or other documentation during the site plan review process.

Inspection of stormwater practices is reported as not occurring or limited in most of the towns. Private owners were listed as responsible for maintenance of stormwater practices over the life of the practice, with Wilton and Merrimack reporting that the town is responsible for some residential practices. Maintenance agreements are generally not required with Milford stating they were sometimes required.

Amherst has formed a stormwater committee to address the numerous issues surrounding stormwater practices. The Stormwater II Committee was created by the selectmen to aid in local compliance with the Federal EPA NPDES Stormwater Program, Phase II. These are population density driven regulations,

therefore, they cover about half of Amherst as well as several individual town sites, such as the transfer station and the DPW garage. Any construction site over one acre in size is also affected by these regulations.

The committee is charged with the following tasks, which will be carried out over a five-year implementation period, beginning in 2004.

- Review existing ordinances and town regulations to determine how they may achieve some of the Phase II goals;
- Collect existing mapping information regarding storm water systems within the urbanized area;
- Identify public education and in-field projects for public participation to heighten awareness and assist in improving Stormwater quality;
- Participation with local officials and the public. Work with the Town regarding establishing a "Task Force";
- Develop a schedule to identify illicit discharges with inspections and sampling if necessary over the five-year program;
- Reviewing existing local regulations and make recommendations to ensure the Town has appropriate measures in place to comply with the Phase II program;
- Review any existing programs the Town may have in place with respect to review of Post-construction Stormwater management for new developments and redevelopments and review the feasibility of incorporating alternative design options; and
- Identification of Best Management Practices (BMP's) for Amherst's Department of Public Works.

The Milford Master Plan recommends the evaluation of Milford's land use regulations, and incorporate where necessary and appropriate (Zoning ordinance, Subdivision regulations, Site plan regulations), the latest recommendations for stormwater management Stormwater management has traditionally focused on storing and directing the volume of water expected in storm events of 25-, 50-, and 100-year magnitudes. Current thinking and regulatory trends also address treating the stormwater to improve the quality of the runoff before it enters either surface or groundwater.

7. Non-Stormwater Discharges

Results of the audit regarding non-stormwater discharges indicated the following:

- Most of the towns have a combination of storm sewers and open channels for their community's stormwater management system. New Ipswich did not report having storm sewers;

- While portions of Merrimack, Milford, Wilton and Greenville are served by municipal sewer systems, the majority of the watershed relies in subsurface waste disposal;

- Some of the communities reported having a spill response plan;

- Only Wilton reported having a program for illicit connection detection;

- All of the communities use sand and road salt (Sodium Chloride) for deicing roads, however Milford and Merrimack report using Calcium Chloride as a deicing alternative while Amherst has posted many "Limited Salt Use" signs on secondary roads. According to the Amherst Public Works department "The reasons for limiting salt use are obvious; it is costly and the mix can produce unwanted environmental side effects. The mess of sand residue in the spring, especially

at locations where the sand mix can wash into streams, requires extensive cleanup and removal work. Once removed dirty sand poses additional problems as it must be stored and used according to EPA regulations. The Town wants to avoid over-use of salt that can seep into water and soils. Since Amherst depends on local wells for its water supply, whether public or private, this consideration is important;

- In addition, street sweeping occurs in many of the towns with the exception of Amherst; and

- The use of fertilizers and pesticides was reported to be used on most of the public lands.

8. Watershed Stewardship Programs

The Conservation Commission internet web sites are the primary means that the communities administer environmental education or outreach programs.

- Milford has a Conservation Plan and Natural Resource Inventory and includes information on stormwater management on its web page;

- Amherst has an Open Space Advisory Committee and maintains the Peabody Mill Environmental Center. The Recreation Commission in Amherst is also a resource for planning and outreach; and

- The Heritage Commission in Merrimack maintains a web page that contains information on the Chamberlain Bridge, the first bridge across the Souhegan River. The Merrimack Village district sponsors various educational programs.

The Souhegan River Watershed Association (SWA) is actively involved in watershed outreach and education. The Association web page located at www.souhegan.org contains extensive information on the watershed. Stewardship activities in which SWA is involved include:


Hiking Trail along the Souhegan River

- Protecting conservation land throughout the watershed;
- Supporting the ongoing water quality monitoring project in the Souhegan and Merrimack Valley;
- Promoting the restoration of Atlantic Salmon;
- Sponsoring the Adopt A Salmon Family in schools within the Souhegan Watershed;
- Sponsoring river cleanups;
- Sponsoring recreational canoe trips;
- Promoting shoreland protection;
- Educating river landowners about the Shoreland Protection Act and the Rivers Management & Protection Program;
- Providing hiking trails throughout the river corridor;
- Protecting public access to the river;
- Fostering watershed education; and
- Working with other watershed and conservation associations.

The goals of the SWA are to protect the integrity of the river, to support the continued utilization of the Souhegan River for multiple uses, and to educate the public about environmental issues pertinent to the health of the Souhegan River.

The local newspaper, the Nashua Telegraph publishes the results of the SWA water quality monitoring and includes information on the general health of the river in its articles. Of particular interest to the public are the bacteria levels at the swimming holes.

K. FINDINGS AND CONCERNS

The Souhegan River Local Advisory Committee (SoRLAC) surveyed public officials within the corridor communities in 2005 about their perceptions, concerns, and opinions regarding the Souhegan River. The following were found to be the primary findings and concerns based on existing conditions, assessment of threats and opportunities, and the survey of public officials in the corridor communities:

- The Souhegan River is an important community resource that provides recreational opportunities including fishing, swimming, boating, bird watching, walking, picnicking, scenic views, and historic resources.

- The Souhegan River is an integral component of the downtown and urban centers in several corridor communities. Riverfront access, use, development, and redevelopment is a focal point. The river is part of the industrial heritage in parts of the Corridor communities.

- Top quality of life issues mentioned in responses to the SoRLAC survey for all of the Corridor communities include water quality, scenic values, fishing, open space, wildlife/waterfowl habitat, and water supply.

- Several hazardous waste disposal sites are located in close proximity to the Souhegan River. Remedial actions are ongoing at The Savage Well, OK Tools, and Fletcher Paint EPA Superfund sites in Milford and the N.H. Plating Company Superfund site in Merrimack.

- Water quality impairments and threats exist on the Souhegan River, tributaries, and other water bodies within the watershed. NHDES has categorized the Souhegan River in need of protection and restoration. Water quality concerns identified for the Souhegan River, major tributaries and water bodies in the watershed include bacteria problems, elevated levels of pH, aluminum, copper, chlorophyll-a, and low dissolved oxygen, and chloride. NHDES listed the suspected source of copper as municipal point source discharges. Elevated bacteria counts in Baboosic Lake are suspected to be from septic systems. Other sources of pollution are listed as unidentified.

- Water quality suffers cumulative effects of sediment and upstream non-point source pollution. Potential sources of pollution include stormwater runoff from impervious surfaces and erosion and sedimentation from land development and other land use activities. Sediment washed into the Souhegan River upstream may settle to the bottom in slow moving water and may not be completely removed.

- According to a recent US Environmental Protection Agency report the nation's aquatic resources are among its most valuable assets. Although environmental protection programs in the United States have improved water quality during the past several decades, many challenges remain. Of special concern are the problems in our urban streams, lakes, estuaries, aquifers, and other water

bodies caused by runoff that is inadequately controlled or treated. These problems include changes in flow, increased sedimentation, higher water temperature, lower dissolved oxygen, degradation of aquatic habitat structure, loss of fish and other aquatic populations, and decreased water quality due to increased levels of nutrients, metals, hydrocarbons, bacteria, and other constituents. The National Water Quality Inventory: 2000 Report to Congress identified urban runoff as one of the leading sources of water quality impairment in surface waters (USEPA, 2002b). Of the 11 pollution source categories listed in the report, "urban runoff/storm sewers" was ranked as the fourth leading source of impairment in rivers, third in lakes, and second in estuaries

- Results of the SoRLAC survey show that water quality and protecting fisheries habitat are very important to the corridor communities. The NHDES 1997 Souhegan River Watershed Report found that one of the most limiting factors in supporting an abundant and diverse fish population was stream bank erosion worsened by lack of adequate buffers. Improving habitat conditions was noted as important to the ecological health of the river.

- Local regulatory protection measures vary within the River Corridor communities. Structure setbacks for the Souhegan River itself range from no structure setbacks in Greenville, 50-foot structure setbacks in New Ipswich, Wilton, Milford and Amherst and a 40-foot structure setback in Merrimack. Structure setbacks under the NHDES Comprehensive Shoreland Protection Act (CSPA) are set at 50 feet.

- Protected wetland buffers specified under local ordinances for the Souhegan River range from none in Greenville, 25 feet in New Ipswich, and Merrimack, 50 feet in Wilton and Milford, and 100 feet in Amherst. Generally, impacts within the buffer are reviewed by the local Conservation Commission. Some of the communities specify standards in their local ordinances regarding removal of vegetation within the buffer. Merrimack specifies a 25 foot no-cut buffer with special exceptions allowed. New Ipswich specifies that within the buffer area not more than 50% of the basal area of trees or 50% of the number of saplings shall be removed for any purpose in a 20 year period. Uses allowed within the protected buffers vary in the local ordinances. For instance, in New Ipswich structure setbacks for wetlands and surface waters include but are not limited to parking lots, streets, and driveways.

- Inadequate or lack of vegetative buffers on aquatic resources within the watershed has the potential to contribute to water quality degradation, erosion and sedimentation, water temperature increases, lack of canopy cover, and wildlife and fish habitat impairments. Buffers can also provide pedestrian access along riverfronts and other water bodies.

- The results of the SoRLAC survey list the following measures that Town boards, public officials, and others surveyed believed are needed to protect the Souhegan River and its watershed:

    - Coordination of planning among watershed towns;
    - Limit shoreline development through land use zoning;
    - Stricter enforcement of local and state regulations related to wetlands; and
    - Stronger local regulations.

- Public access within the River Corridor was rated as very important or important to a majority of the respondents to the SoRLAC survey. Establishment of a River Corridor Trail is a priority for many of the Corridor communities. While Towns have established trails along the river,

coordinated work is needed to complete a continuous trail. Recreation abuses were noted by a majority of those surveyed as a concern along the Souhegan River.

- Education of landowners, communities, and within school programs was rated as the top three actions public officials and other surveyed stated were important in order to protect the Souhegan River and its watershed. The Souhegan Watershed Association, local Conservation Commissions, and other environmental organizations are vital education and outreach resources. Education and awareness raising of effective and comprehensive stormwater management practices and low impact development for local officials, the development community, and landowners will be needed to address water pollution within the watershed.

- Removal of the Merrimack Village Dam has been proposed by its owners, Pennichuck Water Works (PWW). Removal would open up a 14 mile stretch of the Souhegan to fish passage. A study was conducted by a consultant to PWW that outlines the benefits, concerns, and recommendations for additional actions. The Final Report of the dam removal feasibility study was completed in January 2005. Additional studies are ongoing. Addressing public concerns and accepting comments and recommendations from SoRLAC will be important steps prior to dam removal.

L. PRIORITY MANAGEMENT ISSUES

Based on the findings and concerns outlined above, the following are considered to be the priority management issues for the Souhegan River Corridor and Watershed:

1). Adoption of a watershed planning approach that protects, preserves, and restores valuable resources and avoids or minimizes negative impacts.

2). Encouragement of responsible public access to the Souhegan River by providing adequate parking, maintenance, signage, monitoring, trash removal, and enforcement of regulations.

3). Encouragement of land conservation within the watershed and promotion of awareness that one of the many benefits of open space includes the offset of the affects of urbanization on water resources.

4). Prevention of the loss of wetlands and associated uplands. Loss of wetlands, like the loss of riparian forests and floodplains, is known to have serious negative implications for biological diversity, water quality, and watershed hydrology.

5). Prevention of the development of floodplain lands. The building and paving on floodplains can lead to a critical loss of floodwater storage. Loss of flood storage has both economic and ecological consequences: increased flooding down stream and disturbance of the natural cycles of flooding.

6). Maintenance and restoration of vegetated buffers on the aquatic resources within the watershed.

7). Adoption of site design practices that protect aquatic resources. Promotion and utilization of low impact development techniques and standards.

8). Soil erosion prevention. Require, monitoring and enforcement of the use of Best Management

Practices (BMPs) for erosion and sediment control at new and redevelopment sites.

9). Require monitoring and enforcement of the use of water quality BMPs and technologies to help mitigate the impacts of stormwater runoff on receiving waters.

10). Prevention or minimization of non-stormwater discharges through the: identification and control of illicit discharges into the municipal or natural drainage system identification and prevention of private septic system failure, and the establishment and enforcement of set back requirements to prevent the release of pathogens, chemicals, and nutrients to surface water.

11). Promotion of watershed stewardship activities and programs. Increased funding levels to local watershed education and outreach groups through grant proposals and fundraising.

12). Continuance of funding and expansion of water quality and biological monitoring programs. Monitoring and data collection conducted by the Souhegan River Watershed Association and NHDES provide valuable information on the conditions and management issues within the watershed.

Adoption of the Souhegan River Watershed Management Plan by the Corridor communities as part of their Master Plans will be an important step in ultimately implementing the management strategies that have been outlined in the Plan. Implementation of the management strategies is envisioned to include both short term, mid term, and long term timeframes which can be modified and adapted over time. Partnerships and collaboration among the numerous stakeholders in the watershed will be the key to assuring success in protecting the vitality of the Souhegan River watershed. In this case, partnerships mean that the people most affected by management decisions are involved throughout the planning process and are an integral part of shaping key decisions.
It should be noted that the Management Plan represents the first step of a multi-stage process to protect the water resources in the Souhegan River watershed. As management activities are implemented and conditions change in the watershed, priority management issues will need to be changed and the plan will need to be amended to reflect these changes. As watersheds are in a constant state of change, so too should management plans reflect their ever-changing nature.

CHAPTER 5 TOOLBOX

A. WATERSHED PROTECTION TECHNIQUES

Communities across the nation have discovered that they must work at the watershed level to solve their diverse water resource problems. They have also found that no matter what watershed they are working in, the same eight basic management tools are needed to mitigate the impacts of development: watershed planning, land conservation, aquatic buffers, better site design, erosion control, stormwater treatment practices, control of non-stormwater discharges, and watershed stewardship (Center For Watershed Protection).

Some form of all eight tools is generally needed in a watershed to provide comprehensive watershed protection. However, the tools can be applied in different ways in each community.

1. Watershed Planning

Tackling water quality issues using a watershed perspective makes sense because water quality problems often result from small sources that cumulatively have a measurable; negative impact on the larger receiving waters. Good water quality is best protected by managing land practices in the watershed (NHDES Non-point Source Pollution BMPs. 2004). Watershed management is a comprehensive approach to protect and restore water resources through practices on the surrounding land to control storm water runoff. A watershed management project is a local, grass roots environmental effort to improve and protect the water quality and aquatic habitat within a watershed through cooperative efforts of local citizens, environmental groups, local and state agencies, and local businesses.

Identifying the land, aquatic resources and town boundaries within a watershed is an important first step in the management strategy. In basic terms, a watershed is the area of land that drains to a particular point along a stream. Topography is the key element affecting this area of land. The boundary of a watershed is defined by the highest elevations surrounding a stream. The two 40''x 30'' watershed maps provided in this plan are at a scale for display to the public, local officials and at public meetings. Showing watershed boundaries, including labeled water resources, land use, and water quality impairments is an excellent tool for watershed education and outreach. The Souhegan watershed is 220 square miles and includes land in 15 communities, including 2 located in Massachusetts. The watershed is large and diverse.

While the "Tools" that are outlined are applicable to all the watershed communities, the Implementation Strategies will focus on the major watershed towns that consist of river corridor communities and those communities with 50% or greater land area in the watershed. These nine communities are:

- Amherst;
- Bedford;
- Greenville;
- Lyndeborough;
- Merrimack;
- Milford;
- New Ipswich;
- Temple; and
- Wilton.

2. *Identification of Stakeholders*

Stakeholder and partnership involvement is key to implementing the Management Plan. The Souhegan River Local Advisory committee will play a key role in implementing the plan, together with the corridor communities, community involvement by Lyndeborough and Temple, other stakeholders and partners. Obviously the communities that the Souhegan River flows through are priority stakeholders. The Souhegan River Local Advisory Committee will be instrumental in implementing strategies in the corridor communities. Coalitions and partnerships will need to be formed with Lyndeborough and Temple. Other key stakeholders are:

- The Souhegan Watershed Association;
- Planning Boards;
- Zoning Boards of Adjustments;
- Conservation Commissions;
- Open Space and Trail Committees;
- Souhegan Land Trust;
- Department of Public Works;
- Stormwater II Committee;
- Local Businesses;
- Riverfront Land Owners;
- Interested Citizens;
- Recreational users including fishing, hiking, canoeing and kayaking, swimming;
- Schools;
- Environmental Centers (Peabody Mill);
- Agricultural land owners;
- Timber production industry;
- Nashua Regional Planning Commission; and
- Southwestern Regional Planning Commission (Temple, New Ipswich and Greenville).

Why a Watershed Approach?

Fortunately there are many resources available on the basic concepts of watershed protection and how communities can benefit from this approach. One resource is the Center for Watershed Protection (CWP). CWP is a non-profit corporation that provides local governments, activists, and watershed organizations with the technical tools for protecting streams, lakes and rivers. A useful tool that they have developed is a video on why a watershed approach makes sense from a local perspective (See the Center for Watershed Protection web site).

High levels of paved surfaces or impervious cover have many impacts on a watershed. Higher streamflows erode and eventually widen stream channels, dumping eroded sediments into downstream water bodies and enlarging floodplains. As flooding and flows increase in velocity due to increased imperviousness over the watershed, canals and structural channels with no or limited fish or other aquatic life replace rivers and streams. In areas where the floodplain have increase usually located downstream in developed watersheds, roads, bridges and other infrastructure, houses and businesses may be damaged as flood plains adjust to the increasingly intense and flashy flow regime (Comprehensive Environmental Inc. Spotlight Series: Stormwater and Low Impact Development. August 19, 2005).

Many streams and rivers including the Souhegan, draw from groundwater. Impervious surface can block water from recharging the groundwater supply. This can result in increase of peak runoff volumes;

lower stream flows in dry weather and higher stream temperatures because groundwater would previously enter the stream at low temperatures.

Imperviousness is a very useful indicator with which to measure the impacts of land development on aquatic systems. Imperviousness relates directly to specific changes in the hydrology, habitat structure, water quality and biodiversity of aquatic systems. This research conducted in many geographic areas, concentrating on many different variables, and employing widely different methods, has yielded a surprisingly similar conclusion: stream degradation occurs at relatively low levels of imperviousness. Most importantly, imperviousness is one of the few variables that can be explicitly quantified, managed and controlled at each stage of land development (Center for Watershed Protection). Studies on the specific amount of impervious cover within the Souhegan River Watershed have not been conducted. However, given the fact that the watershed includes some highly urbanized areas and that continued growth is expected it will be important to avoid, minimize or mitigate for impervious cover whenever possible.

Watershed Approach in Master Plan
Incorporating a watershed approach to protecting the Souhegan River is important to be included in each Town's Master Plan. The goal of managing land use and impervious cover to protect water resources is a key issue in the Master Plan process. While many of the communities refer to the Souhegan River as an important natural resource in their Master Plans, incorporating specific goals for protection of the River and its watershed is instrumental in updating or modifying zoning ordinances to meet these goals. Under a NH law passed in 2002 Master Plans may incorporate a natural resources section which identifies and inventories any critical or sensitive areas or resources, not only those in the local community, but also those shared with abutting communities. The natural resources section of every town Master Plan should be updated to include a local water resources management and protection plan as specified in RSA 4-C:22. In addition to the natural resource inventory, the Master Plan can include an open space or conservation plan. Together the natural resource inventory and a conservation plan are vital components to protecting the Souhegan River and its watershed.

3. Land Conservation

The goal of land conservation is to keep the most important and sensitive parts of the watershed undisturbed. Land conservation is best done at a subwatershed or town level. Sensitive land may include wetlands, habitat for rare and endangered species, important wildlife habitat, aquatic corridors, floodplains, steep slopes, shorelines, perennial, and intermittent streams.

Open Space Protection
Preserving contiguous parcels of wetlands and forested uplands is useful to mitigate the affects of urbanization. While each of the towns have protected open space, the concept of protecting the Souhegan watershed can be an additional component of their efforts. It will be important to include watershed planning concepts in each of the community's natural resource inventories, open space protection plans or other community initiatives to protect open space. Consideration of the importance of preserving large forest tracts and minimizing impervious cover to the Souhegan River and its watershed needs to be added as a criteria for prioritizing land for protection in each of the major watershed communities. Focusing grant request language on protection of the Souhegan River and its watershed may be useful to successful grant writing efforts.

Wetland Protection
While wetlands are protected at the state and federal level, local ordinances are an important tool to assure the goal of protecting wetlands at the town and watershed level. While much of the Souhegan watershed is undeveloped, the areas that were developed prior to the enactment of state or local wetland

regulations may have experienced wetland fill or destruction. Strong local enactment and enforcement of wetland protection regulations will be vital to avoid or minimize future wetland impacts within the watershed.

Designating Prime Wetlands is one route communities in NH may take to protect the most valuable wetland resources. No communities within the Souhegan watershed have designated prime wetlands. Wetlands can be designated as prime within the scope of RSA 483- A, and NH administrative code of Administrative Rules WT 700. The language states that communities may designate certain wetlands as prime due to their size, unspoiled character, fragile condition or other relevant factors, there making them of "substantial significance". Communities that have designated prime wetlands usually hire a consultant to map their wetlands and list the ones with the highest values as prime. Permitting for projects around and within designated prime wetlands requires additional review and consideration by both the local Conservation Commission and NHDES.

Identifying and mapping wetlands with high value and functions can be done as part of a community's natural resource inventory. Vernal pools are important resources to identify as part of an inventory.

Invasive species are a threat to wetlands as they alter native specie diversity in riparian zones. This can affect hydrological regimes and the functioning of ecological communities. Stream shading, increased erosion and flooding, alterations in nutrient cycling, declines in amphibian and bird populations, and overall loss of native biological diversity are among the documented effects of non-native invasive species in riparian habitats.

Town Conservation Commissions review and make recommendations to NHDES regarding impacts to wetlands and buffers and they are often the primary tool for protecting these resources.

The Souhegan River Local Advisory Committee(SoRLAC) reviews and comments on NHDES Dredge and Fill and Alteration of Terrain application for permits within a quarter mile of the Souhegan River. Sufficient documentation is important for both the Conservation Commissions and LAC reviews. The City of Nashua has developed an application and wetland protection plan form that is submitted as part of its review process. This form may be useful to other communities and can be found online at gonashua.com under the Conservation Commission.

Floodplain Protection

Floodplains are sensitive resources that are often protected by local zoning. Communities are required by the federal Emergency Management Agency (FEMA) to pass certain minimal zoning restrictions for floodplain development, in order to be eligible for the National Flood Insurance Program.


Keyes Flood

The FEMA program allows construction within sensitive floodplain areas if the structures are "floodproofed". Filling in or paving over floodplains decreases the peak flow capacity of a riverine system. The cumulative impacts of filling or paving, over time, can have a significant impact on downstream properties. Municipalities can adopt more stringent overlay zoning requirements than FEMA's to provide protection measures for floodplain areas. Floodplain ordinances can include setbacks and site specific data requirements that are similar to those found in wetland ordinances. Requirements for maximum or no increases in peak flood levels are often considered in floodplain zoning ordinances.

Many communities have chosen to adopt floodplain requirements in their zoning ordinances which are more stringent than the minimum required by the FEMA program. Most of the corridor communities have adopted floodplain zoning districts, and they are structured somewhat differently. The ordinances do not appear to prohibit development in these floodplain areas. However, any development requires special permits and must meet a number of requirements that are spelled out in detail in the ordinance. Requirements can include special provisions for sewer and water facilities, flood-proofing of buildings and the alteration or relocation of portions of a watercourse.

The purpose of local floodplain zoning ordinances that is more stringent than the minimum FEMA requirements is to adopt a resource protection oriented approach to regulating development in floodplains and to decrease the cumulative impacts of the disturbance of these sensitive areas on downstream property owners.

Steep Slopes Protection
Many of the corridor communities have adopted steep slope ordinances. Steep slopes are quite vulnerable to erosion and consequent sedimentation of watercourses, when exposed by disturbance of land and vegetation. For this reason, some communities prohibit the location of roads, structures and septic systems in areas with excessive slopes. Some communities have mapped areas with a slope of greater than a certain percentage, and consider these areas as an overlay district. Some simply specify, in the text of the ordinance, that land with greater than a certain percent slope cannot be built upon or used in calculations to fulfill minimum lot size requirements. All of the Corridor communities, with the exemption of Greenville have some level of development restrictions on steep slopes.

4. Aquatic Buffers

Wetland buffers
A recent paper, entitled Where Rivers are Born: The Scientific Imperative for Defending Small Streams and Wetland (Meyer et. Al. 2003), stated that "… if we are to continue to make progress toward clean water goals, we must continue to protect these small but crucial waters". The paper goes on to state that fishable swimmable goals of the Clean Water Act are not achieved without the careful protection of headwater stream systems. Moreover, the failure to protect small headwater streams can undermine expensive efforts to restore water quality down stream (Rhode Island rivers Council. Establishment of Riparian and shoreline Buffers and the Taxation of Property Included in buffers. January 15, 2005).

Protection of intermittent and perennial streams with local buffers is an important watershed management tool. Buffers for perennial and intermittent streams can be included in local wetland protection districts or ordinances. An intermittent stream is defined by DES as a stream that flows for sufficient time to develop and maintain a defined channel, but which might not flow during dry portions of the year. Unfortunately intermittent streams may not be delineated sufficiently on development plans, many be referred to as drainage ditches and not provided adequate protection. Redirecting intermittent streams can increase the likelihood of flooding due to cumulative affects and locating structures in close proximity to the edge of the stream. Directing untreated stormwater to either intermittent or perennial stream risks impairing these water bodies by pollution, sedimentation, and erosion.

As noted in the previous chapter the Souhegan watershed communities provide varied buffer protection to wetlands. The two methods available include wetland conservation overlay districts and stand alone ordinances. Amherst and Wilton have wetland conservation districts within their zoning ordinances. Buffers are provided within the district depending on the type of wetland. In Amherst, "water resource" wetlands require a 100-foot naturally vegetated buffer. In New Ipswich while wetlands require a 50 foot building set back, no specific vegetated buffer requirements are contained within the ordinance.

Merrimack requires a 25 foot no-disturb buffer around wetlands. While each watershed community may differ in its approach to protecting wetland buffers, the important point is to preserve an area at least 25 feet from the wetland from alteration and tree cutting. Vernal pools may require additional protection of 50 feet or more. Other zoning methods of resource protection are to specify that wetlands, very or poorly drained soils do not count toward minimum lot area or density requirements in any zoning districts. Some ordinances specify that poorly drained soils can only make up 25% of minimum lot sizes.

One problem that communities face is applications for special exception or variances for impacts to wetlands or buffers due to pre-existing nonconforming lots. Documented plans demonstrating how the applicant will develop the land without harmful impacts is important in these cases. The use of best management practices is also important.

Support from the Conservation Commission, Planning Board and Zoning Board of Adjustment and NHDES for strong enforcement of wetland and buffer protection is critical. Educating homeowners and businesses on the value of wetlands and what they can do to protect them is important. The dumping of yard waste and trimmings into wetlands can be a common occurrence that can damage the wetland system. Dumping of oils, gas or other toxic substances into storm drains connected to wetlands and surface waters is a source of pollution that many citizens are not alert to preventing.

Marking wetland buffers with plaques mounted on posts can be effective in reminding people where the buffer boundary is and avoiding encroachment violations. These plaques can be a requirement stipulated by the Conservation Commission or the Planning Board as part of the site plan or subdivision review process. A pamphlet providing specifications for markers and installation instructions is available on the Nashua conservation Commission web site. The Conservation commission designed and purchased the plaques which are then purchased by applicants for land use permits. The Conservation Commission, Department of Public Works or other town groups can install plaques on publicly owned land to both mark boundaries and to educate the public on the existence and restrictions associated with wetland buffers. There is less likelihood of violations such as dumping or tree clearing when the buffer boundary is clearly marked and people know the value of buffers as well as their responsibilities under local regulations.

Educational pamphlets on the purpose and benefits of wetland buffers and the responsibility of those abutting wetlands are a useful tool. These pamphlets can be made available at Conservation Commission, Zoning Board of Adjustment and Planning Board meetings as well as at Town Halls, libraries and other local spots. Towns, with the assistance of grants, can mail educational pamphlets to property owners who abut wetlands and have wetlands and buffers within their lots. Information on non-point pollution and how to maintain and protect buffers can be provided. A copy of the Nashua Wetland Buffer brochure can be found on-line at the Nashua Conservation Commission web site.

Restoring buffers on sites that have had previous development impacts such as paving or vegetation removal can be an important tool to improving site conditions. Proper removal of impervious surfaces in the buffer will help restore its functions. This can be done by recommendation by the Conservation Commission or as part of a requirement by the Planning Board. Grants may also be available for towns to restore buffers on town owned land. Buffers can be restored as part of road and street repairs or improvements as well. The use of native, non-invasive plants should be required as part of any vegetation plan.

Shoreland Buffers

Riparian[31] buffers along streams and rivers are the single most effective protection for our water resources. These strips of vegetation along the banks of rivers and streams filter out polluted runoff and provide a transition zone between water and human land use. Natural buffers are complex ecosystems that provide habitat and improve the stream communities they shelter. The multiple functions of buffers include[32]:

- Sediment Filter. Depending on the width of the buffer, 50-100% of the sediments and the nutrients attached to them can settle out and be absorbed as the buffer plants slow sediment laden runoff waters. Wider forested buffers are more effective than narrow, grassy buffers.
- Pollution filter, transformer and sink. A riparian buffer traps pollutants that could otherwise wash into surface and groundwater. Phosphorous and nitrogen from fertilizer and animal waste can become pollutants if more is applied than plants can use. Because excess phosphorous bonds to soil particles, 80-85% can be captured when sediment is filtered out of surface water runoff passing through the buffer. Chemical and biological activity in the soil, particularly of streamside forests, can capture and transform nitrogen and other pollutants into less harmful forms.
- Streamflow Regulator. By slowing the velocity of runoff, the riparian buffer allows water to better infiltrate the soil and recharge the groundwater supply. Groundwater will reach a stream or river at a much slower rate, and over a longer period of time than if it has entered the river as surface runoff. This helps control flooding and maintains stream flow during the driest time of the year.
- Bank stabilizer. Buffer vegetation helps to stabilize streambanks and reduce erosion. Roots hold bank soil together, and stems protect banks by deflecting the cutting action of waves, ice, and storm runoff.
- Bed stabilizer. Buffers can also reduce the amount of streambed scour by absorbing surface water runoff and slowing water velocity. When plant cover is removed, more surface water reaches the stream, causing the river to crest higher during storms or snowmelt. Stronger flow can scour streambeds, and disturb aquatic life.
- Wildlife habitat. The distinctive habitat offered by riparian buffers is home to a multitude of plant and animal species, including those rarely found outside this narrow band of land influenced by the river. Continuous stretches of riparian buffer also serve as wildlife travel corridors.
- Aquatic habitat. Forested riparian buffers benefit aquatic habitat by improving the quality of nearby waters through shading, filtering, and moderating streamflow. Shade in summer maintains cooler, more even water temperatures, especially on smaller streams. Cooler water holds more oxygen and reduces stress on fish and other aquatic creatures. A few degrees difference in temperature can have a major effect in their survival. Woody debris feeds the aquatic food web. It also can create stepped pools, providing cover for fish and their food supply while reducing erosion by slowing flow.
- Recreation and aesthetics. Forested buffers are especially valuable in providing a green screen along waterways, blocking views of nearby development, and allowing privacy for riverfront landowners. Buffers can also provide recreational opportunities such as hiking trails and camping.

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[31] Riparian: Relating to the zone along rivers and streams. Riparian can also include the zone along lakes and ponds.
[32] Riparian Buffers for the Connecticut River Watershed, prepared by the Connecticut River Joint Commissions of NH and VT.

Riparian buffers offer economic benefits such as increased property values. Properties near healthy, protected streams are valued more than properties located farther away or near unhealthy, aesthetically unpleasant waterways. Buffers protect water quality, which has immense economic value. By keeping sediment out of rivers, for example, buffers may reduce the expenses of drinking water treatment plants. Clean streams and rivers are also valuable for recreation and tourism and are vital factors in attracting new businesses and residents. Finally, protecting streams with buffers is a low-cost way to enhance the survival of endangered aquatic species. In short, riparian buffers are not only essential tools for environmental protection, they are also important factors in the long-term economic health of a community.

The Rhode Island Rivers Report of 2005[33] stated that the Clean Water Act goal that all waters should be fishable and swimmable is not achievable in Rhode Island's waters without the careful protection of riparian buffers.[34] The Rivers Council Report recommends that a high priority should be given to identifying and mapping small headwater streams and their riparian buffers. These areas can be more effectively protected by state and community regulations once they are identified.

The Comprehensive Shoreland Protection Act (CSPA) states that the shorelands of the state are among its most valuable and fragile natural resources and their protection is essential to maintain the integrity of public waters. The Act does not contain its own separate permit requirement. Shoreland on the Souhegan River and three tributaries are protected under the NHDES CSPA. Chapter 483-B of the Act specifies that State and local permits for work within the protected shorelands shall be issued only when consistent with the policies of the CPSA.

Water bodies covered under CSPA in the Souhegan watershed include all fourth order or higher streams. Fourth order or higher streams within the Souhegan watershed include the Souhegan River, Stony Brook, Baboosic Brook and McQuade Brook. Chapter 483-B of the CSPA requires that where existing, a natural woodland buffer shall be maintained within 150 feet of the reference line with certain exceptions. Not more than a maximum of 50 percent of the basal area of trees, and a maximum of 50 percent of the total number of saplings shall be removed for any purpose in a 20-year period. A healthy, well-distributed stand of trees, saplings, shrubs, ground cover, and their living, undamaged root systems shall be left in place. Towns can issue cease and desist orders to those violating the provisions of the CSPA and request assistance from DES in enforcement actions.

Buffer Width

There is not one generic buffer size which will keep the water clean, stabilize the bank, protect fish and wildlife, and satisfy human demands on the land. The minimum acceptable width is one that provides acceptable levels of all needed benefits at an acceptable cost for a particular site. The basic bare-bones buffer is generally 50 feet from the top of the bank. Topographic features including but not limited to grade of slope may affect buffer values and functions. To filter dissolved nutrients and pesticides from runoff a width of up to 100' or more may be necessary on steeper slopes and less permeable soils to allow runoff to soak in sufficiently, and for vegetation and microbes to work on nutrients and pesticides. For cold water fisheries, the stream channel should be shaded completely. Studies show that that at least up to 100', the wider the buffer, the healthier the aquatic food web. To protect against flood damage a smaller stream may require only a narrow width of trees or shrubs; a larger stream or river may require a

[33] Rhode Island Rivers Council. Findings and Recommendations. A Report to the Governor, President of the Senate and Speaker of the House. January 15, 2005.

[34] Federal Water Pollution control Act, Declaration of Goals and Policies Sec. 101 (a) (2) " it is the national goal that wherever attainable, an interim goal of water quality which provides for the protection and propagation of fish, shellfish, and wildlife and provides for recreation in and on the water be achieved by July 1, 1983."

buffer that covers a substantial portion of its flood plain. Structures within the floodplain are not recommended. A 100' buffer will generally remove 60% or more of pollutants, depending on local conditions. It will also provide food, cover and breeding habitat for many kinds of wildlife but only fulfill a few needs for others, such as travel cover (Connecticut River Joint Council Report).

Local Shoreland Ordinances
Chapter 483-B: 8 of the CSPA specify that municipalities may adopt local land use control ordinances relative to all protected shorelands which are more stringent than the minimum CPSA standards. The CSPA goes on to state that municipalities are encouraged to adopt land use control ordinances for the shorelands of water bodies and water courses. Shorelands of local lakes, ponds and streams can be covered by a local shoreland protection overlay district. This local protection could extend to third order streams or other streams determined to be of significant value to the community. Standards under local shoreland ordinances for removal of vegetation within the protected shoreland could be more stringent than what is required under the CSPA. Strong enforcement of a local shoreland ordinance is an extremely important tool.

The use of local zoning can be an effective tool to protect water quality. Regulating land use practices and providing standards for removal of vegetation near streams can significantly reduce the runoff of sediment and other pollutants into water bodies. Conventional zoning, which divides a town into zoning districts and establishes use and dimensional regulations for each district, can actually contribute to the problem of non-point pollution by ignoring the impacts of nearby development. For example, if a lot has a stream running through the rear yard, a large minimum set-back (required under the zoning district regulations) might force a building to be located very close to that stream, resulting in possible degradation to its water quality. By creating a system of "overlay zones" that cross conventional zoning district boundaries and protect stream corridors, lakeshores, and watershed, it is possible to maintain and improve the water quality-even as the community becomes more developed.

In urban riverfront areas, existing development often encroaches directly on the waterfront, leaving little or no vegetated buffer. Incentives and flexible alternatives should be developed to encourage restoration of riparian vegetation during redevelopment of urban parcels. As this redevelopment occurs, requirements to restore riparian buffers together with flexible regulations to ensure that productive use of the land is not restricted will be important.

Examples of several local ordinances are included as guidelines:

- The town of Amherst has enacted a Watershed Protection District. The District includes but is not limited to, all lands within one hundred (100) feet of bodies of water, perennial streams, or intermittent streams. An intermittent stream is defined as one that flows within well-defined streambeds during wet periods. No septic systems and no building shall be constructed with the Watershed Protection District. Permitted uses in the District include miscellaneous trimming, pruning, and thinning according to good forestry practices, Tree Farming, timbering and forestry according to practices approved by the county forester, wildlife refuge, wharves, boat houses, footbridges or similar structures normally associated with use in or near water.

- Sunapee NH has enacted a Shoreline Overlay District that encompasses all lands within 300 feet of lakes and ponds greater than 10 acres. While this particular ordinance does not cover rivers, the standards for cutting and removal of vegetation within the natural woodland buffer are more stringent than state standards under the CSPA. The ordinance requires a cutting and clearing plan subject to approval of the Planning Board.

The Deering Lake Watershed Protection ordinance covers Deering Lake also known as Deering Reservoir, the Deering Lake watershed and the water bodies within the watershed Protection Overlay Zone. Review requirements are stringent. The Planning Board is directed to ensure the following- (1) non-point source pollution is prevented to the maximum extent possible, (2)Best Management Practices (BMPs) are in place sufficiently to remove or neutralize those pollutants that present a potential impact to the water body, (3) grading and removal of vegetation at a development site is minimized and erosion and sediment control measures are in place and properly installed,(4) all septic tanks will be pumped and inspected by a State of NH licensed septic services provider to ensure proper functioning and copy of the pumping and inspection report sent to the Town Planning and Zoning Administer, (5) spill prevention control and countermeasures plan required for activities with contamination risk. Buffer requirements specify an absolute minimum 50 feet after a study demonstrates that water quality will be protected.

5. Better Site Design

To better protect the Souhegan Watershed the goal should be to protect water resources by directing development away from them. Important resources include streams and rivers, wetlands, groundwater recharge areas, well head areas, critical habitats, agricultural, and forestry resources. The companion goal is to increase density of development in areas of minimum impact to resources and the community.

The objectives of better site design are to (1) reduce or control overall impervious cover on the site, (2) preserve and enhance existing natural areas, (3) integrate stormwater management, and (4) retain a marketable product. Specific environmental benefits to better site design are:

- Protection of sensitive forests, wetlands, and habitats from clearing;
- Preservation of urban wildlife habitat;
- Protection of water quality of local streams, lakes and ponds;
- Reduction and management of stormwater pollutants; and
- Reduction of soil erosion both during and after construction.

Tools to work toward these goals include: residential cluster or conservation subdivision design, better site design of roadways and parking areas, subdivision regulations, site plan review, non-residential site plan regulations, health ordinances and low impact design (LID) methods.

Low Impact Development (LID) is a process of minimizing the environmental impacts while developing the land that can be incorporated into each phase of the development process. Its focus is on:

- Preserving the hydrological cycle;
- Focusing on site specific solutions;
- Protecting natural resources;
- Viewing rain/stormwater as an asset; and
- Keeping stormwater on site.

Methods of Low impact development will be discussed in more detail in the Stormwater section.

Lot Development

Each of the corridor communities permits open space or cluster development designs. Large lot zoning was established to preserve "rural character" or as a means to minimize population density, has however, absorbed land at an accelerated rate. Such "large lot" development has created poor economy of layout, in convenience of access to town roads decreased visual quality, or permanent preservation of rapidly diminishing open space.

With expectations of higher development quality and more responsibility placed on land use decision-makers, the need to utilize more efficient methods of developing land is being recognized. Clusters of residential development, where appropriate, provide a way to preserve open space by accommodating growth and at the same time preserving the open rural appearance of a community. This process encourages the concentration of groupings of buildings on those areas of a site which are best suited for development, while requiring the remaining land be retained as common open space to maintain the natural character of the land.

Cluster development allows lots that are smaller than those specified within the zoning ordinance, provided that the land saved is devoted to permanent open space. The number of lots or "density" permitted throughout the subdivision remains essentially the same as in a conventional subdivision. The use of clustering can be limited to a particular zoning district, to areas served by public sewer, or to areas where the presence of certain soils and slope conditions will allow a more intensive use of the land.

Cluster development is authorized by the zoning ordinance and implemented through the subdivision regulations. A cluster development provision should be adopted as an amendment to the municipality's zoning ordinance since such a provision will place controls upon lot size, frontage, density and other characteristics. The zoning ordinance should reference the subdivision regulations and should state that a proposal submitted to the planning board should comply with the applicable provisions of the subdivision regulations. Where there is a conflict, the more stringent provisions of the cluster development ordinance take precedence.

A cluster ordinance should clearly articulate the purpose of the cluster provision and establish the minimum standards required. These standards may relate to basic requirements such as density, setbacks, perimeter buffers, road requirements and the amount of open space to be left in common ownership. The ordinance should also address the legal mechanism by which the open space will be permanently protected. It should also be noted that the municipality's master plan should present the community's goal for open space preservation and should delineate area of unique ecological or scenic value. This provides the basis for the zoning ordinance requirements for open space and conservation of significant natural features.

Street Design

Street design, layout and width can add considerably to the impervious cover in a watershed. The goal, as outlined by the Center for Watershed Protection to minimize imperviousness by reducing the total area of paved surfaces recommends a minimum pavement width allowed for streets in low destiny residential developments that have less than 500 average daily trips (ADT) is 18-22 feet. Both New Ipswich and Wilton indicated that this minimum is allowed. In addition to width the goal for the design of streets is to adopt standards to promote efficient layout with minimum length. The goal for Right of Ways is less than 45 feet for residential. None of the corridor communities reported minimum ROW widths of less than 45 feet. The goal for cul-de-sacs is less than 35' radius or hammerhead. All of the corridor communities reported minimums of greater than 45 feet. Hammerheads are allowed in Milford and Amherst.

Pervious materials can be used for spillover parking areas in all the corridor towns except Greenville. Permeable paving has been demonstrated by the UNH Center for Stormwater to be effective in promoting recharge of stormwater on site. Educating citizens, public officials and the development community on the benefits of limiting impervious cover through better site design will be important to minimize the impact of development on water resources.

Subdivision Regulations
Subdivision regulations can play a significant role in protecting water resources. Subdivision regulations set forth design and engineering standards and construction practices for proposed projects. Project plans must meet these standards in order to gain subdivision plan approval. When subdivision regulations are developed with water resources in mind, these regulations can promote better stormwater drainage and runoff control, environmentally sensitive sewage disposal, and promote designs which implement erosion and sedimentation controls. For example, subdivision regulations can limit septic system siting and use in areas with poorly drained soil; others may require preservation of open space as part of new development projects. Subdivision regulations may also reduce the amount of impervious cover, or provide guidelines for management of stormwater runoff. These regulations may, for example, require that post development groundwater recharge be equal to pre-development recharge.

Site Plan Review
The purpose of the site plan review process is to promote development which is compatible with a community's character and infrastructure. The site plan review process focuses on ensuring that environmental factors such as pollution, noise, and odor are addressed, that natural features are protected, solid waste and waste water disposal are well-managed, and sediment and erosion control is incorporated into development projects. The site plan review process can serve as a vehicle for better protecting water quality if it encourages designs which maintain the hydrological cycle and/or promote techniques to better manage stormwater.

Health Ordinances
RSA 147:1, I authorizes local health officers to make regulations (or ordinances) that in their judgment are required for the health and safety of the people (NH DES, 1995). Protection of public drinking water supplies clearly falls within this broad grant of power. A health ordinance is typically relatively easy to adopt. It takes effect after it is approved by a municipality's Board of Selectmen, recorded by the town clerk, and published in a newspaper of general circulation in the town, or when copies have been posted in two or more public places in town (NH DES, 1995).

Landscaping Methods
Educating homeowners and businesses on landscaping options that reduce impacts to water resources is a key tool. Studies have shown that a lack of sufficient loam on lawns requires more water and more chemicals in order to maintain their appearance. Some communities now require a minimum of loam to remain on all sites. Minimizing clearing and reducing water usage are important educational components of protecting the watershed. Use of plants that require less water is encouraged. Integrated Pest Management (IPM) programs can offer practical and cost effective solutions.

Non-Residential Site Plan Review
Wilton, Amherst and Merrimack have adopted non residential site plan regulations. The Nashua Regional Planning Commission has prepared Model Non-Residential Site Plan Regulations. The goal was to ensure new non-residential and multi family developments meet high standards for design and environmental protection. The model regulations incorporate the latest State of New Hampshire requirements of the site plan review process and incorporate best management practices in site design for urban, suburban and rural communities. The model site plan regulations are intended to be an educational tool and resource for Planning Boards and communities to use as an aid in developing their own site plan regulations. The model recommends water resource standards including stormwater management and erosion control plan requirements, groundwater protection and impervious surfaces.

6. Erosion and Sediment Control

Erosion and sediment control is closely associated with proper stormwater management. This section will focus on riverbank erosion and sedimentation. Erosion and sedimentation as it relates to stormwater will be covered later.

Riverbank erosion and subsequent siltation can negatively impact aquatic life habitat and impair the water quality of streams. Prioritizing erosion sites for restoration and avoiding development or other activities that cause erosion is needed. The 1999 Souhegan River Shoreline survey observed several areas where riverbank erosion was occurring.

Riverbank erosion can be the result of the river's natural tendency to scour and deposit sediments as it flows through the landscape. Seasonal flooding and the abrasion of ice as it breaks up in the spring inevitably chew at the river's banks. People who remove tress and their stumps are surprised when chunks of their land later fall in and wash away.

The traditional remedy for riverbank erosion has been to "armor" the bank with boulders, concrete walls, or riprap. These solid materials have not always withstood the river, and have often have been found to accelerate the passing waters to create greater erosion damage at sites downstream. In recent years, there has been a growing desire on the part of state and federal agencies, scientists, citizen organizations, and landowners to gain a greater understanding of natural river processes, identify ways to reduce the human factors that lead to more erosion, and find more river friendly ways to restore eroded riverbanks.

As an aid to public understanding, the Connecticut River Joint Commissions published a series of fact sheets, The Challenge of Erosion in the Connecticut River Valley, which includes new state of the art stabilizing techniques. These fact sheets provide an overview of river dynamics, the role of riparian buffers, the pluses and minuses of various streambank stabilization techniques, a field assessment work sheet, and how to obtain a permit for work along the riverbank. NHDES grants may be available to inventory erosion sites.

The Connecticut River Joint Commissions recommends a cautious approach that emphasizes a number of issues:

- Scour and deposition of sediments is a natural process common to all rivers, which must be respected;
- The river's dynamic characteristics at individual sites must be evaluated in order to determine whether erosion is "natural" at the site, and therefore cannot be overcome;
- Expenditure of public funds to restore eroded sites should only be done at feasible sites, and those offering distinct potential public benefits in terms of improving water quality, enhancing fish and wildlife habitat, protecting public infrastructure or lands, safeguarding valuable agricultural soils, or preserving historic or archeological sites; and
- Landowner support and cooperation is an essential element for any restoration.

The Connecticut River Joint Commissions developed a system of evaluating and ranking potential restoration sites that is available at www.crjc.org. Wherever possible, the restoration designers are turning entirely to bioengineering as a better more river friendly way to protect against erosion, reinforce soils, develop a root network, and maintain or improve wildlife habitat. Vegetation stabilization is often the tool of choice for stabilization.

Five restoration grant projects funded by the NHDES Watershed Assistance Section are utilizing geomorphic stream measurements as a primary tool for determining appropriate methods of restoring channel stability and aquatic habitats. These projects are utilizing geomorphic stream measurements that eliminate guess work and provide an objective way of assessing stream characteristics and conditions that identify the causes of channel instability. These projects will also demonstrate that addressing river-related problems yields greater benefits when compared to treating symptoms with costly, bank armoring techniques.

7. Stormwater Management

Stormwater runoff is probably the primary threat to the Souhegan River Watershed. As the watershed is developed we see increased peak flows, increased runoff volumes, and negative water quality impacts. The impact on waterways includes:

- **Degradation of Stream Channels**
  - Stream Widening
  - Streambank and Channel Erosion
  - Decline in Stream Substrate Quality
  - Degradation of Stream Habitat
  - Decline in Aquatic Diversity
  - Degradation of Aquatic Diversity
- **Increase Overbank Flooding**
- **Floodplain Expansion**

Years of water quality monitoring by the Souhegan Watershed Association has clearly documented significant increases in bacteria counts following rainstorm events. There is no doubt that if a community feels its surface waters are not "clean" their level of recreational participation in and around those areas will be diminished.

NHDES Alteration of Terrain Permit-
Site excavation and road construction activities are governed by RSA 485-A:17, known as the Alteration of Terrain Program. An Alteration of Terrain permit (AoT) is required from NHDES for disturbance of contiguous land area of greater than 50,000 square feet in areas subject to RSA 483-B (Comprehensive Shoreland Protection Act) or greater than 100,000 square feet in all other areas. Permits typically contain erosion control provisions, which include requirements for installation of BMP's such as stormwater ponds, treatment swales, vegetated buffer strips and infiltration practices. The permit involves both temporary erosion control measures during construction and permanent controls for stormwater following constructions. Temporary practices used during construction may include silt fences, hay bales, temporary check dams. On projects located within 1/4 mile of a designated river as defined by RSA 483, the local rivers advisory (LAC) committee may provide comment. Town comments are also solicited.

EPA and Stormwater
Construction sites (including road construction areas) that disturb one or more acres must obtain a NPDES permit under the Phase II stormwater regulations. The federal permit requires pollution prevention plans to reduce pollution at construction sites. The components of pollution prevention plans are similar to Best Management Practices (BMP's) required by the NHDES Alteration of Terrain Permit Program.

Phase II of the EPA stormwater program requires many small urbanized areas to develop a stormwater program to include construction site runoff control and post construction storm water management at

new and redevelopment sites. Regulations to meet EPA Phase II must be adopted by municipalities by May 2008. To do this, the program should ensure that Best Management Practices (BMP's) are used:

Best Management Practices (BMP's)

Best management practices fall into three general categories:

- Non-structural
- Structural
- Source control

Non-Structural BMP's generally consist of:

- Behavior modification
- Phosphate Ban
- Zoning
- Better Site Planning
- Limit Impervious Surface
- Low Impact Development

Nonstructural approaches to source controls and pollution prevention consist of:

- Street and parking lot sweeping
- Pollution Prevention Plans
- Catch Basin Cleaning
- Snow and Snowmelt Management
- Local Ordinances and Regulations
- Public Education

Structural BMP's generally consist of:

- Retention/Detention (Wet Ponds/Dry Ponds)
- Created wetlands
- Infiltration
- Filtration
- Bioretention/Biofilters
- Low Impact Development(LID)
- "Proprietary" or "Manufactured" devices

Examples of Structural BMP's that attempt to address water quality issues are outlined in the NHDES publication- Innovative Stormwater Treatment Technologies. Best Management Practices Manual, May 2002.

The appropriate use of Best Management Practices (BMP's) that fit site conditions and provide for adequate monitoring and inspection are very important tools to protecting water resources, If water quality impacts are considered from the beginning stages of a project, new development and redevelopment provide opportunities for water quality protection. BMP's should be appropriate for the local community, minimize water quality impacts, and attempt to maintain or restore proper predevelopment runoff conditions. In choosing appropriate BMP's towns are encouraged to participate in locally based watershed planning efforts and attempt to involve a diverse group of shareholders including interested citizens.

BMP' should be noted on a "plan". Non-structural BMP's should include weekly inspections during construction and after a storm event. A pre-construction meeting between the town engineer and the owner to go over requirements and responsibilities is important. Phasing and sequencing are important tools to manage stormwater. The Erosion and Sediment Control Plan needs to be installed early in the process. Limiting the disturbed area and making sure seeding is done during the growing season is vital.

The goal of minimizing disturbance on a site aims to preserve natural vegetation and to develop a design that minimizes impervious cover. Development plans that reduce impacts and preserve the natural hydrology of a site should be encouraged.

Standard BMP's fall into the following four categories:

- Perimeter Protection
- Stabilized Construction Entrance(s)
- Sediment Traps
- Diversions- keep clean water off site

Proper installation and maintenance of BMP's is especially important near critical areas and steep slopes. Altered flow patterns can stress a previously effective BMP and cause it to fail. BMP's only work if they are maintained after every storm. It is imperative to have someone get out into the field during construction activity to adequately judge the potential effectiveness of BMP's submitted with plans.

Post- construction BMP's that require post-development flows to be equal to predevelopment flows can be important tools in stormwater management. Treatment requirements are also needed to address pollutant loadings. Infiltration practices and Low Impact Development (LID) is geared toward protecting the hydrologic cycle that is normally badly damaged during development. LID can be applied to existing development by retrofitting existing paved or otherwise impervious sites with infiltration or storage units. Dispersed units can be better than single end of pipe treatment devises since they come closer to replicating the natural hydrology of the site.
Tools for communities to move toward better management of stormwater include:

- Revise existing development controls through subdivision and site plan review upgrades to promote retaining runoff on each site. Including standards for treating stormwater are necessary components;
- Minimize site disturbance through clustering and other methods and stake out clearing limits and stockpiles;
- Review engineering calculations for pre and post runoff assumptions;
- Adopt guidance and design criteria;
- Set good examples on municipally owned properties. Keep parking areas, outdoor storage areas, and streets clean of debris. Street sweeping can be used to remove sediment, debris and trash from streets and parking areas. Clean out catch basins and other flow control devises regularly;
- Conduct preconstruction meetings with owners and contractors to review stormwater plans and BMP's. Create milestone and inspection list;
- Town Engineer or representative conducts inspections regularly; and
- Penalty provisions for noncompliance with design, construction or operation and maintenance.

Stormwater structural BMP's are constantly being improved and a community needs to be responsive to these changes, developments or improvements in control technologies. The UNH Stormwater Center is a useful resource to learn how effective the technologies are at treating stormwater. Their demonstration

project provides useful and practical information to consider in permitting treatment options for stormwater. Publications with helpful information for municipalities include:

- NHDES Publications such as "Innovative Stormwater Treatment Technologies. Best Management Practices Manual";
- Stormwater Management and Erosion and Sediment Control Handbook;
- Non-point Source Pollution: A Guide for Citizens and Town Officials;
- Erosion Control Magazine-www.erosioncontrol.com;
- Stormwater Magazine- www.stormhro.com;
- UNH Stormwater Center- www.unh.edu/erg/cstev; and
- Comprehensive Environmental Inc. Stormwater Technical Design Criteria. June 2005. www.ceiengineers.com.

8. Non-Stormwater Discharges

The NHDES publication Best Management Practices to Control Non-point Source Pollution, A Guide for Citizens and Town Officials, January 2004, has comprehensive information on practices to protect water resources from pollution. NHDES lists urban and suburban land uses, construction, forestry, septic systems, recreational boating, agriculture, and physical changes to the stream channels as potential sources of NPS pollution. Best management practices by land use/activity are recommended. Included are suggested practices for septic systems, golf courses, site excavation, road construction and other common land use activities.

Illicit discharge detection and elimination is one of the best management practice tools required under the EPA NPDES General Permit for Stormwater Discharges from small municipal separate storm sewer systems (MS4). All outfalls must be mapped and inspected by May 2008. NHDES has been active in identifying outfalls and conducting samples of dry weather discharges in some of the larger communities in NH, including some along the Souhegan River. Activities beyond sampling include attempting to trace sources of illicit discharges. Communities will need to prepare an illicit Discharge Detection and Elimination (IDDE) Plan and consider illicit discharge ordinances. Souhegan River Watershed towns that are subject to EPA Phase II rules will need to continue working with NHDES to address illicit discharges.

9. Watershed Stewardship Programs

Watershed management plans will be successful only if there are engaged stakeholders, a defined and manageable geographic area, specific and realistic objectives, and a core organization with the capacity to implement the plan well into the future. The watershed management plan needs to generate an active process, which is adopted by the residents and town officials of each of the watershed communities. The Management Plan is a dynamic framework for watershed protection, which must constantly be revisited and revised as necessary to adapt to changes and to assimilate additional action plans. Adoption as part of the Master Plans of each community is important to assure that it is seen as a useful, guiding policy.

This can be accomplished by establishing a partnership between the key organizations and stakeholders. Fortunately the Souhegan Watershed Association and the Souhegan River Local Advisory Committee are currently active participants in protection of the river. Partnerships between these core organizations and other stakeholder groups will be key in adopting a watershed approach to protecting the Souhegan River. Specific objectives of a partnership for the Souhegan watershed should include:

- Education and outreach;
- Land preservation;
- Regulatory and compliance coordination;

- Watershed assessment; and
- Capacity building.

Numerous stakeholders in the watershed communities have identified these same objectives. The idea of a partnership is to bring all these parties together to facilitate a coordinated effort at the watershed level. Four towns in the watershed (Merrimack, Amherst, Milford, and Bedford) are designated as EPA Phase II communities. This means that these towns are mandated by EPA to implement six municipal stormwater control measures designed to improve surface water runoff from stormwater. These measures are important components of watershed protection and bring the Department of Public Works of these communities into the partnership with a vested interest in accomplishing the goals established by the partnership.

The Souhegan Watershed Association currently is involved with multiple education and outreach activities and it is expected that these activities will continue and be expanded. Some watershed organizations have requested and obtained funding for watershed coordinator positions. Coordinators are generally responsible for convening meetings, overseeing implementation of specific action plans and for building the capacity and membership of the watershed partnership.

Funding Opportunities
Funding assistance for watershed management is available from various government and private sources. The NHDES publication Non-point Source Pollution Guide for Citizens and Town Officials, January 2004 contains overview and contact information for financial assistance programs offered by the State of NH. The NHDES Watershed Assistance Section has awarded watershed assistance grants to local watershed organizations and New Hampshire communities to address non-point source pollution problems.

Funds for NHDES Watershed Assistance and Restoration Grants are appropriated through the U.S. Environmental Protection Agency under Section 319 of the Clean Water Act. Approximately $700,000 is expected to be available in 2006, contingent upon receiving federal funds. Approved projects must plan or implement measures that prevent, control, or abate NPS pollution. Projects should:

- be directed at encouraging, requiring, or achieving implementation of best management practices (BMPs), whether structural or non-structural, to abate land use management;
- be feasible, practical and cost effective; and
- provide an informational, educational, and/or technical transfer component.

Nonprofit organizations registered with the NH Secretary of the State and governmental subdivisions including municipalities, regional planning commissions, non-profit organizations, county conservation districts, state agencies, watershed associations, and water suppliers are eligible to receive Watershed Assistance and Restoration Grants. For more information, contact Eric Williams at 603/271-2358, ewilliams@des.state.nh.us or Jeff Marcoux at 603/271-8862, jmarcoux@des.state.nh.us.

CHAPTER 6 IMPLEMENTATION STRATEGIES

Based on the priority management issues, the following goals, objectives, and implementation strategies have been outlined. The goals, objectives, and strategies have been categorized using the *Eight Tools of Watershed Protection* developed by the Center for Watershed Protection. Each goal has one or more objectives followed by a number of strategies. Strategies are specific actions which can be implemented in order to meet the specific objective. Potential lead contact, organization, and partners describe the persons or groups who are likely to take the lead or be involved in implementing a specific strategy. Potential funding sources are listed where potential sources for financial support could be identified. Identifying all options for funding will be a primary responsibility of those taking a lead in implementing a specific strategy.

Time frames for Strategies are listed as short, medium, and long-term. Short term is estimated to be within the next year, medium is within the next three years, and long-term is within five years or ongoing. These time frames have been provided as general guidelines and are based on several variables including but not limited to time commitment from lead contacts, volunteers and available resources. While initiation of a strategy may include short-term action, completion will depend on many factors. One of the first implementation strategies is envisioned to be a meeting of the SoRLAC to discuss the Implementation Strategies and determine priorities. SoRLAC would also determine an action plan for recommending to each Corridor community that either all or part of the Management Plan be adopted as part of the community Master Plan.

To measure success and evaluate if steps are being taken to reach desired management priorities and goals, an annual audit of strategy actions taken by each watershed community is suggested. Benchmarks will need to be established by the person(s), organizations and partnerships that will be responsible for implementing each strategy based on dedicated resources, funding availability, time frames of grants, availability of volunteers, and other commitments from partnerships.

Goals, objectives, and strategies will need to be adjusted over time as conditions, information, priorities, and resources change.

1. Watershed Planning

GOAL: CONTINUE AND EXPAND WATERSHED PROTECTION ACTIVITIES, CONTINUE TO RAISE AWARENESS OF THE WATERSHED AND THE MANAGEMENT PLAN.

OBJECTIVE #1: COORDINATE THE DEVELOPMENT OF A PRIORITIZED LIST OF IMPLEMENTATION STRATEGIES.

Strategy:

A. The SoRLAC would meet to review the Implementation Strategies in detail and set priorities. A coordinated strategy would be discussed for meeting with each local Planning Board to recommend adoption of all or part of the Management Plan as part of their Master Plans. Based on the prioritized list of Implementation Strategies coordination with other key partners could be initiated and time frames for completion established.

Time Frame: Short-term

OBJECTIVE #2: ADOPTION OF THE MANAGEMENT PLAN AS PART OF EACH WATERSHED COMMUNITY'S MASTER PLANS.

Strategy:

A. Make presentations to the Planning Boards of the corridor towns to encourage the adoption of the Management Plan as part of their Master Plans.
B. Provide copies of the Management Plan to the Planning Boards and Display the Watershed Conditions and Assessment maps at town halls.

Potential Lead Contact, Organizations, and Partners: SoRLAC, SWA.

Time Frame: Short term

OBJECTIVE #3: OBTAIN FUNDING FROM NHDES WATERSHED ASSISTANCE AND RESTORATION GRANTS TO HIRE A SOUHEGAN RIVER WATERSHED COORDINATOR (SRWC) WHO WILL DRIVE THE IMPLEMENTATION ACTIVITIES.

Strategy:

A. Prepare and submit watershed assistance grant request to NHDES to fund a Souhegan River Watershed Coordinator position (SRWC). The SRWC would be the lead contact for the priority projects that SoRLAC identifies. The SRWC would assist partners in implementing projects. SRWC assistance may involve preparing grant requests for funding key projects.

Potential Lead Contact, Organization, and Partners: SoRLAC, SWA, NHDES

Potential Funding Sources: NHDES Watershed Assistance Grant or other available funding sources.

Time Frame: Short Term

GOAL: INCREASE UNDERSTANDING OF THE WATERSHED THROUGH RESEARCH AND MONITORING.

OBJECTIVE #1: ENHANCE EXISTING WATER QUALITY MONITORING PROGRAMS, CONDUCT RESEARCH, AND COMPILE DATA. UNDERSTANDING THE NATURAL RESOURCES WILL LEAD TO BETTER MANAGEMENT OF THE SOUHEGAN WATERSHED.

Strategy:

A. Request funding for the continuation and possible expansion of the water quality monitoring conducted by the Souhegan Watershed Association. Continue DNA investigations.
B. Secure funding for continued NHDES water quality monitoring and bioassessments. Funding would cover data analysis, compilation, and it's made available on the NHDES web site.
C. Obtain funding to develop a detailed drainage network map of intermittent and perennial streams and tributaries that can be used to guide water quality monitoring, road maintenance, stormwater management development review, and emergency response planning. Map can be used to promote the placement of adequate riparian buffers on streams.
D. Identify priority subwatersheds as a tool for prioritizing management strategies.
E. Establish a long-term, comprehensive testing protocol of all the tributaries leading to the Souhegan River. Focus monitoring on tributary and storm drain inflows, storm events, and the effectiveness of

existing stormwater treatment practices. Examine the quality of stormwater runoff at a subwatershed level. Identify hot spots.

F. Prioritize hot spots and recommend best management practices that address the pollutants identified at hot spots and water quality of impacted waters.

Potential Lead Contact, Organizations, and Partners: SRWC, Municipalities, SoRLAC, SWA, and the NRPC

Potential Funding Sources: Watershed Municipalities including the Department of Public Works, NH NHDES Drinking Water Source Protection Program, NH NHDES Watershed Assistance Program, Federal Targeted Watershed Grant Program, Private Sources.

Time Frame: Mid Term, and Long term

OBJECTIVE #2: CONTINUE THE COLLECTION AND COMPILATION OF DATA ON WATERSHED CONDITIONS AND ASSESSMENTS.

Strategy:

A. Continue to compile and inventory data and information on watershed resources. Encourage the completion of Natural Resource Inventories in all the watershed communities. Include historical and cultural information in inventory.
B. Inform the stakeholders and partners of the ongoing activity of the collection and compilation of information and data on watershed conditions and assessment. Request that reports, monitoring results, and other information be sent to the Souhegan Watershed Association, the Souhegan River Watershed Coordinator or the NRPC. Update inventory and maps as additional information is developed through such activities as water quality monitoring, studies done in the watershed communities, natural resource inventories, newly acquired protected parcels and easements, and plans developed by the NRPC and other organizations.
C. Continue to investigate the proposal by Pennichuck Water Works to remove the Merrimack Village Dam. Meet with Town officials, Pennichuck Water Works, NH Fish and Game, and other partners to fully understand and evaluate the impacts and possible benefits of the project. Develop a list of mitigation options and conditions to recommend pending final approval of the dam removal project.
D. Develop and host web page containing information and examples of implementation of the Management Plan.
E. Periodically contact the lead contact, organizations, and partners to obtain new data and information on watershed conditions, assessments, and activities. Conduct annual audits of activities or initiatives occurring within the watershed communities that are part of the Implementation Strategies. Obtain and document examples of success stories and impediments to implementation that can serve as models and learning curves for future actions.
F. Update GIS maps with new information.
G. Update any web sites hosting data or information regarding the Souhegan Watershed.
H. Update the Management Plan with new data and information.

Potential Lead Contact, Organization, and Partners: SRWC, Municipalities, SoRLAC, SWA, Audubon Society, NH Natural Heritage Bureau, UNH, NHDES, NRPC, Pennichuck Water Works.

Potential funding sources: NHDES Regional Environmental Planning Program

Timetable: Midterm, and Long-term

OBJECTIVE #3: DEVELOP PRESENTATIONS AND BROCHURES ON RESOURCES AND WATER QUALITY WITHIN THE WATERSHED AND THE BENEFIT OF A WATERSHED APPROACH FOR PROTECTION.

Strategy:

A. Identify and compile information on examples of successful watershed management practices in New Hampshire and other states. Document anticipated or realized benefits.
B. Design Watershed/Water Quality presentations and brochures. Use results obtained by SoRLAC survey to emphasize top concerns regarding the Souhegan River.
C. Make presentations and distribute brochures to Town Officials, Conservation Commissions, Department of Public Works, Planning Boards, Schools, Residents, and Businesses in the watershed municipalities.
D. Make presentation to Town Officials, Planning Boards, Board of Selectmen, Department of Public Works, Schools and other stakeholder and partner groups or organizations. Include watershed maps in presentation.
E. Host workshops targeted to all watershed municipalities to present information on watershed conditions and watershed planning techniques. Invite members of watershed planning organizations and outreach organizations such as the Center for Watershed Protection, NHDES Watershed Outreach Coordinator, NHDES Aquatic Education Coordinator, NH Department of Transportation (NHDOT) Public Information Officer to attend presentations.

Potential Lead Contact, Organizations, and Partners: SRWC, SoRLAC, SWA, NHDES, DOT

Potential Funding Sources: Municipal, NHDES

Time Frame: Midterm

OBJECTIVE # 4: GAIN A BETTER UNDERSTANDING OF CURRENT AND LIKELY FUTURE AMOUNTS OF IMPERVIOUS COVER IN THE WATERSHED AND BY SUBWATERSHED.

Strategy:

A. Conduct a simplified build-out analysis for priority sub-watersheds. Use this data to determine current and future amounts of impervious cover based upon current zoning and to increase understanding of the impacts associated with impervious cover.

Potential Lead Organizations, and Partners: SRWC, SWA, SoRLAC, Municipalities, NHDES, NRPC.

Potential Funding Sources: NHDES Regional Environmental Planning Program.

Time Frame: Mid-term

2. Land Conservation

GOAL: CONSERVE UNDEVELOPED AND SENSITIVE LAND WITHIN THE WATERSHED TO LIMIT IMPERVIOUS COVER AND MITIGATE THE EFFECTS OF URBANIZATION.

OBJECTIVE # 1: DEVELOP DETAILED GIS MAP OF PROTECTED LAND IN THE WATERSHED THAT INCLUDES EASEMENT AND TRAIL DATA.

Strategy:

A. Obtain funding from NHDES or other sources to create a detailed GIS map for the Souhegan Watershed showing protected land, easement, and trail data. Funding request would include compiling data on all existing protected lands, digitizing this data, and using GPS to digitize easement and trail data. Create both watershed and Town maps.
B. Use maps to estimate amount of impervious cover in the watershed or sub-watershed.
C. Incorporate water quality protection goals in municipality open space protection plans.

Potential Lead Contact, Organization, and Partners: SRWC, NRPC, Municipalities, SPNHF, NHDES

Potential Funding Sources: NHDES

Time Frame: Mid-term, Long-term

OBJECTIVE # 2: PROTECT LARGE TRACTS OF LAND IN THE WATERSHED THAT CROSS TOWN BOUNDARIES. ENCOURAGE TRAIL AND EASEMENT CONNECTIONS.

Strategy:

A. Meet with the Conservation Commissions, Open Space Committees, Trail Committees, and other land protection groups to show the watershed maps and provide a visual picture of land protection within the entire watershed. Support and encourage community goals for land protection and coordination as part of the goal to improve water quality throughout the entire watershed. Identify and prioritize target parcels that would create large tracts of protected land within the watershed. Request that data on protected parcels, easements, and trails be forwarded to the SRWC, SRWA, and the NRPC to update GIS maps.
B. Organize a workshop on "How Community Land Protection Data Can be Included in Souhegan Watershed GIS Maps". This workshop would provide information and training on formatting data to allow easy inclusion and updates of GIS maps. Land protection data would include purchased parcels, easements, and trails. The Souhegan Watershed Coordinator would develop and provide forms for communities to use in submitting data to update GIS maps using the UNH GRANITE data form as a starting point.

Potential Lead Contact, Organization, and Partners: SRWC, the NRPC, UNH, Conservation Commissions, Land Trusts, Open Space Committees, Trail Committees.

Potential Funding Sources: Municipalities, NHDES, LCHIP, UNH Cooperative Extension Community Conservation Assistance Program, NH DRED Forest Legacy Program, USDA Farmland Protection Program.

GOAL: TO IDENTIFY AND PROTECT WETLANDS WITHIN THE WATERSHED

OBJECTIVE #1: EVALUATE WETLANDS ZONING ORDINANCES IN EACH WATERSHED COMMUNITY AND ACTIVELY PURSUE STRENTHENING OF PROTECTION MEASURES.

Strategy:

A. Review current wetland regulations to evaluate the effectiveness of provisions in existing ordinances. Local ordinance may need updating or modifications to improve protection or provide more clarity.
B. Evaluate whether Designation of prime wetlands allowed under NHDES RSA 482-A:15 regulations would be a useful tool for protecting wetlands of high value. Provide information to towns on NHDES prime wetland designation process.
C. Obtain funding to identify and map wetlands as part of a Natural Resource Inventory or as an individual project. Obtain funding for Prime Wetlands studies if town decides to pursue that option.
D. Require Planning Boards in the watershed to condition approval of proposed projects in wetlands upon approval of State and Federal wetland permits.

Potential Lead Contact, Organization, and Partners: Conservation Commissions, Planning Boards, Municipal Officials, SoRLAC, SWA, NHDES

Potential Funding Sources: Municipalities, NH Fish a Game Department Fisheries Habitat Conservation Program.

Time Frame: Mid Term

GOAL: PROTECTION OF FLOODPLAINS TO AVOID OR MINIMIZE FLOODING IMPACTS AND TO PROTECT SENSITIVE AREAS.

OBJECTIVE: ENCOURAGE EACH TOWN IN THE WATERSHED TO ADOPT LOCAL FLOODPLAIN ZONING ORDINANCES WHICH ARE MORE STRINGENT THAN THE MINIMUM FEMA REQUIREMENTS.

Strategy:

A. Evaluate existing local floodplain ordinances and determine if the town should be encouraged to reevaluate the effectiveness of the provisions. Propose revisions where they are determined to be appropriate.
B. Educate local officials on the benefits of a resource protection oriented approach to regulating development in floodplains and to decrease cumulative impacts of the disturbance of these sensitive areas on downstream property owners.
C. Obtain funding to develop a Souhegan River and major tributaries flooding restoration plan. A Plan would spell out the necessary steps and coordination points between the communities. NHDES and NHDOT if a major flood were to occur and significantly impact the river and adjacent structures. Goal would be to provide a regulatory and action framework for balancing the maintenance and restoration of river functions and values with the need for short-term emergency repairs.

Potential Lead Contact, Organization, and Partners: Conservation Commissions, Planning Boards, Municipal officials, SoRLAC, SWA.

Time Frame: Mid Term

GOAL: PROPERLY MANAGE EROSION AND SEDIMENTATION RESULTING FROM DEVELOPMENT ACTIVITIES ON STEEP SLOPES.

OBJECTIVE #1: AVOID OR MINIMIZE SIGNIFICANT CUTS INTO SLOPES.

Strategy:

A. Evaluate the effectiveness of any provisions contained in local master plans or ordinances that encourage or impose limits on steep slopes.
B. Educate local officials on issues regarding development on steep slopes. Encourage awareness of the issue that alteration of steep slopes may result in accelerated runoff, erosion, or hillside slippage and that such processes may result in harmful consequences to the property of neighboring land owners, drainage concerns, and negative environmental effects such as siltation of rivers and streams.
C. Encourage the adoption of steep slope ordinances as a means of providing more explicit guidance to landowners as to the kinds of uses and minimum space standards which can be permitted in these areas.
D. Encourage the Planning Board to adopt provisions in the zoning ordinance to exclude slopes of 25% or more from calculations of buildable area of a lot.

Potential Lead Contact, Organization, and Partners: Conservation Commissions, Department of Public Works, Municipal Officials, SoRLAC, SWA.

Time Frame: Mid-term

GOAL: PROTECTION OF GROUNDWATER AND DRINKING WATER SUPPLIES

OBJECTIVE #1: ADOPT OR MODIFY AQUIFER PROTECTION OVERLAY DISTRICTS AS PART OF LOCAL ZONING ORDINANCES.

Strategy:

A. Evaluate existing local regulations to determine if provisions exist to provide adequate protection of aquifers, groundwater, and drinking water sources.
B. Encourage participation in the NHDES wellhead protection program by undertaking local inventories of potential threats to existing wells.
C. Educate local officials, citizens, and businesses on local groundwater resources and threats to contamination.
D. Encourage Planning Boards to adopt local protection measures to manage activities in wellhead areas.

Potential Lead Contact, Organization, and Partners: Public Health Officers, Department of Public Works Conservation Commission, SoRLAC, SWA, NHDES.

Time Frame: Short Term, Mid-term

3. Aquatic Buffers

GOAL: STRENGTHEN THE ENFORCEMENT OF CURRENT WETLAND AND SURFACE WATER BUFFER PROVISIONS IN LOCAL ORDINANCES.

OBJECTIVE #1: ENCOURAGE CONSERVATION COMMISSIONS AND PLANNING BOARDS TO ENFORCE RESTRICTIONS ON ACTIVITIES WITHIN BUFFERS.

Strategy:

A. Develop brochure on landowner responsibilities for maintaining and protecting buffers. Explicitly state which activities are not allowed such as dumping of leaves, mowing, use of pesticides, and removal of trees.
B. Obtain NHDES funding to design and purchase metal buffer plaques that can be installed on posts to mark buffers. Nashua has received a NHDES watershed assistance grant to cover the cost of supplies for marking buffers. Plaques can be installed on town owned land by DPWs or CC's and be required to be installed by developers on proposed subdivisions and other new developments. Developers can purchase plaques from the town. Benefit is having plaques be a consistent design. Marking of buffers can be a useful tool to assist enforcement of zoning ordinances.
C. Encourage Planning Boards to require that land containing wetland buffers be marked with plaques.
D. Encourage Department of Public Works to mark town-owned land containing buffers with plaques. This step can potentially be part of a town's compliance with EPA Phase II Stormwater rules.
E. Enforce provisions of local ordinances by sending notices of wetland or buffer violations.

Potential Lead Contact, Organization, and Partners: Conservation Commissions, Department of Public Works, Code Enforcement Officers, NHDES.

Potential Funding Source: NHDES Non-point Source Local Initiatives Grant (Section 319 Grants), Conservation License Plate Grant Program- NH State Conservation Committee, Department of Public Works.

Time Frame: Mid-term

GOAL: PROTECT SIGNIFICANT SHORELINES THAT ARE PARTICULARLY ECOLOGICALLY SENSITIVE.

OBJECTIVE #1: PROMOTE THE AWARENESS OF BUFFERS AS AN EFFECTIVE BEST MANAGEMENT PRACTICE FOR WATER RESOURCE PROTECTION.

Strategy:

A. Educate local officials, residents and businesses on the cost-effective benefits of buffers for the protection of water resources and avoiding or minimizing flood damage.
B. Compile examples of local shoreland and wetland overlay districts. Compare provisions for buffer protection and determine applicability to local goals and conditions.

Potential Lead Contact, Organization, and Partners: Conservation Commissions, Planning Board, SoRLAC, SWA.

Time Frame: Mid-term

OBJECTIVE #2: ENCOURAGE THE ADOPTION OF A LOCAL SHORELAND PROTECTION DISTRICT ADJACENT TO THE SOUHEGAN RIVER AND CONSIDER APPLYING THE DISTRICT TO TRIBUTARY STREAMS AND WATERBODIES GREATER THAN 10 ACRES.

Strategy:

A. Demonstrate the benefits of a local Shoreland Protection District Ordinance which is more stringent than the NHDES Comprehensive Shoreland Protection Act. Compile examples of local shoreland protection ordinance standards. Educate local officials on stricter standards and increased enforcement provisions in a local ordinance that better meet town goals compared to the standards in the NHDES CSPA.
B. Based on Town priorities and goals, develop a list of provisions which can be applied to shorelines as part of the ordinance. Provisions for prohibited uses, building set backs, erosion control, and the cutting and removal of natural vegetation within the natural woodland buffer should be included. Consideration to increasing the building setback for the Souhegan River from 50 feet under CPSA to 65 feet or more should be given. Exemptions for urbanized conditions can be afforded.
C. Make presentations to Planning Boards to recommend adoption of a Shoreland Protection Ordinance to be added to local Master Plans.
D. Work with local officials and Conservation Commissions to develop and recommend a Shoreland Protection District Ordinance, to Planning Boards.
E. Make Presentations at Planning Board meetings to raise awareness of town officials of where waterbodies traverse municipal boundaries. Encourage the Towns that share these resources to cooperate to adopt similar shoreland standards.

Potential Lead Contact, Organization, and Partners: Conservation Commissions, Planning Boards, SoRLAC, SWA.

Time Frame: Mid-term

OBJECTIVE #3: INCREASE PROTECTION OF WETLANDS AND STREAMS BY ADOPTING OR MODIFYING EXISTING ORDINANCES TO INCLUDE BUFFERS.

Strategy:

A. Evaluate existing ordinances to determine if buffer requirements are sufficient to protect wetlands from encroachment from development activities. The Center for Watershed Protection has useful information and links on the demonstrated benefit of buffers. Determine buffer width that is needed to protect the resource. Wetlands of different values can be provided appropriate buffers; the most significant and valuable wetlands should be provided the most protective buffers. Consider including protection for vernal pools and associated buffers.
B. Provide supportive information about the benefits of wetland and riparian buffer setbacks to the Planning Boards.
C. Provide supporting materials to encourage setbacks and buffer restrictions that are protective of the wetlands values and functions.

Potential Lead Contact, Organization, and Partners: Conservation Commission, Municipal Officials, SWA.

Time Frame: Mid-term

4. Better Site Design

GOAL: MAINTAIN OR IMPROVE WATER QUALITY AND HABITAT CONDITIONS IN THE WATERSHED BY MINIMIZING THE AMOUNT OF IMPERVIOUS COVER.

OBJECTIVE #1: INCORPORATE TECHNIQUES TO REDUCE IMPERVIOUS COVER AND/OR DIRECT RUNOFF ONTO PERVIOUS SURFACES IN THE DESIGN OF NEW DEVELOPMENT AND REDEVELOPMENT PROJECTS.

Strategy:

A. Collect Information on other NH community experiences with cluster developments. For example, in Bedford, cluster developments require a minimum open space of 25%, of which no more than half of that can be comprised of wetlands, surface waters, or steep slopes. Forty percent of the open space must be contiguous so that it is suitable for recreation, agriculture, and other activities. Bedford also requires a 50-ft. wide buffer around the lots and their adjacent neighbors or roads. Outcomes for cluster developments in other Souhegan watershed communities should be evaluated. In the Town of Windham, which is outside the watershed, clusters are common and conservation subdivisions are not required, but the majority of new subdivisions are classified as such. Windham requires 65% open space and a minimum of 10 acres that does not have to be contiguous. By following these practices, Windham has preserved almost 800 acres of open space in the last six years.
B. Encourage watershed communities to adopt cluster or conservation subdivision land use controls as alternatives to traditional tract development in order to preserve resources such as prime forest, agricultural lands as open space, and reduce impervious cover.
C. Encourage practices that limit impervious cover and promote infiltration. Examples include using permeable materials for spillover parking and reducing the required minimum width of pavement in low-density residential developments.

Potential Lead Contact, Organization, and Partners: Planning Boards, Conservation Commissions, Open Space Committees, SWA, NRPC.

Time Frame: Mid-term

GOAL: ENSURE NEW NON-RESIDENTIAL AND MULTI FAMILY DEVELOPMENTS MEET HIGH STANDARDS FOR DESIGN AND ENVIRONMENTAL PROTECTION.

OBJECTIVE #1: ENCOURAGE ALL WATERSHED COMMUNITIES TO ADOPT NONRESIDENTIAL SITE PLAN REGULATIONS.

Strategy:

A. Provide copies of the NRPC Model Non-Residential Site Plan Regulations to all watershed communities.
B. Provide information to Planning Boards on specific water quality benefits of the regulations.
C. Encourage Planning Boards to require Stormwater Management Plans as part of the site plan review process. Stormwater Management Plans can require the placement of oil traps in storm drains to handle parking lot and other site runoff in addition to other best management practices. The potential for runoff to have adverse impacts on adjacent properties can be reduced by requiring, through proper stormwater management practices, that all runoff is handled on-site with no net increase in off-site flow. Performance standards for erosion and sediment control and stormwater management should be incorporated into the site plan review regulations and applied to nonresidential and multifamily land uses.

Potential Lead Contact, Organization, and Partners: Planning Boards, NRPC, SWA.

Time Frame: Mid-term

GOAL: REDUCE POLLUTION OF WATER RESOURCES FROM LANDSCAPING CHEMICALS AND REDUCE WATER CONSUMPTION.

OBJECTIVE #1: ENCOURAGE THE ADOPTION OF LANDSCAPING REQUIREMENTS AS A TOOL TO PROTECT WATER QUALITY.

Strategy:

A. Prepare and present information to Planning Boards and citizens on the benefits of adequate top soil to reduce the need for excessive application of lawn chemicals and watering.
B. Encourage the adoption of subdivision/site plan review that requires 6 inches of top soil for landscaping.
C. Provide advice to citizens on proper use of lawn chemicals to prevent over treatment. Encourage local landscaping businesses and other organizations to make available a landscaping guidance brochure that informs residents and businesses of tips on how to prevent overuse of lawn chemicals.

Lead Contact, Organization, Partners: SRWC, SoRLAC, SWA, Planning Boards, Conservation Commissions, Landscape Companies.

Time Frame: Mid-term

5. Erosion and Sediment Control

GOAL: REDUCE POLLUTION FROM SITE DEVELOPMENT PROJECTS

OBJECTIVE #1: REQUIRE EROSION CONTROL BEST MANAGEMENT PRACTICES THROUGH THE DEVELOPMENT REVIEW PROCESS, INCLUDING CONSTRUCTION INSPECTION AND SITE STABILIZATION.

Strategy:

A. Evaluate the effectiveness of existing erosion control and sediment control requirements in local subdivision regulations and consider revisions to these requirements to include standards to meet water quality goals.
B. Present supporting information to the Planning Board to recommend revisions that address water quality goals such as standards to promote pretreatment, recharge, and infiltration practices.
C. Encourage the adoption of provisions within subdivision regulations that allow the Planning Board to require site specific and technical studies to be prepared by qualified consultants, at the expense of the applicant. These provisions should include the option for the Planning Board to require an independent review of those studies by a qualified consultant, hired by the Planning Board at the owner's expense.

Potential Lead Contact, Organization, and Partners: Planning Boards, Building Inspectors, DPWs, Contractors.

Time Frame: Mid-term, Long-term.

OBJECTIVE #2: INSPECTION AND ENFORCEMENT OF EROSION AND SEDIMENT BEST MANAGEMENT (BMPS) PRACTICES DURING CONSTRUCTION.

Strategy:

A. Develop local guidance or requirements on types of erosion and sediment control practices that must be used.
B. Inspect construction sites for compliance with sediment and erosion control on a regular basis and after each major rain event.
C. Provide training on BMPs for erosion control inspectors and contractors.
D. Encourage local construction companies to obtain training on BMP and EPA Stormwater Pollution Prevention Plan requirements. Request copies of plans on large projects and those adjacent to sensitive areas.
E. Encourage contractors and homebuilders to develop subcontractor trade sheets that explicitly state what the company expects from subcontractors in terms of protecting the quality of stormwater runoff from construction sites. Trade sheets can be tailored to the subcontractors' specialties, such as painting, stucco, or concrete.
F. Encourage towns to hold pre-construction meetings with contractors to review BMPs and emphasize daily maintenance.
G. Encourage contractors and homebuilders to train subcontractors on BMPs. Encourage the requirement that subcontractors sign a statement that they and their employees will comply with NPDES and other regulations to protect water quality when they work on sites.
H. Train members of SoRLAC on proper installation and maintenance of erosion and sediment control BMPs. Encourage the Planning Boards or Planning staff to inform SoRLAC of all construction activities within the quarter mile Corridor and allow them an opportunity to provide comment to these local Boards or staff. Encourage that arrangements/approvals be made for SoRLAC members to accompany the Planning board or staff on site inspections at priority sites. Currently SoRLAC only submits comments to NHDES on projects that disturb more than 50,000 square feet and require a NHDES Dredge and Fill or Alteration of Terrain permit.

Potential Lead Contact, Organization, and Partners: Planning Boards, Building Inspectors, DPWs, Contractors.

Time Frame: Mid-term, Long-term

GOAL: RESTORE STREAM FUNCTIONS THAT HAVE BEEN DAMAGED BY EROSION AND SEDIMENTATION

OBJECTIVE #1: DEVELOP A SYSTEM FOR EVALUATING AND RANKING POTENTIAL RESTORATION SITES

Strategy:

A. Obtain funding to put together a Stream Team for the Souhegan River to focus on river restoration and streambank stabilization and provide a venue for communication among river management stakeholders.
B. Provide and promote education, training and technical assistance to SoRLAC and SWA regarding natural stream channel design and restoration.

Potential Lead Contact, Organization, and Partners: SoRLAC, SWA, NHDES, NH Fish and Game, NH Department of Transportation, US Forest Service, Trout Unlimited, US Army Corps of Engineers, UNH, Consulting Companies.

Potential funding Sources: NHDES Watershed Assistance Restoration Grant.

Time Frame: Mid-term, Long-term

6. Stormwater Management

GOAL: REDUCE POLLUTION FORM NON-POINT SOURCES IN THE WATERSHED

OBJECTIVE #1: REDUCE POLLUTION DURING THE CONSTRUCTION PHASE OF SITE DEVELOPMENT PROJECTS

Strategy:

A. Obtain funding to train local officials, DPWs, Planning Board Members, Conservation Commissions on Stormwater BMPs.
B. Require erosion control BMPs through the development review process, including construction inspection and site stabilization.
C. Encourage watershed communities to update the development review process to include erosion control from construction to site stabilization.
D. Encourage that BMPs are incorporated in all land use activities including land use planning, zoning, and subdivision/site plan reviews.
E. Develop a checklist for inspectors to use during site visits. A sample checklist has been included in Appendix X.
F. Promote consistent application of the provisions of the Shoreland Protection Act. Educate Planning Board on provisions of both local buffer and setback requirements and NHDES Comprehensive Shoreland Protection Act requirements and the applicable waterbodies.

Potential Lead Contact, Organization, and Partners: Planning Boards, Building Inspectors, Code Enforcement Officers.

Time Frame: Mid-term, Long-term

OBJECTIVE #2: REDUCE POLLUTION FROM POST CONSTRUCTION SITE DEVELOPMENT PROJECTS

Strategy:

A. Adjust the Site Plan Review/Subdivision Plan Review Processes to encourage designs which maintain existing hydrologic processes and functions.
B. Educate town officials and Planning Boards on Low Impact Development Techniques. Hold Workshops to demonstrate options and showcase success stories.
C. Encourage publicity in town web sites, newspapers, and pamphlets on low impact designs. Provide information on contractors and suppliers of low impact techniques or materials.
D. Encourage better site design for residential lot conversion which incorporates BMPs for stormwater management and erosion control.
E. Update the Building Permit process and provide education to promote changes.
F. Encourage the use of stormwater design criteria in regulations to achieve EPA Phase II Stormwater Compliance and promote low impact development.
G. Use the model stormwater technical design criteria provided in appendix X as starting point to develop criteria.

H. Encourage the requirement of an operation and maintenance agreement between the permitting agency and owner, builder, or homeowner's association that include penalties for non-compliance.
I. Identify a candidate site the Souhegan River Corridor for installing a bioretention area to demonstrate its benefits and functions. Bioretention cells are depressed areas, generally about 6 inches used as infiltration or with an underdrain filter. Plants used in the cells should tolerate wet and dry conditions. An example of a bioretention area can be seen adjacent to the front parking lot at Pennichuck Square on Route 101A.
J. Work with developer and owner to obtain funding from NHDES to offset costs of bioretention area installation.
K. Promote publicity of benefits of bioretention area.

Potential Lead Contact, Organization, and Partners: SRWC, SoRLAC, SWA, Town officials, DPWs, Conservation Commission, NHDES, Private Landowner, Developer.

Potential Funding Sources: NHDES Watershed Assistant Grants.

Time Frame: Mid-term

OBJECTIVE #3: REDUCE THE QUANTITY OF POLLUTANT INPUTS (E.G. SALTS, NUTRIENTS, METALS, OILS, GREASE, AND VOLATILE ORGANIC COMPOUNDS) FROM ROAD SYSTEMS.

Strategy:

A. Encourage the implementation of a comprehensive road maintenance management program in the watershed which safeguards public safety, identifies sensitive areas, identifies corresponding low salt zones, and uses techniques for minimizing the use of deicing materials.
B. Encourage new road designs that limit impervious cover and minimize negative environmental effects.
C. Dispose of material from street sweeping, the cleaning of catch- basin sumps, and snow collection in an environmentally sound manner.

Potential Lead Contact, Organization, and Partners: Watershed municipalities, NHDES, NH DOT, Planning Boards, Selectmen.

Time Frame: Mid-term, Long-term

7. Non-Stormwater Discharges

GOAL: LOCATE, QUANTIFY, AND CONTROL NON-STORMWATER POLLUTANT SOURCES IN THE WATERSHED.

OBJECTIVE #1: ELIMINATE TRASH AND DEBRIS FROM THE SOUHEGAN RIVER AND TRIBUTARIES .

Strategy:

A. Obtain funding for a trash and debris survey.
B. Organize annual clean-ups with volunteers and municipal officials. Contact private landowners to encourage that they remove trash on their land as part of a multi-town initiative to keep the Souhegan River and other rivers and streams in the watershed clean of trash. Publicize clean-up activities and provide positive publicity for private landowners and businesses that participate and cooperate with trash removal and prevention efforts. Clean-ups could be part of community Earth

Day events. Target the edge of the Souhegan River and/or tributaries to at least 50 feet beyond the edge of the stream.

C. Identify and notify landowners to encourage removal of trash and debris. Volunteer efforts may also be used for some clean-up work.
D. Encourage community publicity of clean-up events.
E. Request assistance from AmeriCorp volunteers and other organizations that volunteer community hours.

Potential Lead Contact, Organization, and Partners: SRWC, SoRLAC, SWA, Volunteers, Businesses.

Time Frame: Mid-term, Long-term

OBJECTIVE #2: REDUCE POLLUTANTS ENTERING WATERWAYS FROM STREET SANDING OPERATIONS, DEICING OPERATIONS, AND ANIMAL WASTE

Strategy:

A. Initiate or continue a litter management program by street sweeping downtown and other key areas on a regular basis.
B. Promote the use of non-chloride deicing materials adjacent to sensitive areas such as streams, wetlands, and floodplains. Promote street sweeping to remove sand from entering wetlands and streams.
C. Review snow-dumping procedure to promote snow storage in areas away from surface waters.
D. Promote town wide programs to clean catch basins.
E. Inspect storm drains on a regular basis.
F. Encourage the adoption of a "pooper scooper" ordinance.
G. Develop a ditch/swale inspection and cleaning program.

Potential Lead Contact, Organization, and Partners: Municipalities, DPWs, Stormwater Committees, Conservation Commissions.

Time Frame: Mid-term

OBJECTIVE #3: REDUCE POLLUTANTS ENTERING WATERWAYS FROM ILLICIT DISCHARGES

Strategy:

A. Obtain funding to identify and map outfalls and their connections on the Souhegan River and its major tributaries. The pipe survey conducted as part of the 1999 Shoreline Survey prepared by SWA and NRPC should be used as baseline data to identify areas that will need future attention and monitoring. A more detailed survey may be needed to gain an understanding of sources of pollutants entering the stream and feasible remediation options. Future surveys should include GPS data points to identify outfalls that can be added to GIS maps.
B. Compile sample illicit discharge and detection and elimination plans (IDDE) from other communities.
C. Prepare an IDDE plan.
D. Review illicit discharge provisions in local ordinances.
E. Initiate or continue dry weather field survey of outfalls.

F. Conduct sampling of dry weather discharges and attempt to trace source of illicit discharges.
G. Remove illicit discharges as budgetary funding allows.

Potential Lead Contact, Organization, and Partners: Watershed Municipalities, NHDES

Potential Funding Sources: NH DES Drinking Water Source Protection Program, NH DES Watershed Assistance Grants, EPA Targeted Watershed Grants Program.

Time Frame: Mid-term, Long-term

OBJECTIVE #4: REDUCE NUTRIENT, BACTERIA, AND VIRUS INPUTS FROM SEPTIC SYSTEMS.

Strategy:

A. Develop and implement a septic system inspection program to identify failed systems in the 250 foot shoreland zone around the Souhegan River and other waterbodies covered under the NHDES CSPA.
B. Use water quality monitoring data obtained by SWA to identify failing systems along the Souhegan River.
C. Tie inspection of septic systems to the building permit process for additions and changes to existing buildings.
D. Establish a finance program for cases of economic hardship.
E. Educate homeowners about septic systems use and maintenance.

Potential Lead Contact, Organization, and Partners: Watershed Municipalities, SoRLAC, SWA, Homeowner Associations.

Potential Funding Sources: In-kind support, NH DES Small Outreach and Education Grant Program for Non-point Source Pollution.

Time Frame: Mid-term, Long-term

OBJECTIVE # 5: PREVENT OR REDUCE POLLUTANTS FROM ENTERING WATERWAYS FROM CHEMICAL SPILLS

Strategy:

A. Encourage Fire Department to develop a spill response plan that identifies all catch basins leading to the Souhegan River and other water bodies.
B. Require that all firms handling hazardous materials have HazMat plans and properly handle the materials.

Lead Contact, Organization, and Partners: Watershed Communities, Fire Departments, DPWs.

Time Frame: Mid-term

OBJECTIVE #6: REDUCE INPUTS OF VOLATILE ORGANIC CHEMICALS FROM RESIDENTIAL HEATING FUEL STORAGE AND USE.

Strategy:

A. Encourage the adoption of an ordinance which requires that new installations for residential heating fuel storage and replacement must either be double-walled tanks or secondary containment, be weather protected if located outdoors, and have encapsulated lines.
B. Ensure local enforcement of state code requirements for oil burning equipment installations and tank replacements (e.g. fill alarms with audible whistle, use of UL approved tanks, protected lines).
C. Encourage inspections and testing of residential heating fuel tanks.
D. Educate homeowners about spill liability, methods of secure storage and spill prevention, how to get tanks inspected, how sump pumps can contaminate water resources, what to do if a leak is found, and permit and code requirements.
E. Educate local residential heating fuel distributors about the locations of sensitive areas and public water supplies. Remind companies about spill reporting requirements.

Potential Lead Contact, Organization, and Partners: Selectmen, Water Departments, Building Inspectors, Code Enforcement Officers, Fire Departments, Oil Industry, SoRLAC, SWA.

Potential Funding Sources: NH Small Outreach and Education Grants for Non-point Source Pollution.

8. Watershed Stewardship Programs

GOAL: DEVELOP STORMWATER AND WATERSHED EDUCATION OR OUTREACH PROGRAMS TARGETED TOWARDS FOSTERING HUMAN BEHAVIOR THAT PREVENTS OR REDUCES POLLUTION OVER A RANGE OF LAND USES AND ACTIVITIES.

OBJECTIVE #1: PROMOTE AWARENESS OF THE WATERSHED AND THE SOUHEGAN RIVER WATERSHED MANAGEMENT PLAN.

Strategy:

A. Have SoRLAC write a letter to the Planning Boards of each watershed town encouraging them to incorporate the Souhegan River Management plan into each of their Master Plans by reference or formal incorporation. Provide a printed copy of the plan as well as in electronic format. Conduct a follow up process through phone calls and meetings, if necessary. Send letters announcing the Souhegan Watershed Management Plan with a copy of the Executive Summary to all Conservation Commissions, DPWs, and Environmental Organizations. Highlight that a copy of the plan is available on the NRPC and NHDES web site.
B. Encourage watershed Planning Boards to incorporate the Implementation Strategies into planning decisions.
C. Request funding for the notification of the residential and business communities of the watershed towns of the Management Plan.
D. Design a Souhegan River Watershed logo.
E. Design, print, and distribute Souhegan Watershed brochures showing watershed boundaries and significant resources.
F. Encourage Corridor communities to post Souhegan River signs adjacent to the river.

G. Encourage Towns to post signs at recreational sites along the Souhegan River that inform users of the watershed boundaries and requesting the cooperation in keeping the area litter free and avoiding eroding or damaging the area.
H. Post copies of the watershed map at Town Halls and other public places to encourage an awareness of the watershed.
I. Send articles at least four times a year to local newspapers to be published that highlight or showcase activities in the Watershed.
J. Encourage additional membership in the Souhegan Watershed Association.
K. Develop a mailing list of residents and businesses within a quarter mile corridor of the Souhegan River to mail informational brochures, surveys, and notification of the Management Plan.
L. Develop an e-mail list of town officials and citizens who responded to the SoRLAC survey and provided an e-mail contact information. Send notification of the Management Plan to these contacts and encourage them to become involved in the implementation of the Plan. Encourage other interested citizens and businesses to add their names to the email mailing list so they are informed of watershed related public meetings and other activities.
M. Create and present several versions of a presentation about the Watershed and the Management Plan targeted to audiences such as Channel 9, local newspapers, radio shows, local TV channels, schools, community organizations, Rotary and Chamber of Commerce, Downtown Groups, Canoe and Kayak Groups and Equipment Stores, and Fishing Equipment Stores. Encourage awareness of the Watershed and encourage participation in the implementation of the management strategies.
N. Design and develop a self-guided map for tours of the Souhegan River Corridor which includes routes and interpretative information.
O. Coordinate River festivals involving businesses, education, and environmental groups.
P. Encourage policing and patrolling of recreational sites to reduce abuses and littering.

Potential Lead Contact, Organization, and Partners: SRWC, SoRLAC, SWA, Residents, Businesses, Environmental Groups, NHDES.

Potential Funding Sources: Donations, In-kind services, NHDES Watershed Grant, fundraising.

Time Frame: Mid-term, Long-term

OBJECTIVE #2: INCREASE AWARENESS OF THE RESIDENTIAL AND BUSINESS COMMUNITY OF NON-POINT SOURCE POLLUTION.

Strategy:

A. Request funding for storm drain stenciling projects and associated outreach in high visibility Souhegan River Watershed neighborhoods.
B. Work with corridor DPWs to locate target Watershed neighborhoods with high visibility, safe traffic, and appropriate storm drains for stenciling.
C. Design, develop, print, and distribute brochures on the threat from non-point source pollution to water quality in the watershed. Mail brochures to residents abutting the Souhegan, tributaries and other sensitive areas.
D. Promote awareness of impaired and threatened waters by displaying watershed assessment map.
E. Prepare press releases to highlight water quality threats of non-point source pollution.
F. Work with SWA to emphasize stormwater threats during the Salmon Release Program.

G. Develop a presentation for elementary schools addressing clean water needs of fish and how stormwater can be a problem. Make presentations during Clean Water Week.
H. Run three videos on Cable Access TV or in the schools "After the Storm", "Stormwater is Never Away", and "A River Reborn".
I. Create a presentation board for display in city halls, libraries, and at other functions where the public is gathered to teach about Non-point Source Pollution.
J. Work with local landscape companies and other businesses to develop a display board or brochures on environmentally sensitive landscape techniques. Low impact techniques such as permeable pavers for driveways and walkways can also be showcased. Provide information on companies that provide the design or supplies for these techniques. Work with businesses to display educational materials. Send press releases to local newspapers to recognize partners and mention which businesses made contributions.

Potential Lead Contact, Organization, and Partners: SRWC, SWA, Businesses, DPWs, citizens, libraries, local newspapers, Radio shows, Schools.

Potential Funding Sources: Donations, Volunteers, In-kind services, DPWs.

Time Frame: Mid-term, Long-term

OBJECTIVE #3: INCREASE ACCESS TO THE SOUHEGAN RIVER CORRIDOR FOR PASSIVE AND EDUCATIONAL ACTIVITIES AND EDUCATE THE USERS OF THE BIKE/FOOTPATHS ABOUT THE WATERSHED AND ECOSYSTEM.

Strategy:

A. Identify all bike paths and walking trails in the corridor.
B. Identify ownership of trail areas and easements and determine areas that are publicly available to walk or bike.
C. Provide information in a format that can be made into digital maps to the NRPC to place trails on the existing map with other attributes such as roadways and landmarks. The use of GPS to digitize trail and easement data may be useful to add them to existing maps.
D. Make maps available on town and the NRPC web sites and in print form at public locations.

Potential Lead Contact, Organization, and Partners: Conservation Commissions, Open space Committees, Bike Groups, Snowmobile Clubs, Businesses, the NRPC.

Potential Funding Sources: Contributions, In-kind Services, Fundraising, NHDES grants.

Time Frame: Mid-term, Long-term

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CHAPTER 7 MEASURING RESULTS

The next step is to meet with local officials to recommend that the Souhegan River Management Plan be adopted as part of each community Master Plan. To begin implementing the management strategies a public outreach campaign will be needed with town boards, citizens and businesses in the watershed communities. It is important that the Souhegan River Local Advisory committee continue to be active in order to initiate implementation of the strategies. In order to assess the status of implementing the strategies a yearly watershed audit is recommended that documents all activities and outcomes that have occurred toward implementing each strategy. The audit would consist of a checklist of actions taken within the previous year that were taken as part of implementing a goal or associated objective.

The checklist would include a description of the action, steps taken to complete the action, who was involved and expected benefits. Expected benefits would include but are not limited to:

- Pollutant load reductions;
- Increased awareness of the watershed boundaries and characteristics;
- Increased landowner education on the need for stewardship adjacent to surface waters;
- Improved trail access and connections along the Souhegan River;
- Increased recreational opportunities in the Souhegan River corridor;
- Increased community awareness of runoff as a source of water pollution and specific actions that can be taken prevent problems;
- Adoption of new practices to reduce non-point source pollution from residential or nonresidential developments;
- Increase media coverage of watershed opportunities, threats and steps taken to implement the Management Plan;
- Additional education in schools, school programs on practices to prevent water quality problems;
- Less litter and debris near surface waters;
- Improved conservation planning in utility and road projects;
- Stronger local regulations to protect the watershed;
- Stricter enforcement of local and state regulations;
- More incentives for landowners to voluntarily manage land appropriately; and
- Continued protection of sensitive land in the watershed with conservation easements and other methods.

Pollutant Load Reduction Estimates

In conducting the annual audit, the benefit of reduced pollutant loads would have both qualitative and quantitative components. The first component would be qualitative and consist of documenting pollutant load benefits that are expected to result from such actions as installing buffer signs, removing debris and litter, using less chemicals on residential lawns and public lands, sweeping streets and other practices that are anticipated to prevent or reduce pollutants from entering wetlands and surface waters. A second quantitative component would be estimates of pollutant load reductions from the implementation of BMP projects intended to control sediments and/or nutrients. The recommended tool to accomplish this is using the methods described in the EPA "Region 5 Model" and/or the Water Erosion Prediction Project (WEPP) computer model to estimate NPS load reductions. These models are described at websites http://it.tetratech-ffx.com/stepl/ and http://forest.moscowfsl.wsu.edu/fswepp/.

The model can be used to assess potential pollutant load reductions for specific BMP's. For instance, the projected amount of pollutant reduction that could conceptually be gained by installing a buffer strip adjacent to a golf course can be calculated using this model. In addition to assessing site specific impacts, the model can be used to educate and train public officials, landowners and other groups to the potential benefits of best management practices.

Another tool to estimate pollutant load reductions is to use the Median Pollutant Removal percentages for treatment best management practices that have been provided in Table 7-1.

Table 7-1: Pollutant Removal for Treatment BMP's

	Median Pollutant Removal %						
Treatment BMP	**Total Suspended Solids**	**Total Phosphorous**	**Soluble Phosphorous**	**Total Nitrogen**	**Nitrate**	**Copper**	**Zinc**
Stormwater Detention Ponds	47	19	6	25	4	26	26
Stormwater Retention Pond	80	51	66	33	43	57	66
Stormwater Wetlands	76	49	35	30	67	40	44
Water Quality Swales	81	34	8	8	31	51	71
"Vegetated " Buffer (30 feet)	58-95	19-80	---	7-77	19-80	---	---

Source for Treatment BMP's: Brown and Shueler 1997

Source for Vegetated Buffer Treatment level: Dilaha et al. 1988

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APPENDIX A-1

WATERSHED CONDITIONS MAP

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APPENDIX A-2

WATERSHED ASSESSMENT MAP